Sardar Patel University Mandi

District Mandi -175001 (HP) India

www.spumandi.ac.in

(Established Under H.P. Legislative Assembly Act 03 of 2022)

Syllabus for M.Sc. Physics
2 Years (CBCS)
Session 2022-23 Onwards

Faculty of Physical Sciences
Sardar Patel University Mandi (HP)

Sardar Patel University
Mandi-175001

FACULTY OF PHYSICAL SCIENCES

SYLLABI

FOR

M.Sc. Physics
(Semester System)

CREDIT BASED SYSTEM

(Effective from Session 2022-23 and Onwards)

DEPARTMENT OF PHYSICS

Sardar Patel University

Annexure- 1

Sardar Patel University

Courses of Study and Syllabi for M. Sc. Physics

Semester-I		Max. Marks	**(Credits)**
Course-PHYMS-I01	Mathematical Physics	80+ 20 I.A	**(4)**
Course- PHYMS-I02	Classical Mechanics	80+ 20 I.A	**(4)**
Course- PHYMS-I03	Electronics- I	80+ 20 I.A	**(4)**
Course- PHYMS-I04	Computational Methods in Physics	80+ 20 I.A	**(4)**
Course- PHYMS-I05	Laboratory	80+ 20 I.A	**(6)**

Additional Optional Course I-PHYMS-I06
Computer Application in Physics Nodal Center based — 80 (Theory 40 + Practical40) + 20 I.A **(3)**

Semester-II			
Course- PHYMS-201	Quantum Mechanics-1	80+ 20 I.A	**(4)**
Course- PHYMS-202	Condensed Matter Physics	80+ 20 I.A	**(4)**
Course- PHYMS-203	Statistical Physics	80+ 20 I.A	**(4)**
Course- PHYMS-204	Electrodynamics	80+ 20 I.A	**(4)**
Course- PHYMS-205	Laboratory	80+ 20 I.A	**(6)**

Additional Optional Course-II - PHYMS-206
Computer Application in Physics Nodal Center based — 80 (Theory 40+ Practical 40) + 20 I.A **(3)**

Semester-III			
Course- PHYMS-301	Quantum Mechanics-II	80+ 20 I.A	**(4)**
Course- PHYMS-302	Material Science	80+ 20 I.A	**(4)**
Course- PHYMS-303	Nuclear Physics	80+ 20 I.A	**(4)**
Course- PHYMS-304	High Energy Physics	80+ 20 I.A	**(4)**

Course- PHYMS-305 Laboratory	80+ 20 I.A	**(6)**

Semester-IV

Course- PHYMS-401 Electronics –II	80+ 20 I.A	**(4)**
Course- PHYMS-402 Elective Papers one of the following	80+ 20 I.A	**(4)**

i) PHYMS-402 (a) Advanced High Energy Physics
ii) PHYMS-402 (b) Nuclear & Particle Astrophysics
iii) PHYMS-402 (c) Advanced Quantum Mechanics

Course- PHYMS-403 Elective Papers one of the following	80+ 20 I.A	**(4)**

i) PHYMS-403 (a) Nano Physics
ii) PHYMS-403 (b) Mesoscopic Physics
iii) PHYMS-403 (c) Advanced Computational Physics .

Course- PHYMS-404 Elective Papers one of the following	80+ 20 I.A**.**	**(4)**

i) PHYMS-404 (a) Advanced Nuclear Physics
ii) PHYMS-404 (b) Nuclear Technology
iii) PHYMS-404 (c) Opto – Electronics

Course- PHYMS-405 **Project**	100	**(10)**

Note: *Each theory course is given 4 credits as per 4 hours of lectures per week and each practical course is given 6 credits for 12 hours of engagements per week. The Project work in the IV semester is given 10 credits for 20 hours of engagement per week. Therefore M.Sc in Physics programme is given 92 credits. Student will have to earn 92 credits to pass M.Sc. Physics programme. Nodal Centre based Additional Optional course is given 3 credits each.*

Program Outcomes

1. Becoming Masters of physics by gaining advanced knowledge of the courses proposed in the syllabus.
2. Developing analytical thinking to correlate experimental and theoretical aspects of various specialized branches of physics
3. Developing integrative approach while learning diverse courses which leads to unified thinking towards Physics and all natural phenomena.
4. Learning basic aspects of various courses to develop problem solving aptitude to strengthen the learning of Physics
5. Apply the knowledge and skill in the design and development of Electronic circuits and characterization of material properties
6. Becoming professionally trained in the various specialized areas of physics for their application in industry.
7. To develop inter-disciplinary outlook, collaborative thinking and team work for quality research output
8. Becoming aware and successful in their career outlets in India and abroad as excellent professionals such as Scientists, scientific officers (in BARC, ISRO, DRDO, Meteorology & Geology, and Forensic Sciences etc.), teachers and technicians
9. To develop rational thinking and scientific temperament in all pursuits of life of aspirants for their own benefit and society.
10. Demonstrate highest standards of ethical conduct and professional behaviour, critical, interpersonal and communication skills as well as a commitment to life-long learning.

Program Specific Outcome for M.Sc. Physics:

1. Understanding the basic concepts of physics particularly in Mathematical Physics, quantum mechanics, computational physics, electronics, electrodynamics and statistical physics and to realize how diverse phenomena observed in nature can be derived from a small set of fundamental laws
2. Learn to carry out experiments in basic as well as certain advanced areas of physics such as condensed matter physics, nuclear physics and electronics
3. Learning computational modelling for the purpose of research in the frontline specific areas of the Physical Sciences
4. A career oriented learning that develops analytical and problem-solving skills that contributes to the professional development of aspirants

SEMESTER- I

<table>
<tr><td>Course Code</td><td colspan="2">PHYMS-101</td><td>No. of hour per semester</td><td>52</td></tr>
<tr><td>Name of the course</td><td colspan="4">Mathematical Physics</td></tr>
<tr><td>Duration of the Course</td><td colspan="4">One Semester (13 Weeks)</td></tr>
<tr><td>Lectures to be Delivered</td><td colspan="2">39 (13 X 3)</td><td colspan="2"></td></tr>
<tr><td>Tutorial</td><td colspan="2">13 (13 X 1)</td><td colspan="2"></td></tr>
<tr><td>Semester End Examination</td><td colspan="2">Total Maximum Marks = 100
Credits = 4</td><td colspan="2">Pass Marks</td></tr>
<tr><td rowspan="3"></td><td>Theory</td><td>MM 80</td><td colspan="2">32</td></tr>
<tr><td>Internal Assessment</td><td>MM 15</td><td colspan="2">06</td></tr>
<tr><td>Attendance</td><td>MM 5</td><td colspan="2">----</td></tr>
</table>

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Have good understanding of basic elements of complex analysis and make use of Cauchy Integral theorem and Residue Theorem to compute certain types of integrals.
2. Build vector spaces and matrices, identify their properties and solve the problems using matrix methods.
3. Get introduced to special functions like beta, gamma, Laguerre, Bessel, Legendre and Hermite functions.
4. Utilize the Fourier and Laplace transforms to solve differential equations.
5. Make use of Green's function to solve scattering problems in Physics.
6. Get familiarize with group theory.

Section A

Complex Variables:

Analyticity of the function of a complex variable, Cauchy integral theorem and formula. Expansion of an analytic function; Taylor and Laurent series. Residue theorem, contour integration, Jordan Lemma. Applications in evaluation of definite integrals. Dispersion relation, saddle point method.

Vector Spaces:

Vector Spaces and Matrices; linear independence, Bases; dimensionality; inner product; linear transformations. Matrices; Inverse; Orthogonal and Unitary matrices; Independent elements of a matrix; Eigen-values and eigen-vectors; Diagonalization; Complete orthonormal set of functions.

Section B

Special and Orthogonal Functions:

Partial differential equations, separation of variable technique in Cartesian, Spherical, Cylindrical Coordinates. Special functions related to these equations (Laguerre, Bessel's, Legendre and Hermite) and their applications to boundary value problems, Sturm-Liouville theory and orthonormal eigen-functions. Beta and Gamma functions. Fourier and Laplace transforms and their properties. Applications of Laplace Transforms to solve differential equations.

Section C

Green's Function:

Non homogeneous boundary value problems and Green's functions in one dimension. Eigen-function expansion of Green's function. Fourier transform method of constructing the Green's function, Green's function in 3-dimensions, application to scattering problem

Group Theory:

Postulates, multiplication tables, subgroup, direct product group, isomorphism and homomorphism. Representation of a group, Schur's Lemma and orthogonality theorem (Statement only), reducible and irreducible representation. Permutation group C42 group (group of the symmetry of a square), Lie group, Lie algebra, orthogonal groups and unitary group.

***Books Recommended*:**

1. G. Arfken: Mathematical Methods for Physicist 4^{th} edition (Academic Press).
2. J. Mathews and R. L. Walker: Mathematical Methods of Physics (I. B. House Pvt.Ltd.).
3. C. Harper: Introduction to Mathematical Physics (Prentice Hall of India).
4. A. W. Joshi: Vectors & Tensors (Wiley Eastern Limited).
5. A. W. Joshi: Elements of Group Theory (Wiley Eastern).
6. Riley, Hobson & Bence: Mathematical Methods for Physics and Engineering (Cambridge University Press)

***NOTE**: - In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	PHYMS-102		No. of hour per semester	52
Name of the course	**Classical Mechanics**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Understand the limitations of Newtonian mechanics in modern branches of Physics such quantum mechanics, statistical physics, electrodynamics etc.
2. Realize significance of Lagrangian and Hamiltonian formulations in macroscopic (classical) and microscopic physics.
3. Use Lagrangian and Hamiltonian formulations in solving mechanics problems such as central force problem, Kinematics and Dynamics of Rigid bodies etc.
4. Realize the significance of advanced formulations of mechanics such as Hamilton-Jacobi theory in handling periodic motion problems.
5. Understand the role of canonical transformation in describing the motion of a system and symmetry properties.
6. Use Lagrangian and Hamiltonian formulations to describe continuous systems so as to understand basic concept of Classical Field Theory

Section A

Variational Principles and Lagrangian Formulation of Mechanics:

D'Alembert's Principle and Lagrange's equations. Constraints and generalized coordinates. Calculus of variations, Hamilton's principle and derivation of Lagrange's equation from it. Extension to non-holonomic and non-conservative systems. Symmetry properties of space and time and the corresponding theorems (with reference to cyclic coordinates). Simple applications of Lagrangian formulation for a single particle and a systems of particles. Lagrangian formulation of relativistic mechanics.

Central Force Problem:

Equations of motion and first integrals. Equivalent one dimensional problem and classification of orbits. The virial theorem. Differential equation for a orbit with a general power law potential. **Applications**: Kepler problem; scattering in c.m. and lab-coordinates.

Section B

Kinematics and Dynamics of Rigid Bodies:

Generalized coordinates of a rigid body, orthogonal transformations and the transformation matrix. The Euler's angles and Euler's theorem on motion of rigid bodies, infinitesimal rotations, motion in a rotating frame of reference, Coriolis force on (i) air flow on the surface of earth (ii) projectile motion (iii)atomic nuclei. Angular momentum and Kinetic energy of motion about a point. Moment of inertia tensor, the principle axis transformation. Euler's equation of motion.

Applications: Torque free motion of a rigid body. Heavy symmetric top with one point fixed.

Hamilton-Jacobi Theory:

The Hamilton-Jacobi equation for (i) Hamilton's principle function, and (ii) Characteristics function. Separation of variables in Hamilton- Jacobi equation. Action angle variables. **Applications:** Harmonic oscillator with Hamilton-Jacobi and action angle variable methods. Kepler's problem with action angle variable method.

Section C

Hamiltonian Formulation of Mechanics:

Legendre's transformations and Hamilton's equations of motion. Derivation of Hamilton's equations from variational principle. The principle of least action. Canonical transformations; Poisson's and Lagrangian brackets, their invariance under a canonical transformation, equations of motion in the Poisson's bracket notation; infinitesimal canonical transformations, constants of motion and symmetry properties.

Applications: Hamiltonian formulation of (i) harmonic oscillator and (ii) relativistic mechanics. Examples of canonical transformations, with reference to harmonic oscillator. Example of Poisson bracket, (i) harmonic oscillator; (ii) angular momentum.

Lagrangian and Hamiltonian Formulations for continuous systems and fields: Transition from discrete to continuous system, Lagrangian formulation for continuous systems stress-energy tensor and conservation theorems. Hamiltonian formulation others theorems.

Books Recommended

1. H. Goldstein, Classical Mechanics 2nd ed. (Indian Student Edition, Addison-Wesley/ Narosa).
2. J. B. Marion, Classical Mechanics (Academic Press).
3. L. D. Landau and E. M. Lifshitz, Mechanics 3rd ed. (Pergamon).
4. R. G. Takwale & P. S. Puranik, Introduction to Classical Mechanics (Tata McGraw –Hill)
5. Kiran C. Gupta, Classical Mechanics of Particles and Rigid Bodies (Wiley Eastern).
6. N. C. Rana and P. S. Joag, Classical mechanics (TMH).

***NOTE**: - In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C*

Course Code	PHYMS-103		No. of hour per semester	52
Name of the course	Electronics –I			
Duration of the Course	One Semester (13 Weeks)			
Lectures to be Delivered	39 (13 X 3)			
Tutorial	13 (13 X 1)			
Semester End Examination	Total Maximum Marks = 100 Credits = 4		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Understand various sequential logic circuits, registers, counters and A/D and D/A converters.
2. Understand the construction and working of microprocessor with reference to 8085.
3. Understand operational amplifiers, its characteristics, parameters and applications.
4. Build the knowledge of various microwave devices.
5. Distinguish between advantages and disadvantages of microwave transmission.
6. Build the knowledge of microwave communication systems.

Section A:

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

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.

Section B:

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.

Section C:

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. Microwaves by K.L. Gupta, Wiley Eastern Ltd. New Delhi, 1983.
2. Digital Principle and Application by, A. P. Malvino and Donald P. Leach, TMH, New Delhi 1993.
3. Electronic communication system by G. Kennedy and B. Davis, TMH, New Delhi 1993.
4. Semiconductor Devices by S. M. Sze JWS,1995
5. Op-amp and Linear Integrated Circuit by Ramakanth A. Gayakwad,sss PHI, second edition, 1991.
6. Microprocessor Architecture, programming and Applications with 8085/8086 by Ramesh S. Gaonkar, Wiley – Eastern Let. 1987 (for unit v)

NOTE:- In all, ten questions will be set. Question No.1will cover the entire syllabus and will be short answer type. The remaining 9 questions will be three each from section A, B and C. Students will attempt 5 questions in all including Q No.1 (Compulsory) and at least one from each section.

Course Code	PHYMS-104		No. of hour per semester	52
Name of the course	Computational Methods in Physics			
Duration of the Course	One Semester (13 Weeks)			
Lectures to be Delivered	39 (13 X 3)			
Tutorial	13 (13 X 1)			
Semester End Examination	Total Maximum Marks = 100 Credits = 4		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Understand basic computational techniques, computer languages (FORTRAN, C and C++) and operating systems.
2. Utilize various computational methods for solving non-linear equations.
3. Understand and apply Monte Carlo methods.
4. Get a detailed knowledge of numerical integration methods and apply them to various physical problems.
5. Make use of interpolation and extrapolation.
6. Utilize computational techniques to solve simultaneous algebraic equations.
7. Apply various computational methods for solving ordinary and partial differential equations.
8. Construct the knowledge of non-linear dynamics.

Section A

Basics: Computer arithmetic, machine precision, types of errors, subtractive cancellation, multiplicative error, errors and their estimation, flowcharting and algorithms, error propagation, errors in algorithms. Computer languages (Procedural and object oriented), Brief recapitulation of FORTRAN, C, C++, operating systems (proprietary and open source), shells, editors and programs, modular and top-down programming, Simulation and computation (examples: radioactive decay, area of a pond, value of pi)

Root Finding: Solutions of non-linear equations by plotting method, bisection method, false position method, Newton Raphson method, secant method, order of convergence in different methods. Application: developing an algorithm to find bond angle of a diatomic molecule using a modeled interaction potential.

Monte Carlo Methods: True random numbers, pseudorandom numbers, generators for pseudorandom numbers,. Tests for pseudo random number generators. Monte carlo method: Applications: Random walk, Radioactive decay simulation, area of an irregular plane, value of pi, multidimensional integration, variance reduction, importance sampling, non uniform randomness, von-neumann rejection.

Differentiation: Forward Difference, Central Difference, unstable nature of differentiation. Differentiation of interpolating polynomials.

Section B

Integration: numerical integration using trapezoidal rule , Simpson's Method, Romberg integration, Newton-Cote's formulae, Gaussian quadrature; weight function and its use in dealing with singularity in the integrand. Application: Semi-classical quantization of molecular vibrations.

Interpolation and extrapolation: Lagrange's interpolation using polynomials, difference tables, Cubic-spline method, least square method of fitting data, linear and polynomial regression. Application: Charge on Millikan's oil drop data and estimation of charge on an electron.

Simultaneous Algebraic Equations:Various matrix operations, direct and iterative methods for solving simultaneous algebraic equations, Gauss elimination method, pivoting, refinement, Gauss Seidel method

Eigenvectors and eigenvalues: homogeneous equations, characteristic equation. Method and secant method. Order of convergence in different Power method, Jacobi, Given's and Householder's methods. Applications: Electric Circuit Network problem, secular equation for dispersion relations, electronic structure of many body problems, brief overview.

Section C

Ordinary differential equations (Initial value problems): Euler, Taylor series and Second order Runge-Kutta method (derivation), Fourth order Runge- Kutta method (without derivation) Predictor- Corrector method. Numerov method, shooting method. Applications: Non-linear oscillators, schrodinger equation for particle in a box,

Partial Differential Equations (Boundary value problems): Elliptic, parabolic and hyperbolic equations and corresponding difference equations for each type.Applications: solution of Laoplaces equation, Poission Equation, and heat equation

Non- linear Dynamics: Non-linear growth, logistic map, properties of non-linear maps, fixed points, period doubling, attractors, bifurcation diagrams, generating random numbers from logistic maps, Figenbaum constant. A chaotic pendulum, limit cycle and mode coupling, phase space orbits, chaotic and random motion in phase space, bifurcation diagram of a pendulum.

Books Recommended

1. Rubin Landau, M Paez: Computational Physics (John Wiley)
2. Tao Pang: Computational Physics (Cambridge University Press)
3. V. Rajaraman: Computer Oriented Numerical Methods (PHI).

4. E Balagurusamy: Numerical Methods (Tata Mcgraw Hill).
5. S. E. Koonin: Computational Physics (Addison Wesley).
6. Vetterming, Teukolsky, Press and Flannery: Art of Computing, Numerical Recipes (in C, C++, Fortran) (Cambridge University Press)

NOTE:- In all, ten questions will be set. Question No.1will cover the entire syllabus and will be short answer type. The remaining 9 questions will be three each from section A, B and C. Students will attempt 5 questions in all including Q No.1 (Compulsory) and at least one from each section

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Course Code	PHYMS-105		No. of hour per semester	180
Name of the course	Laboratory			
Duration of the Course	One Semester (13 Weeks)			
Semester End Examination	Total Maximum Marks = 100 Credits = 6		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Course V: LABORATORY

Note: *Students are expected to do as many experiments as possible but not less than 10 experiments out of the following list doing 3 experiments from each of the sections A, B and C. 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. Marks will be posted in the copy and on the index of the copy. A record of the same will be kept in the laboratory also.*

Course Outcomes:
After completion of course, students will have hand on experience of
1. Various experimental and computational tools thereby developing analytical abilities to address real world problems.
2. Adopting the skills related to research, education and industry-academia.
3. Spectrometer, electronic circuits; CRO, semiconductor devices etc.
4. Photocell, Millikan's oil drop experiment, experiments related to optics: Cauchy constants, Michelson's Interferometer, Fresnel's experiment.
5. Computer based experiments using BASIC/FORTRAN/C/C++.
6. Electronics devices related experiments.
7. Seminars/presentations related to practical courses.

Section A

1. Kelvin double bridge: determination of low resistance.
2. Anderson bridge: determination of self-inductance.
3. Scherring bridge: determination of capacitance.
4. Study of integrating and differentiating circuits.
5. Study of clipping and clamping circuits.
6. Study of CRO.
7. Study of characteristics of semi-conductor devices (UJT, FET).
8. Study of regulated power supply.
9. Study of thyratron characteristics.

Section B

10. e/m of electron by helical method.
11. Plank's constant by photocell.
12. Millikan's oil drop experiment.
13. Cauchy's Constant.
14. Verification of Fresnel's amplitude relations.
15. Ultrasonic wave velocity in liquids by ultrasonic diffraction.
16. Constant Deviation Spectrometer
17. Determination of wavelength and difference in wavelengths of sodium lines, and thickness of mica sheet using Michelson Interferometer.

Section C

Computer based experiments using BASIC/ FORTRAN/C/C++:

18. Statistical and error analysis of (a) given data (b) error estimation in computation.
19. (a) Roots of a quadratic/ cubic equation (b) summation of a series.
20. Numerical differentiation and integration of simple functions.
21. Operations on a matrix (a) inversion (b) diagonalisation (3x3 matrix) (c) solution of simultaneous equations.
22. Plotting and interpolation of a function.
23. Finding the value of Pi using monte carlo method

M. Sc. PHYSICS (1st SEMESTER): LABORATRORY/ PRACTICAL COURSE

1. Design of a Regulated Power Supply
2. Design of a Common Emitter Transistor Amplifier
3. Experiment on Bias Stability
4. Negative Feedback (Voltage series/shut and current series/shunt)
5. Astable , Mono-stable and Bi-stable multivibrator.
6. Characteristics and application of Silicon Controlled Rectifier.
7. Testing goodness of fit of Poisson distribution to cosmic ray bursts by chi-square test.
8. Determination of Half Life of ‘In’
9. Determination of range of Beta-rays from Ra and Cs.
10. X-ray diffraction by Telexometer.
11. Determination of lonization potential of Lithium.
12. Determination of e/m of electron by Normal Zeeman Effect using Febry-Perot Etalon.
13. Determination of Dissociation Energy of Iodine (I) Molecule by photographing the absorption bands of Iodine in the visible region .
    (a) Measurement of wavelength of He-Ne Laser Light using ruler.
    (b) Measurement of thickness of thin wire with laser.

M. Sc. Physics (1st Semester): Tutorial: Laboratory/ Practical Course

This is only a suggestive list, the faculty concerned can add more topics as per the need of the students

1. Network Analysis-Thevemin and Nortan’s equivalent circuits.
2. Basics of p-n junction: Diffusion current, Drift current, Junction width, forward and Reverse Biasing; Significance of Fermi level in stabilizing the junction.

3. Zener diode: Characteristics and voltage regulation.
4. Transistor biasing and stability
5. Wein's bridge and phase shift.
6. Solving Boolean expressions.
7. Mechanism and production of electrical pulse through absorption of nuclear radiation in medium.
8. Dead time efficiency, counting techniques, energy resolution.
9. Lattice extinctions in X-ray diffraction.
10. Atomic scattering power and geometrical structure factor.

<table>
<tr><td>Course Code</td><td colspan="2">PHYMS-106</td><td>No. of hour per semester</td><td>52</td></tr>
<tr><td>Name of the course</td><td colspan="4">COMPUTER APPLICATIONS IN PHYSICS (Nodal Centre based course)
Additional Optional Course I</td></tr>
<tr><td>Duration of the Course</td><td colspan="4">One Semester (13 Weeks)</td></tr>
<tr><td>Lectures to be Delivered</td><td colspan="2">39 (13 X 3)</td><td colspan="2"></td></tr>
<tr><td>Tutorial</td><td colspan="2">13 (13 X 1)</td><td colspan="2"></td></tr>
<tr><td>Semester End Examination</td><td colspan="2">Total Maximum Marks = 100
Credits = 3</td><td colspan="2">Pass Marks</td></tr>
<tr><td rowspan="3"></td><td>Theory</td><td>MM 40</td><td colspan="2">15</td></tr>
<tr><td>Practical</td><td>MM 40</td><td colspan="2">15</td></tr>
<tr><td>Internal Assessment</td><td>MM 20</td><td colspan="2">06</td></tr>
</table>

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section A

Essentials of operating Systems and Linux Usage:

Operating systems; DOS, Windows and Linux. Introduction to file manipulation, print, view compiling, debugging, executing, Job control, search and Miscellaneous commands in the three operating systems, Usage of text editors (edit, vi and EMACS). Problem solving; flow charts and algorithms, writing the code, testing the code. Compiling and execution

Section B

Programming language (FORTRAN 90/95):

Evolution of FORTRAN. Elements of Fortran 90 (source form, Expressions and Assignment, comments, statement ordering, intrinsic types (object classes), literal constants, implicit typing, numerical and logical declerations, character decleration, symbolic constants, scalar initialization, scalar expressions, scalar assignments, intrinsic numeric expressions, intrinsic logical operations, character operations, operation precedence), Control Constructs (if, cycle, exit, select case, indexed loops, Intrinsics and Basic I/O, Intrinsic Procedures (classes, functions, subroutines), functions (type conversion, mathematical, numeric, character, Pointers and Derived Types, Modules and Object-based Programming, Arrays (conformance, element ordering, syntax, sections, I/O, constructors, initializing) **Applications I**:

Programming Exercises on Root finding, interpolation and extrapolation, least square fitting, Polynomial equation fitting, differentiation and integration, solution of ordinary differential equations (Initial value problem, at least ten problems).

Section C

Applications II (Software Packages):

Word processing for scientific usage. Electronic spreadsheets to model simple physical problems and graphical presentation, EXCEL, LATEX, Computer-Computer Interactions, Electronic mail, FTP, Remote Login Telnet, DOS Windows to Unix transfers.

Programming exercises (at least ten)

References

1. M. Metcalf and J. Reid, Fortran 90/95 Explained,Oxford, 1996
2. Computer oriented numerical methods, V. Rajaraman (Prentice Hall of India)
3. A Scientists and Engineers Guide to Workstations and Computers, R.H. Landau, P.J. Fink (John Wiley and Sons).
4. Red Hat Linux 7.2, Christopher Negus, IDG Books India (P) Ltd.

NOTE:- *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Computer applications: Exercises (suggested) on Additional Optional Course- I

Exercises to be done using Fortran 90/95

1. Manipulation of natural numbers (like lcm, hcf, prime
2. , sorting, conversion of decimal to binary numbers, Fibonacci sequence etc),
3. Evaluation of statistical quantities (mean, SD, correlation)
4. Summation of series
5. Matrix manipulation (add, multiply)
6. Finding root of a non-linear equation using bisection method and Newton raphson method
7. Interpolation and extrapolation Least square fitting
8. Differentiation (solution of equation of motion) Integration (area under a curve)

Exercises to be done using Excel &VBA

1. Choose a set of 10 values and find standard deviation, mean, variance, moments etc. of at least 25 data points
2. To guess the roots of a non-linear equation by conditional formatting
3. Simulating radioactive decay using taylor expansion
4. Plotting Special Mathematical functions using spreadsheets
5. Using spreadsheets for matrix operations such as addition, multiplication and finding the determinant
6. Create a spreadsheet to simulate projectile motion
7. solving poisson equation and laplace's equations by setting a spreadsheet.

SEMESTER II

Course Code	**PHYMS-201**		**No. of hour per semester**	**52**
Name of the course	**Quantum Mechanics - I**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:
After completion of course, students will able to
1. Learn the basic concepts of matrix algebra in quantum mechanics.
2. Understand Hilbert space, concepts of basis and operators, Dirac, bra and ket notations.
3. Understand the theory of orbital and spin angular momentum, tensor operators, CG coefficients and Wigner Eckart theorem.
4. To understand time independent and dependent perturbation theory.
5. To apply time independent and dependent perturbation theory to non-degenrate and degenerate systems.
6. Make use of variation principle to ground state of helium atom.

Section A

Matrix formulation of Quantum Mechanics:

Matrix Algebra: Matrix addition and multiplication, Nul unit and Constant Matrices, Trace, Determinant and Inverse of a Matrix, Hermitian and unitary Matrices, Transformation and diagonelization of Matrics, Function of Matricies and matrices of infinite rank.Vector representation of states, transformation of Hamiltonian with unitary matrix, representation of an operator, Hilbert space. Dirac bra and ket notation, projection operators, Schrodinger, Heisenberg and interaction pictures. Relationship between Poisson brackets and commutation relations. Matrix theory of Harmonic oscillator.

Section B

Symmetry in Quantum Mechanics:

Unitary operators for space and time translations. Symmetry and degeneracy. Rotation and angular momentum; Commutation relations, eigenvalue spectrum, angular momentum matrices of J_+, J_-, J_z, J^2. Concept of spin, Pauli spin matrices. Addition of angular momenta, Clebsch-Gordon coefficients and their properties, recurssion relations. Matrix elements for rotated state, irreducible tensor operator, Wigner-Eckart theorem. Rotation matrices and group aspects. Space inversion and time reversal: parity operator and anti-linear operator. Dynamical symmetry of harmonic oscillator.

Applications: non-relativistic Hamiltonian for an electron with spin included. C. G. coefficients of addition for j =1/2, 1/2; 1/2, 1; 1, 1.

Section C

Approximation Methods for Bound State:

Time independent perturbation theory for non-degenerate and degenerate systems upto second order perturbation. Application to a harmonic oscillator, first order Stark effect in hydrogen atom, Zeeman effect without electron spin. Variation principle, application to ground state of helium atom, electron interaction energy and extension of variational principle to excited states. WKB approximation: energy levels of a potential well, quantization rules. Time-dependent perturbation theory; transition probability (Fermi Golden Rule), application to constant perturbation and harmonic perturbation. Semi-classical treatment of radiation. Einstein coefficients; radiative transitions.

Books Recommended

1. L. I. Schiff, Quantum Mechanics (McGraw Hill).
2. Eugan Merzbacher, Quantum Mechanics Johan Wiley & Sons Inc.
3. P. M. Mathews and K. Venkatesan, A Text-Book of Quantum Mechanics (TMH)
4. C. Cohen-Tannoudji, Bernard Diu, Franck Loloe, Quantum Mechanics Vols-I&II (John Wiley).
5. J. J. Sakurai, Modern Quantum Mechanics (Addison-Wesley).
6. A. K. Ghatakh and S. Lokanathan, Quantum Mechanics 3rd ed. (MacMillan).

NOTE*:- In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	PHYMS-202		No. of hour per semester	52
Name of the course	Condensed Matter Physics			
Duration of the Course	One Semester (13 Weeks)			
Lectures to be Delivered	39 (13 X 3)			
Tutorial	13 (13 X 1)			
Semester End Examination	Total Maximum Marks = 100 Credits = 4		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Understand, apply and analyze the phenomenon of lattice vibration, phonon dispersion relations, lattice specific heat, thermal conduction by phonons and Umklapp processes.
2. Understand apply and analyze the concept of Fermi sphere, Fermi temperature Fermi energy and momentum for describing properties of metals using free electron gas model.
3. Understand, apply and analyze the response of free electron gas in magnetic field, Hall effect, the role of Boltzmann Transport equation.
4. Understand and apply energy band theory, Bloch Theorem, Kronig-Penny Model, pseudo potential method of band structure determination etc.
5. Explain the phenomenon of superconductivity, Meissner Effect, London equation, superconducting band gap, BCS theory, Josephson effect and Macroscopic quantum interference
6. Understand, apply and analyze the phenomena of dielectric and ferroelectric solids, their characteristic properties of lattice structure, Piezo and Pyro-electricity.
7. Distinguish between crystalline and non-crystalline solids. Build knowledge of various properties of amorphous materials and Glass transition.
8. Identify various point defects in solids and their applications

Section A

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 specificheat 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.

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.

Section B

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.

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.

Section C

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).

Non-Crystalline Solids:

Diffraction pattern, amorphous materials, radial distribution function Glasses, viscosity and hopping rate. Amorphous ferro-magnets and semiconductors. Low energy excitation in amorphous solids, heat capacity and thermal conductivity.

Point defects:

Lattice vacancies, diffusion, color centres. Surface and interface physics; crystallography, electronic structure and surface states. Dislocation; shear strength of single crystals, slip, edge ;and screw dislocations. Burgers vector. Dislocation density, crystal growth, strength of alloys, Hume Rothery rules, phase diagrams.

Books Recommended

1. C. Kittel: Introduction to Solid State Physics, VI Edition, (John Wiley and Sons).
2. N. W. Ashcroft and N. D. Mermin: Solid State Physics (H. R. W. International edition).
3. C. A. Wert and R. M. Thomson: Physics of Solids (McGraw Hill)

NOTE:- *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	PHYMS-203	No. of hour per semester	52
Name of the course	Statistical Physics		
Duration of the Course	One Semester (13 Weeks)		
Lectures to be Delivered	39 (13 X 3)		
Tutorial	13 (13 X 1)		
Semester End Examination	Total Maximum Marks = 100	Pass Marks	

	Credits = 4		
	Theory	**MM 80**	**32**
	Internal Assessment	**MM 15**	**06**
	Attendance	**MM 5**	**----**

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Explain the fundamental principles of statistical physics.
2. Have vast knowledge of thermodynamic quantities.
3. Build knowledge of Gibb's distribution and Maxwell distribution.
4. Utilize Gibb's distribution for derivation of thermodynamics relations.
5. Grasp the knowledge ideal gases and non-ideal gases and related phenomena and theories.
6. Build the knowledge of quantum statistical distribution laws: Bose-Einstein and Fermi-Dirac and study examples of these distributions.
7. Explain and apply the Phenomenon in very high density systems

8. **Section A**

9. **Section A**

10. **The Fundamental Principles of Statistical Physics**: Statistical Distributions, Statistical independence, Loiuville's theorem, The significance of energy, The statistical matrix, Statistical distribution in quantum statistics , entropy, the law of increase of entropy.

11. **Thermodynamic Quantities:** Temperature, Macroscopic motion, Adiabatic processes, Pressure, Work and quantity of heat, The heat function, The free energy and the thermodynamic potential , Relations between the derivatives of thermodynamic quantities, The thermodynamic scale of temperature, The joule- Thomason process, Maximum work, Maximum work done by a body in an external medium, thermodynamic inequalities, Le Chatelier's principle, Nernst's theorem, The dependence of the thermodynamic quantities on the number of particles, Equilibrium of a body in an external field, Rotating bodies, Thermodynamic relation in the relativistic region.

12. **Section B**

13. **The GIBBS Distribution**: The Gibbs Distribution, The Maxwellian Distribution, The probability distribution for an oscillator, The free energy in the Gibbs distribution , Thermodynamic perturbation theory , Expansion in powers of h , the Gibbs distribution for rotating bodies, the Gibbs distribution for a variable number of particles, The derivation of the thermodynamic relations from the Gibbs distribution.

14. **Ideal Gases**: The Boltzmann distribution, The Boltzmann distribution in classical statistics, Molecular collisions, Ideal gases not in equilibrium, The free energy of an ideal Boltzmann gas, The equation of state of an ideal gas , Ideal gases with constant specific heat, The law of equipartition, Monatomic ideal gases, The effect of the electronic angular momentum.

15. **Non- Ddeal Gases:** Deviations of gases from the ideal state, Expansion in powers of the density, Van der Waals formula, relationship of the virial coefficient and the scattering amplitude, Thermodynamic quantities for a classical plasma, The method of correlation functions, Thermodynamic quantities for a degenerate plasma. The method of correlation function, thermodynamic quantities of a degenerate plasma.

16. Section C

17. **The Fermi And Bose Distributions** : The Fermi distribution, The Bose Distribution, , Fermi and Bose gases not in equilibrium, Fermi and Bose gases of elementary particles, A degenerate electron gas, The specific heat of a degenerate electron gas, Magnetism of an electron gas, Weak fields, and strong fields, A relativistic degenerate electron gas , A degenerate Bose gas, Black body radiation.

18. **Properties of Matter at Very High Density**: The equation of state of matter at high density, Equilibrium of bodies of large mass, the energy of a gravitating body, Equilibrium of a neutron sphere.

19. Books Recommended:

20. 1. L. D. Landau and I. M. Lifshitz: Statistical Physics Third Edition (Part – I) (Pergamon).
21. 2. R. K. Pathria, Statistical Physics (Pergamon).
22. 3. David Chandler: Introduction to Modern Statistical Mechanics (Oxford University Press).
23. 4. R. P. Feynmann: Statistical Mechanics (Addison Wesley).
24. 5. F. Mandl, Statistical Physics (Wiley).
25. 6. C. Kitlle, Elementary Statistical Physics (John Willey & Sons)

26.

27. ***NOTE:-*** *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	**PHYMS-204**	**No. of hour per semester**	**52**
Name of the course	**Electrodynamics**		

Duration of the Course	One Semester (13 Weeks)		
Lectures to be Delivered	39 (13 X 3)		
Tutorial	13 (13 X 1)		
Semester End Examination	Total Maximum Marks = 100 Credits = 4		Pass Marks
	Theory	MM 80	32
	Internal Assessment	MM 15	06
	Attendance	MM 5	----

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Make use of four-vector formulation of electrodynamics and Understand of electromagnetic field tensor and its invariants.
2. Build knowledge about Lorentz transformations and derive Langrangian for the electromagnetic field.
3. Understand non-relativistic and relativistic motion of charged particle in Uniform constant fields.
4. Apply the concept of classical radiation theory for charged particle.
5. Gain clear understanding of scattering, absorption and dispersion of electromagnetic waves.
6. Understand the various physical phenomena observed in plasma.

Section A

Relativistic Electrodynamics:

Space time continuum and four vectors. Light cone. Idea of causal events. Lorentz transformation as orthogonal transformations in 4-dimensions. Four vector formulation of electrodynamics. Electromagnetic field tensor and its invariants. Invariance of Maxwell equations under Lorentz transformations and covariant formulation of Maxwell equations. Lagrangian for the electromagnetic field. Equation of motion of a charged particle in an electromagnetic field.

Section B

Charged Particle dynamics:

Non-relativistic motion in uniform constant fields, non-relativistic motion of a charged particle in a slowly varying magnetic field, adiabatic invariance of flux through an orbit, magnetic mirror. Relativistic motion of a charged particle.

Classical Radiation Theory

Lienard-Wiechert potential, Field of a charge in arbitrary motion, Field produced by a charge in uniform motion, Radiated power from an accelerated charge at low velocities, Larmor's power formula, Radiation from a Charged Particle with collinear velocity and acceleration, radiation from a Charged Particle in circular motion; cyclotron and synchrotron radiation, Bremsstrahlung. Cerenkov radiation. Radiation reaction (damping) and width of spectral line. Abraham-Lorenz model of an electron and self force.

Section C

Scattering, Absorption and Dispersion:

Scattering of electromagnetic waves by a free electron and by bound electrons (Thomson scattering and Raleigh scattering), absorption of radiation by a bound electron, electromagnetic theory of dispersion, dispersion in dense media. Causality and dispersion relations: Kramer-Kronig relations.

Plasma Physics

Elementary concepts: Derivation of moment Equations from Bolzmann equation, Plasma Osicillations, Debye Shielding, Plasma parameter, Magnetoplasma , Plasma confinement. Hydrodynamical Description of Plasma: Fundamental equations. Hydromagnetic waves: Magnetosonic and Alfven waves. Wave Phenomena in Magnetoplasma: Polarization, phase velocity, Group velocity, cut-offs, resonance for Electromagnetic wave propagating parallel and perpendicular to the Magnetic field.

Books Recommended

1. S. P. Puri, Classical Electrodynamics (TMH).
2. J. B. Marion and M. A. Heald, Classical Electromagnetic Radiation, 2nd Ed. (Academic Press).
3. J. D. Jackson, Classical Electrodynamics 3rd. (Wiley Eastern).
4. L. D. Landau and E. M. Lifshitz, The Classical theory of Fields (Pergamon Press).
5. B. G. Levich, Theoretical Physics Vol. I & II (NH).

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Course Code	PHYMS-205		No. of hour per semester	180
Name of the course	Laboratory			
Duration of the Course	One Semester (13 Weeks)			
Semester End Examination	Total Maximum Marks = 100 Credits = 6		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Course X: LABORATORY

Note: *Students are expected to do as many experiments as possible but not less than 10 experiments out of the following list doing 3 experiments from each of the sections A, B and C. 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. Marks will be posted in the copy and on the index of the copy. A record of the same will be kept in the laboratory also.*

Course Outcomes:

After completion of course, students will have hand on experience of

1. Various experimental and computational tools thereby developing analytical abilities to address real world problem.
2. Able to adopt the skills related to research education and industry-academia.
3. He-Ne Laser, tunnel diode, zener diode, amplifier, oscillator circuits, FET.
4. Experiments related to hall coefficient, B-H curve, band gap of semiconductors, Stefan's constant , ionization potential of Hg/Ne.
5. Computer based experiments.
6. Seminars/presentations related to practical courses.

General

1. Susceptibility of a given salt by Quincke's method.
2. B-H curve of a given material and to determine its parameters.
3. Band gap of a semiconductor by Four Probe Method.
4. Ultrasonic wave velocity in liquids by interferometer method.
5. Stefan's constant.

6. Susceptibility by Gouy's method.
7. Solar cell characteristics.
8. Dielectric constant of a liquid by dipole meter.
9. Ionization potential of mercury/ neon.
10. Wave velocity and attenuation in solids by pulse method.
11. Determination of specific heat of graphic at different temperatures.
12. Study of variation of modulus of rigidity and internal friction of a specimen rod with temperature.
13. Study of tunnel diode and Zener diode.
14. Study of frequency response of amplifiers.
15. Study of Oscillator circuits

Computer based experiments

16. Semi classical quantization of molecular vibration.
17. Scattering by a central potential.
18. Solution of ordinary differential equation and application to order and Chaos in two dimensional motion.
19. Structure of white dwarf stars.
20. Particle motion in infinitely deep square well potential.
21. Scattering states in step potential and tunneling effect.
22. Study of ising model using monte carlo method

M.Sc. PHYSICS (2nd SEMESTER): LABORATORY / PRACTICAL COURSE

1. Experiment on FET and MOSFET characterization and application as an amplifier.
2. Experiment on Uni-Junction Transistor and its applications.
3. Digital I: Basic Logic Gates, TTL, NAND and NOR
4. Digital II : combinational Logic
5. Flip-Flops.
6. Operational Amplifier (741).
7. Differential Amplifier.
8. Measurement of resistivity of a semiconductor by four probe method at different temperatures and Determination of band gap.
9. Determination of Lande’s factor of DPPH using Electron Spin Resonance (ESR) spectrometer.
10. Measurement of Hall coefficient of given semicoundutor: Identification of type of semiconductor and estimation of charge carrier concentration.
11. To study the fluorescence spectrum of DCM dye and to determine the quantum yield of fluorescence maxima and full width at half maxima for this dye using monochromator.
12. To study Faraday effect using He-Ne-Laser.

M.Sc. Physics (2nd Semester): Tutorial : Laboratory / Practical Course
This is only a suggestive list, the faculty concerned can add more topics as per the need of the students

1. Effect of capacitance and load resistance on output of an amplifier.
2. Integrated circuit timer familiarization.

3. Op-amp differentiator.
4. Multiplexers and Demultiplexers.
5. Registors and Counters
6. Radiation level and activity measurement.
7. Shielding, mass absorption coefficient.
8. Coincidence circuits, counters, timers.
9. Coherence and it's relevance in diffraction.
10. Identification of charge type by Hall voltage measurement.
11. How does four probe method solve the problem of contact resistance?

Course Code	**PHYMS-206**	**No. of hour per semester**	**52**
Name of the course	**COMPUTER APPLICATIONS IN PHYSICS (Nodal Centre based course)**		
Duration of the Course	**One Semester (13 Weeks)**		
Lectures to be Delivered	**39 (13 X 3)**		
Tutorial	**13 (13 X 1)**		
Semester End Examination	**Total Maximum Marks = 100 Credits =3**	**Pass Marks**	
	Theory / **MM 40**	**15**	
	Practical / **MM 40**	**15**	
	Internal Assessment / **MM 20**	**06**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section A

Recent trends:

Multimedia and its applications. Essentials of a web page, HTML and its features Essentials of parallel computation and features of parallel programming.

Section B

Object Oriented Programming (C++):

OOP fundamentals: objects, classes, encapsiulation, abstraction, inheritance, polymorphism, reusability, overloading.

Structure of a C++ program:

Variables, data types, identifiers, declaration of variables, scope of variables, initialization of variables, strings as non-numerical variables, constants. Operators. Basic input/otput functions. Control structure: if and else, for , while, do while, break, continue, goto, exit, switch. Functions, scope of variable in a function, void, argument passing (by value, by refrence) overloaded functions), void, inline function, recursivity, declaring functions. Arrays: initializing arrays, multidimensional arrays, arrays as parameters, character sequences: null terminated character sequences. Pointers: refrence operator (&), de-refrence operator (*), declaring variables of pointer types, pointers and arrays, pointer initialization, pointer arithmetic, pointers to pointers, void pointers, null pointers, pointers and functionsData structures, pointers to structures, nesting structures, other darta types (typedef, unions, enumerations

Classes, function templates and preprocessor directives: Classes, constructors and destructors, overloading constructors, deconstructors, overloading constructor, default constructor, pointers to classes, classes defined with stuct and union. Overloading operator, keyword this, static numbers Friendship function, friend classes, inheritance between classes, multiple inheritance. Polymorphism, pointers to base class, virtual number, abstract base classes, Function templates, class templates, template specialization, name space alia, std, exceptions. Type casting. Preprocessor directives

Section C

Applications III:

Initial value and boundary value problems (2-dim), Matrix operations, inversion, eigen functions and Eigen values. Monte Carlo method: Basic strategy, generating random numbers, evaluation of two and three dimensional integrals.

Programming exercises (at least ten).

References:

1. Let Us C, Kanetkar.
2. Let Us C++ Kanetkar
3. The ANSI C Programming Language, Keringhan and Ritchie, Prentice Hall of India Ltd.
4. C by Example, Noel Kalicharan, Cambridge University Press.
5. Computer Oriented Numerical methods, V. Rajaraman
6. Elements of Parallel processing, V Rajaraman
7. Computational Physics: An Introduction, R.C. Verma, P.K. Ahluwalia, K.C. Sharma, New Age International Limited.

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Computer applications: Exercises (suggested) on COURSE II to be implemented in Nodal Center for Computer Applications

Developing following basic programs in C++

1. Inversion of matrix
2. Diagonalization, eigenvalue and eigen functions
3. Solution of oscillator (undamped and damped)problem
4. Motion of a projectile
5. Initial value problems Boundary value problems (2 and 3-dim)
6. MC method: generation of random numbers
7. Evaluation of two dimensional integral
8. Evaluation of three dimensional integrals.
9. Write a program to study the electromagnetic oscillations in an LCR circuit using Runge Kutta Method
10. To study phase trajectory of a chaotic pendulum
11. Use Monte Carlo method to study nuclear radioactivity and modifying it to include the case of an unstable daughter nuclei.
12. To study the motion of a satellite around earth under central force field.

Note on COURSE I, II on Computer Applications in Physics

1. Both these courses are pre-requisite to the main course.
2. Admission to these courses be made at the time of admission to M.Sc.
3. Exemption is allowed only to those students who have the requisite background.
4. Students in these courses be examined at the end of the year
5. These courses must be cleared by the students, marks scored in these will not be counted towards division.

SEMESTER III

Course Code	**PHYMS-301**	**No. of hour per semester**	**52**
Name of the course	**Quantum Mechanics - II**		
Duration of the Course	**One Semester (13 Weeks)**		
Lectures to be Delivered	**39 (13 X 3)**		
Tutorial	**13 (13 X 1)**		
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**	**Pass Marks**	
	Theory	**MM 80**	**32**
	Internal Assessment	**MM 15**	**06**
	Attendance	**MM 5**	**----**

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able to

1. Explain different components of Quantum theory of scattering such as scattering amplitude, differential scattering cross-section, asymptotic wave function, scattering potential, such as Square-well, Hard sphere, coulomb potential.
2. Apply the Born Approximation (BA) and Partial wave analysis (PWA) to solve scattering problems of fundamental particles to determine scattering cross-section.
3. To be able to identify the applicability of BA or PWA method for solving differential scattering cross-section and to be able to analyze and justify the conditions for applicability of a given method.
4. Application and deduction of Breit Wigner formula for one level and two levels, non-resonant scattering. s-wave and p-wave resonances.
5. The solving and application of the Schrodinger equation for a system consisting of identical particles, symmetric and anti-symmetric wave functions.
6. Discuss the theory of the ground state of two electron atoms; ortho-and para-helium. Spin and statistics connection, permutation symmetry and Young tableaux.
7. Learning to analyze differential scattering cross-section of scattering of identical particles.
8. Determining the criterion for application of relativistic quantum mechanics, Derivation of Klein-Gordan (KG) Equation, defining charge and current densities and application of K.G. equation for charged particle in EM field.
9. Solving KG equation for hydrogen atom for the justification of relativistic correction of hydrogen spectrum.
10. Explaining the Dirac formalism for relativistic motion of fundamental particles and

deducing covariant form of Dirac equation.

11. Analyzing probability density and probability current, solving Dirac equation for hydrogen atom and hyperfine structure.
12. Learning the procedure for quantization of wave fields, quantization of non-relativistic Schrodinger equation, second quantization, N-representation and deduction of creation and annihilation operators.

Section:A

Scattering Theory:

General considerations; kinematics, wave mechanical picture, scattering amplitude, differential and total cross-section. Green's function for scattering. 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. Application to low energy scattering; resonant scattering, Breit-Wigner formula for one level and two levels, non-resonant scattering. s-wave and p-wave resonances. Exactly soluble problems; Square-well, Hard sphere, coulomb potential. Born approximation; its validity, Born series.

Section:B

Identical Particles:

The Schrodinger equation for a system consisting of identical particles, symmetric and anti-symmetric wave functions, elementary theory of the ground state of two electron atoms; ortho- and para-helium. Spin and statistics connection, permutation symmetry and Young tableaux. Scattering of identical particles.

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), non-relativistic limit. Extension of Klein-Gordon equation to spin 1 particles.

Section C

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 and bilinear covariance, plane wave solution, energy spectrum of hydrogen atom, electron spin and magnetic moment, negative energy sea, hole interpretation and the concept of positron. Spin-orbit coupling, hyperfine structure of hydrogen atom.

Quantization of wave fields: The procedure for quantization of wave fields, quantization of non-relativistic Schrod-inger 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. J. J. Sakurai, Advanced Quantum Mechanics (Addison Wesley).

NOTE:- *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	**PHYMS-302**		**No. of hour per semester**	**52**
Name of the course	**Material Science**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able (in) to

1. Explaining Langevin theory of diamagnetism, quantum theory of para-magnetism, Analysis and discussion of Nuclear demagnetization. Solving Paramagnetic susceptibility of conduction electrons.
2. Explain and examine Ferro and anti ferromagnetic order and molecular field theory. Ferromagnetic domain, anisotropy energy and Block wall. Coercive force and hysteresis, magnetic bubble domains.
3. Explaining Nuclear magnetic resonance and relaxation times. Analysis of Ferro and anti-ferromagnetic resonance. Principle of Maser action (application), three level maser, Ruby laser. Semiconductor junction lasers.
4. Definitions and Basic concepts of Phase Diagrams and Phase Transformation , criteria for solubility limit, comparing one-component phase diagrams, Binary phase diagrams: binary isomorphous systems, interpretation of phase diagrams.
5. Learning Binary eutectic systems and development of microstructure in eutectic alloys, ceramic and ternary phase diagram, the application of Gibbs phase rule.
6. Phase transformations: the kinetics of phase transformations, metastable versus equilibrium states, isothermal and continuous cooling transformation diagrams and tempered martensite transformations
7. Principles of XPS and AES, Instrumentation, Routine limits of XPS, Applications of XPS & AES. Scanning Tunneling Microscopy: Working principle, Instrumentation Modes of operation Difference between STM and AFM
8. X-ray Characteristics and Generation, lattice planes and Braggs law, Powder diffraction, Transmission Electron microscopy: Basic of TEM, Reciprocal Lattice, Specimen Preparation Bright Field and Dark Field Images Electron energy Loss Spectroscopy

9. Scanning Electron Microscopy: Introduction,: IR spectroscopy, UV and visible spectroscopy. Mössbauer Spectroscopy Basic theory, experimental set up and Mössbauer parameters

Section A

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. Principle of Maser action, three level maser, Ruby laser. Semiconductor junction lasers.

Section B

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.

Section C

Materials Characterization Techniques

Principles of X-ray Photometery Spectroscope (XPS) and Anger electron Spectroscopy (AES) , Instrumentation, Routine limits of XPS, Applications of XPS & AES.

Scanning Tunneling Microscopy (STM): Working principle, Instrumentation, Modes of operation

Atomic Force Microscopy (AFM): Introduction, Working Principle Instrumentation Modes of operation Difference between STM and AFM

X-ray Characteristics and Generation, lattice planes and Braggs law, Powder diffraction, Transmission Electron Microscopy (TEM) : Basic of TEM, Reciprocal Lattice, Specimen

Preparation Bright Field and Dark Field Images Electron energy Loss Spectroscopy. Scanning Electron Microscopy: Introduction,: Inferred (IR) spectroscopy, Ultraviolet (UV) and visible spectroscopy. Mössbauer Spectroscopy Basic theory, experimental set up and Mössbauer parameters.

Books Recommended

1. C. Kittel: Introduction to Solid State Physics 6th Edition (Wiley). A,
2. W. Ashcroft and N. D. Mermin: Solid State Physics (H. R. W. International Edition, 1976).C. A. Wert and R. M. Thomson: Physics of Solids (McGraw Hill).
3. William D. Callister, Jr.: Callister's Materials science and Engineering, Wiley India (P) Ltd.
4. S. Somiya et al. : Hand Book of Advanced Ceramics Vol. I & II
5. Sam Zhang, Lin Li and Ashok kumar: Materials Characterization Techniques

NOTE:- *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	PHYMS-303		No. of hour per semester	52
Name of the course	Nuclear Physics			
Duration of the Course	One Semester (13 Weeks)			
Lectures to be Delivered	39 (13 X 3)			
Tutorial	13 (13 X 1)			
Semester End Examination	Total Maximum Marks = 100 Credits = 4		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week.

Course Outcomes:

After completion of course, students will able (in) to

1. Analysis of nuclear masses, nuclear mass formula, stability of nuclei, beta decay and double beta decay
2. Illustrating the properties of nuclear states: quantum numbers, angular momentum. Parity. Isotopic spin (isobaric spin, isospin), solving deuteron problem.
3. Explaining Exchange forces and tensor forces, Meson theory of nuclear forces, analyzing Nucleon-Nucleon scattering, Spin dependences of nuclear forces
4. Explaining Effective range theory, Symmetry and nuclear force, Isospin invariance and operator general form of the nuclear potential, application of Yukawa theory of nuclear interaction.
5. Explain The Nuclear Shell, Shell Model Potential and Magic Numbers, analysis Spin-Orbit couplings, Valence Nucleons and Ground State Spin of Nuclei, justification of collective structure of Odd-A nuclei
6. Explaining the Nuclear Collective Model: Nuclear Collective Vibrations, analyzing Nuclear Collective Rotation, Single-particle motion in a deformed potential
7. Classifying and analyzing different 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.
8. Modelling and analysis of Optical Potential- average interaction potential for nucleons, energy dependence of potential
9. Identifying Compound nucleus formation and direct reactions, Compound resonances, deduction of Berit-Wigner formula, Inverse reactions (Reciprocity Theorem).

Section: A

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.

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.

Section: B

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

Section: C

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).

Reference books:

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).

NOTE:- *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	**PHYMS-304**		**No. of hour per semester**	**52**
Name of the course	**High Energy Physics**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week.

Course Outcomes:
After completion of course, students will able (in) to

1. Explaining Kinematics of Scattering Interaction Picture, Scattering Matrix, Two and Three body phase space, Space- time symmetries, Invariance Principles
2. Explaining Parity, Intrinsic party, Party constraints on the S- Matrix for Hadronic Reactions, Time – Reversal Invariance, Principle of Detailed Balance, Nucleon – Nuclean Scattering Amplitudes
3. Unitarity constraints Internal symmetries, criterion Selection Rules and Globally conserved Quantum Numbers, Isospin, , Charge Conjugation, G- parity, CP and CPT Invariance
4. Unitary Groups, Isospin and SU (2), SU (3), Particle Representation' SU (3), Uspin, V-spin Irreducible Representations of SU (3)
5. Applications of Flavor SU(3), Mass Splitting in Flavor SU (3), Quark Model, Gell-Mann Okubo Mass Formula
6. Weak Interactions, Classification of weak Interactions; Leptonic Semi- Leptonic and Non- Leptonic Decay, Tau- Theta Puzzle, Parity Violation in Weak Decays
7. Understanding of I = ½ rule forΔQ rule for Semileptonic Decays, Δ S= ΔSelection Rules: hadronic decays, Universality of Weak Interactions, Fermi Theory of weak interactions
8. Intermediate Vector – Boson Hypothesis, Helicity of Neutrino, Two Component Theory of Neutrino, KoKo Mixing and CP Violation, KoKo Regeneration

Section : A

Kinematics of Scattering Interaction Picture, Scattering Matrix, Two and Three body phase space, Space- time symmetries, Invariance Principles, Parity, Intrinsic party, Party constraints 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 Quantum Numbers, Isospin, , Charge Conjugation, G-parity, CP and CPT Invariance.

Section: B

Unitary Groups, Isospin and SU (2), SU (3), Particle Representation' SU (3), U-spin, V-spin Irreducible Representations of SU (3), Applications of Flavor SU(3), Mass Splitting in Flavor SU (3), Quark Model, Gell- Mann Okubo Mass Formula.

Section: C

Weak Interactions, Classification of weak Interactions; Leptonic Semi- Leptonic and Non-Leptonic Decay, Tau- Theta Puzzle, Parity Violation in Weak Decays Selection Rules: Δ S= ΔQ rule for Semileptonic Decays, ΔI = ½ rule for hadronic decays, Universality of Weak Interactions, Fermi Theory of weak interactions, Intermediate Vector – Boson Hypothesis, Helicity of Neutrino, Two Component Theory of Neutrino, KoKo Mixing and CP Violation, KoKo Regeneration.

Text and reference Books:

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)

NOTE:- *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	PHYMS-305		No. of hour per semester	180
Name of the course	Laboratory			
Duration of the Course	One Semester (13 Weeks)			
Semester End Examination	Total Maximum Marks = 100 Credits = 6		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Course XV Laboratory

Note: *Students are expected to do as many experiments as possible but not less than 10 experiments out of the following list doing 3 experiments from each of the sections A, B and C. 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. Marks will be posted in the copy and on the index of the copy. A record of the same will be kept in the laboratory also.*

Course Outcomes:
After completion of course, students will have hand on experience of

1. Experimentation of Michelson Interferometer and thickness of mica sheet with objective of determination, analysis and validation and justification of theory
2. Experimentation with G. M. Counter (a) characteristics (b) dead time (c) statistical distribution of counting rate with objective of determination, analysis and validation and justification of theory
3. To determine the dielectric constant of a solid and a liquid using Lecher wire with objective of determination, analysis and validation and justification of theory
4. Simulation of lattice dynamics of a mono-atomic and diatomic lattice with objective of determination, analysis and validation and justification of theory
5. Modulation and demodulation: A.M. and F.M in electronic circuits with objective of determination, analysis and validation and justification of theory
6. Designing and study of OPAMP: characteristic and parameter measurements. OPAMP as (a) an active filter and frequency response (b) basic mathematical operations using OPAMP.
7. Boundary value and eigen-value problems. (a) stationary solution of one dimensional Schrodinger equation (b) atomic structure in HF approximation using computational methods
8. Plotting of radial eigen function of harmonic oscillator using computational method

Section A

1. Michelson Interferometer and thickness of mica sheet
2. Fabry-Perot Interferometer.
3. G. M. Counter (a) characteristics (b) dead time (c) statistical distribution of counting rate.
4. End point energy of beta spectrum.
5. Proportional counter and low energy gamma ray measurements.
6. Hall effect.
7. Lecher wire: dielectric constant of a solid and a liquid.
8. Magneto resistance.
9. Determination of specific heat of solids (metals and alloys).
10. Fourier analysis of a complex signal.
11. Simulation of lattice dynamics of a mono-atomic and diatomic lattice.
12. Determining the laser beam characteristics (power distribution, beam spot size, divergence of laser beam, depth of field, beam waist, quality of laser beam, spatial coherence of beam)
13. Fraunhoffer diffraction (single slit, double slit, circular aperture)
14. Determining thickness of a thin wire by diffraction using laser beam
15. Measure the wave length of laser light with transmission grating.
16. Measurement of thread angle, pitch and diameter of screw using laser beam
17. Study reflection, laws of reflection, internal reflection, critical angle, index of refraction of glass, index of refraction of prism, multiple internal reflection in glass and interference

Section B

1. Characteristics of lumped transmission line.
2. Modulation and demodulation: A.M. and F.M.
3. Designing and study of OPAMP: characteristic and parameter measurements.
4. OPAMP as (a) an active filter and frequency response (b)basic mathematical operations using OPAMP.
5. Study of multi vibrators (a) a stable (b) bi-stable (c) mono-stable.

6. Study of polarization using laser beam (measurement of state of polarization of light wave, measurement of brewster’s angle of glassplate, verification of Maul’s law
7. To study magneto-optic rotation and magneto optic modulation.
8. To create hologram of a given object

Section C

(***Computer based experiments***)

1. Boundary value and eigen-value problems.
   (a) stationary solution of one dimensional Schrodinger equation
   (b) atomic structure in HF approximation.
2. Special functions and Gaussian quadrature:(a) partial wave solution of quantum scattering (b) Born and eikonal approximation in quantum scattering.
3. Plotting of radial eigen function of harmonic oscillator.
4. Fast fourier transforms of some simple functions.
5. Simulation of an order disorder phase transition for a three states potts model

UGC M.SC. Physics (III Semester): Laboratory/Practical Course

(a) CONDENSED MATTER PHYSICS

1. Measurement of lattice parameters and indexing of powder photographs.
2. Interpretation of transmission laue photographs.
3. Determination of orientation of a crystal by back reflection Laue method.
4. Rotation/oscillation photographs and their interpretation.
5. To study the modulus of rigidity and internal friction in metals as a function of temrature.
6. To measure the cleavage step height of crystal by Multiple Fizeaue fringes.
7. To obtain Multiple beam Fringers of Equal Chromatic order. To determine crystal step height and study birefringence.
8. To determine magnetoresistance of a Bismuth crystal as a function of magnetic field.
9. To study hysterisis in the electrical Polarization of a TGS crystal and measure the Curie temperature.
10. To measure the dislocation density of a crystal by etching.

(a I) CONDENSED MATTER PHYSICS

1. Study of X-ray diffraction from liquid, amorphous materials.
2. Determination of dislocation density by Reflection X-ray topography.
3. To take Buerger Precession photograph of a crystal and index the reflections.
4. To measure the superconductiviy transition temperature and transition width of high-temperature superconductors.
5. To determine the optical constants of a metal by reflection of light.
6. Model evaluation of dispersion curves of one-dimensional lattice.

(b1) ELECTRONICS

1. Pulse Amplitude Modulation/Demodulation
2. Pulse position/Pulse Width Modulation/Demodulation
3. FSK Modulation Demodulation using Timer/PLL
4. Microwave characterization and Measurement
5. PLL Circuits and applications
6. Fibre Optics communication
7. Design of Active filters
8. BCD to Seven Segment display
9. A/D and D/A conversion
10. Experiments using various types of memory elements
11. Addition, Subtraction, Multiplication & Division using 8085/8086
12. Wave form generation and storage oscilloscope
13. Frequency, Voltage, Temperature measurements
14. Motor Speed control., Temperature control using 8086.
15. Trouble shooting using signature analyzer.
16. Assemble language programming on PC.
17. Experiments based on computer Aided Design.

Setting up of new experiments will form tutorial for this laboratory course.

(C I) NUCLEAR AND PARTICLE PHYSICS

1. To determine the operating voltage, slope of the plateau and dead time of a G.M. counter.
2. Feathers' analysis using G.M. Counter.
3. To determine the operating voltage if a –photomultiplier tube and to find the photopeak efficiency of a Nal (Tl) crystal of given dimensions for gamma rays of different energies.
4. To determine the energy resolution of a Nal(Tl) detector and to show that it is independent of the again of the amplifier.
5. To calibrate a gamma ray spectrometer and to determine the energy of given gamma ray source.
6. To determine the mass attenuation coefficient of gamma rays in a given medium.
7. To study the Compton scattering using gamma rays of suitable energy.
8. To study the various modes in a multichannel analyzer and to calculate the energy resolution, energy of gamma ray.
9. To determine the beta ray spectrum of Cs-137 source ad to calculate the binding energy of k- Shell electron of Cs-137.
10. To study the Rutherfold scattering using aluminum as scatterer and Am-241 as a source.
11. To measure the efficiency and energy resolution of a HPGe detector.
12. Alpha spectroscopy with surface barrier detector – Energy analysis of an unknown gamma source.
13. Determination of the range and energy of alpha particles using spark counter.
14. The proportional counter and low energy X-ray measurements.
15. X-ray fluorescence with a proportional counter.
16. Neutorn activation analysis.
17. Gamma – gamma coincidence studies.
18. Identification of particles by visual range in nuclear emulsion.
19. Construction and testing of a single channel analyzer circuit.
20. Decoding and display of the outputs from the IC – 7490.
21. To observe Mossbauer effect in a nonmagnetic and a magnetic environment and to deduce nuclear magnetic moments.

Text and Reference Books

S.S.Kapoor and V.,S. Ramamurthy, nuclear Radiation Detectors, Wiley Eastern Ltd, new Delhi, 1986.

R.M. Singru, Introduction to Experimental nuclear Physics, John Wiley & Sons 1974.

Alpha, Beta and gamma Ray Spectroscopy, K. Siegbah, North – Holland, Amsterdam, 1965.

W.H. Tait, Radiation Detection, Butterworths, London, 1980.

K. Sriram and Y.R.Waghmare, Introduction to Nuclear Science and Technology, A.M. Wheeler, 1991.

Nicholson, nuclear Insturmentation.

(e) NUCLEAR AND PARTICLE PHYSICS

1. Mounting a Scintillation Crystal to a Photomultiplier Tube.
2. Pulse Cable making
3. Pulse Shaping with an RC Circuit and to Display with an Oscilloscope.
4. Training in the Usage of oscilloscope and Electronic Meters – Sensitivity and Resolutin Study.
5. Usage of Radiation Monitors.
6. Setting up the Gamma Ray spectrometer

7. Photoelectric Effect, Compton Effect, Pair Production and Back Scattering
8. Discriminators
9. Pulse height as a Function of Applied Voltage for Gas Counters
10. Proportional Counter Characteristics
11. Scintillation Process in Intrinsic and Extrinsic Inorganic Crystals and Organic Crystals
12. Signal Formation in Solid State Devices
13. Neutron Activation Analysis

SEMESTER IV

Course Code	PHYMS-401	No. of hour per semester	52
Name of the course	Electronics –II		
Duration of the Course	One Semester (13 Weeks)		
Lectures to be Delivered	39 (13 X 3)		
Tutorial	13 (13 X 1)		
Semester End Examination	Total Maximum Marks = 100	Pass Marks	

	Credits = 4		
	Theory	MM 80	32
	Internal Assessment	MM 15	06
	Attendance	MM 5	----

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:
After completion of course, students will able (in) to

1. Circuit design, analysis Analog Computation, Active Filters, Comparators, Logarithmic and Anti–Logarithmic Amplifiers, Sample and Hold Amplifiers
2. Waveform Generators, Square and Triangular Wave Generators, Pulse Generators. Read only Memory (ROM) and Applications, Random Access Memory (RAM) and applications
3. Circuit design, analysis, comparison and evaluation of Digital to Analog Converters, Successive Approximation and Dual Slope Converters, Application of DACs and ADCs
4. Learning, comparing, identifying and examining Pulse-Modulation Systems: Sampling Theorem, Low-Pass and Band-Pass signals, PAM, Channel BW for a PAM Signal, Differential PCM Adaptive Delta Modulation Continuously Variable Slope Delta Modulator (CVSD).
5. Understanding, comparing and analyzing Digital Modulation Techniques: Binary Phase-Shift Keying (BPSK), Differential Phase-Shift Keying (DPSK), Quadrature Phase-Shift Keying (QPSK)
6. Application analysis and prioritizing of various keying techniques Phase-Shift Keying (PSK), Quadrature Amplitude Shift Keying (QASK), Binary frequency Shift Keying (BFSK), Frequency Shift Keying (FSK) , Minimum Shift Keying (MSK)
7. Fabrication of Integrated Devices: Thin Films Deposition Techniques: Vacuum Pump and Gauges-Pumping Speed throughout, Effective Conductance Control
8. Applying, analyzing and evaluation of Chemical Vapor Deposition (CVD), MOCVD, PEMOCVD Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering, Laser Ablation, Chemical Solution Techniques: Sol gel, Hybrid, Metal Organic.
9. Understanding, outlining and analyzing the Lithography, Etching and Micro- 43 machining Silicon, Fabrication of Integrated Circuits and Integrated Micro-ElectroMechanical Systems (MEMS).

Section A:

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

Section B:

Digital Communications

Pulse-Modulation Systems: Sampling Theorem, Low-Pass and Band-Pass signals, PAM, Channel BW for a PAM Signal, Flat-top sampling, Signal recovery through Holding, Quantization of Signals, Quantization, Differential PCM, Delta Modulation, Adaptive Delta Modulation Continuously Variable Slope Delta Modulator (CVSD).

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).

Section C:

Fabrication of Integrated Devices: Thin Films Deposition Techniques: Vacuum Pump and Gauges-Pumping Speed throughout, Effective Conductance Control, Chemical Vapor Deposition (CVD), MOCVD, PEMOCVD (Plasma Enhanced Chemical Vapor Deposition), Physical Vapor Deposition: Thermal Evaporation, Molecular Beam Epitaxy (MBE), Sputtering, Laser Ablation, Chemical Solution Techniques: Sol gel, Hybrid, Metal Organic. Lithography, Etching and Micro-machining Silicon, Fabrication of Integrated Circuits and Integrated Micro-Electro-Mechanical Systems (MEMS).

Text and References Books

1. Microelectronics by Jacob Millman, Megraw-Hill International Book Co.New Delhi, 1990.
2. Taub and Schilling, Princiles of Communication Systems, Second Edition, TMH, 1994.
3. Thin Films Phenomenon by K.L. Chopra
4. The material Science of Thin films, Milton S. Ohning.
5. Deposition Techniques for films and coating R.F. Bunshah (Noyes Publications).

NOTE:- *In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.*

Course Code	**PHYMS-402(a)**		**No. of hour per semester**	**52**
Name of the course	**Advanced High Energy Physics**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section: A

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, Goldstone Bosons, Higgs Mechanism, Generalized Local gauge invariance, Ablian and Non Abelian gauge invariance.

Section : B

Weinberg- Salam Theory of Electroweak Unification , the matter fields, the gauge fields, The gauging of SU (2) X U (I), 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.

Section : C

SU (5) Grand Unified Theory, the generators of SU (5), The Choice of fermoin 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).

Text and Reference Books:

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

NOTE:- In all, 10 questions will be set. Question No.1will cover the entire syllabus and will be of objective/ short answer type. The remaining 9 questions will be set taking three questions each from Sections A, B and C. The student will attempt 5 questions in all, including question No. 1 (compulsory) and selecting at least one question from each section A, B and C.

Course Code	PHYMS-402 (b)		No. of hour per semester	52
Name of the course	Nuclear & Particle Astrophysics			
Duration of the Course	One Semester (13 Weeks)			
Lectures to be Delivered	39 (13 X 3)			
Tutorial	13 (13 X 1)			
Semester End Examination	Total Maximum Marks = 100 Credits = 4		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able (in) to

1. Infer 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
2. Stellar Evolution: the Hertzsprung- Russel Diagram, Evolution of Stars: The Chemical Composition of the Observable Universe, Techniques for Abundance Determination:

3. Examining the Direct and Indirect Methods; The Abundances of Elements in the Universe, The main Sequence Stars
4. Examination and evaluation of Thermonuclear and Nuclear Reactions in Stellar Interiors; PP II and PP III Chains; The CNO Cycle, Helium burning, Hydrostatic C,O and Si
5. Understanding and examining Burning Explosive Nucleosynthesis in stars, Supernovae: Explosions of Supermassive Stars, , Formation of the heavy Element
6. Abundances of the Heavy Elements- Processes of Neutron Capture, Neutron Capture Reactions. The S-process , Nucleosynthesis; the r-process; The p- process: Weak Interaction Mechanism Spallation Reactions, thermonuclear Reactions
7. Understanding and examining 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
8. Basic Assumptions, the Standard Model of the Universe Cosmological Limits on Neutrino Mass, Primordial Nucleosynthesis
9. Understanding and analyzing the Helium Production, Bounds on the number of light neutrinos, The Baryon Number generation, the Cosmological Constant, The Inflationary Universe.

Section: A

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.

Section: B

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 C Detonation Mechanism, The Neutrino Transport Mechanism, Deceleration of the Central Pulsar, The Helium Flashes, the Novae Outbursts 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.

Section : C

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 , Freeze out, Cosmological Limits on Neutrino Mass, Primordial Nucleosynthesis, Helium Production, Bounds on the number of light neutrinos, Cosmological Bounds on Heavy Neutrinos, baryon Asymmetry of the Universe, The Baryon Number generation, the Cosmological Constant, The Inflationary Universe.

Recommended Books

1. An Introduction to Nuclear Astrophysics, Jean Audouze and Sylvte Vaudair.

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)

NOTE:-*In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section*

Course Code	PHYMS-402 (C)	No. of hour per semester	52

Name of the course	**Advanced Quantum Mechanics**		
Duration of the Course	**One Semester (13 Weeks)**		
Lectures to be Delivered	**39 (13 X 3)**		
Tutorial	**13 (13 X 1)**		
Semester End Examination	**Total Maximum Marks = 100** **Credits = 4**		**Pass Marks**
	Theory	**MM 80**	**32**
	Internal Assessment	**MM 15**	**06**
	Attendance	**MM 5**	**----**

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section A

Quantization of fields: Quantization of neutral and complex scalar fields, U (1) gauge invariance Quantization of Dirac field covariant anticommutation relations, Quantization of electromagnetic field. Interaction Lagrangion for the fields, QED lagrangian.

Section B

Scattering Matrix and Feynman Rules: The S-Matrix reduction of S- Matrix chronological product, Wicks theorem Furry's theorem Covariant perturbation theory interaction lagrangian for QED, Feynman Diagrams and Feynman rules for QED in configuration and momentum space, Electron- Positron scattering, Coulomb scattering of Electrons, electron – positron annihilation , Compton scattering.

Section C

Renormalization of QED: Self energy correction, vacuum polarization and vertex correction, classification of Divergences, Renormalization of mass and charge, wave function renormalization .

Reference :

1. Theory of photons and electrons, J.M. Jauch and E.Rohrlich
2. Relativistic Quantum field, J.D. Bjorkern amd S.D.Drett.
3. Quantum electrodynamics , A.I. Akhiezer and Berestetskl

NOTE:*-In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section*

Course Code	PHYMS-403 (a)		No. of hour per semester	52
Name of the course	Nano Physics			
Duration of the Course	One Semester (13 Weeks)			
Lectures to be Delivered	39 (13 X 3)			
Tutorial	13 (13 X 1)			
Semester End Examination	Total Maximum Marks = 100 Credits = 4		Pass Marks	
	Theory	MM 80	32	
	Internal Assessment	MM 15	06	
	Attendance	MM 5	----	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able (in) to

1. Realize the impact of development of nanomaterials in everyday life such as in nano-electronics, energy sector, automobile, defense, space, medical field, several other industries and future perspectives
2. Understand the concepts of bulk and quantum nanostructures.
3. Know how to synthesize nanomaterials by vacuum based technology and chemical precursor methods.
4. Familiar with basic theoretical modeling of nanostructured materials and prediction of their properties.

5. Understand the concept of using natural occurring materials as templates for synthesizing nanomaterials.
6. Realize the influence of one, two and three dimensional confinements on electronic and other properties of naostructured materials.

Section : A

Bulk Nanostructured Materials

Solid Disordered Nanostructures: Methods of synthesis, Failure Mechanism of Conventional Grain-Sized Materials, Mechanical Properties, Nanostructured Multilayers, Electrical Properties, Other properties, Metal Nanocluster Composite Glasses, Porous Silicon

Nanostructure Crystals: Natural Nanocrystals, Computational Prediction of Cluster Lattices, Arrays of Nanoperticles in Zeolities, Crystals of Metal Nanoparticles, Nanoparticle Lattices in Colloidal Suspensions, Photonic Crystals

Section : B

Nanostructures Ferromagnetism

Basic of ferromagnetism, Effect of Bulk nanostructuring of Magnetic properties, Dynamics of nanomagnets, Nanopore Containment of magnetic particles, Nanocarbon ferromagnets, Giant and colossal Magnetoresistance, Ferrofluids

Quantum Wells, Wires, and Dots

Introduction, Preparation of Quantum Nanostructures, Size and Dimensionality effects: size effect, conduction electrons and dimensionality, F`ermi gas and Density of States, Potential wells. Partial confinement, properties dependent and desntiy of states.

Synthesis of Nnaomaterials-I (physical methods)

Introduction, Mechanical methods, methods based on evaporation, sputter deposition, chemical vapour deposition, electric arc deposition, ion beam techniques (ion implanataion), Molecular beam epitaxy (MBE)

Section : C

Synthesis of Nnaomaterials-I (Chemical methods)

Introduction, Colloids and Collids in solutions, Growth of Nanoparticles, Synthesis of Metal Nanoparticles by Collodal Route, Synthesis of semiconductor nanoparticles by colloidal route, Langmuir-Blodgett (L-B) methods, microemulsions, sol-gel method

Some special nanomaterials

Introduction, Carbon nano tubes, ordered porous materials using micelles as tempelates, self assembled nanomaterials, core sell particles.

Text and Reference Books

1 NANOTECHNOLOGY: PRINCIPLES AND PRACTICES (Sulabha K. Kulkarni, Capital publishing company)

2.INTRODUCTION TO NANOTECHNOLOGY (Charles P. Poole, Jr. Frank J. Owens: Wiley INDIA**)**

3. Nanostructured Materials (Jackie Y. Ying: Academic Press**)**

NOTE:- *In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section*

Course Code	**PHYMS-403 (b)**		**No. of hour per semester**	**52**
Name of the course	**Mesoscopic Physics**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section: A

Preliminary concepts: Two dimensional electron gas, effective mass, density of states, characteristic lengths, low and high field magneto resistance, transverse modes, drift velocity, fermi velocity
Conductance from transmission: Resistance of ballistic galvanometer, Landauer Formula, Launder buticker formalism
Transmission function, S-matrix and green's functions, tight binding model, self energy, relation to other formalisms, feynman paths

Section: B

Quantum hall effect, origin of zero resistance, effect of back scattering Brief remarks on fractional quantum hall effect.
Localization and fluctuations: localization length, weak localization, effect of magnetic field, cundctance fluctuations, diagrammatic perturbation theory
Double barrier tunneling: coherent resonat tunneling, effect of scattering, single electron tunneling

Section: C

Optical analogies: Electrons and phonons: conceptual similarities, linear optics, non-linear optics, coherent sources
Non-equilibrium green function formalism: correlation and scattering functions, self energy and green's function, kinetic equation, calculating the self energy, solution procedure, current flow and energy exchange, relation to Landauer Butticker formalism, relation to Boltzmann formalism, strongly interacting systems, resonant tunneling with phonon scattering.

References:

1. Introduction to Mesoscopic Physics, Y Imry, Oxford University Press (2001)
2. Electronic Transport in Mesoscopic Systems, Supriya Dutta, Cambridge University Press
3. Quantum Transport: Atom to Transistor, Supriya Dutta, Cambridge University press.

NOTE:- *In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section*

Course Code	**PHYMS-403 (C)**		**No. of hour per semester**	**52**
Name of the course	**Advanced Computational Physics**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	

	Attendance	**MM 5**	**----**

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section A

Concepts of deterministic and stochastic simulation methods, limitations of simulational physics, percolation, percolation threshold, cluster labeling, critical exponents, fractal dimension, regular fractals and self similarity, fractal growth processes. One particle system moving in a spring potential.

Monte Carlo Method (Stochastic Methods)

Random walk on one, two and three dimensional lattices, self-avoiding walk, micro-canonical ensemble monte carlo method (Case Study: one dimensional ideal gas, Ising Model, heat flow), Canonical ensemble monte carlo method (Metropolis method, classical ideal gas, ising model, hard rods), isothermal-isobaric ensemble monte carlo method, grand-canonical ensemble monte carlo method

Section B

Molecular Dynamics (Deterministic Methods)

Molecular Dynamics as deterministic simulation, integration schemes (euler, predictor corrector, verlet), calculating thermodynamic quantities, organization of simulation, microcannonical ensemble molecular dynamics (case study: monoatomic particle system interacting via lennard jones potential), canonical ensemble molecular dynamics (case study: isokinetic simulation of a system of monoatomic particle system using lennard jones potential), isothermic-isobaric ensemble molecular dynamics (case study: simulation of a system of monoatomic particle system using lennard jones potential at constant temperature and constant pressure). Brief discussion of Anderson scheme and Nose scheme.

Section C

Symbolic Computing:

Symbolic Computing Systems, Basic symbolic mathematics, computer calculus, Linear systems, Non-linear systems, Differential equations, Computer graphics, Dynamics of a flying sphere. Basics of Mathematica: numerical computations, algebraic computations, calculus, graphics, Procedural programming

High Performance Computing: The basic concept, High performance computing systems Parallelism and Parallel computing, Data parallel programming, Distributed computing and message passing, Some current applications.

Computing Hardware Basics: Memory and CPU

Components: Memory Hierarchy, The Central Processing unit

CPU Design: RISC, CPU Design; Vector Processing, Virtual Memory, Programming for virtual memory, Programming for Data Cache.

Recommended Books:

1. Computer Simulation Methods, Heermann, Springer Verlag (Good for N-body methods and Monte Carlo approach).
2. Computational Physics, S.E. Koonin, Addison Wesley (New York)
3. Computational Physics, T Pang, Cambridge University Press
4. Computational Physics, R.H. Landau, M J Paez, John Wiley & Sons.
5. Computer Simulation Methods in Theoretical Physics, DW Heermann, Springer Verlag
6. The Art of Molecular Dynamics Simulation, D.C. Rapaport, 2nd Edition, Cambridge University Press.
7. Understanding Molecular Simulations, Frankel and Smit, 2nd edition, Elsevier
8. An Introduction to Computer Simulation Methods, Applications to Physical Systems, 2nd/3rd Edition, Harvey Gould and Jan Tobochnik.
9. Monte Carlo methods in statistical physics & The Monte Carlo method in condensed matter physics, K.Binder, Springer, 1986/1992.
10. Solid State Physics, N.W.Ashcroft & N.D Mermin.
11. A First Course in Scientific Computing: Symbolic, Graphic, and Numeric Modeling Using Maple, Java, Mathematica, and Fortran90, R H. Landau, Princeton University Press.
12. An Introduction to Computer Simulation, Woolfson and Pert, Oxford
13. Computational Physics, Thijssen, Cambridge (Advanced and quite specialised)
14. Computational Techniques in Physics, MacKeown & Newman, Adam Hilger
15. Numerical Recipes in FORTRAN, 2nd Edition, Press et al. Cambridge (An advanced text for reference).
16. H. GOULD and J. TOBOCHNIK ``An Introduction to Computer Simulation Methods: Application to Physical Systems, Parts 1 and 2 " or the single volume 2nd edition
17. W. H. PRESS, B. P. FLANNERY, S. A. TEUKOLSKY and W. T. VETTERLING, ``Numerical Recipes", Cambridge University Press, 1986 (1st or 2nd editions, Fortran, C or C++ only).
18. Mathematica, S Wolfram, Addison Wesley Pub Co.

NOTE:- In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section

Course Code	**PHYMS-404 (a)**		**No. of hour per semester**	**52**
Name of the course	**Advanced Nuclear Physics**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section: A

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.

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.

Section: B

The Fermi gas model, The one body potential General properties, The harmonic oscillator potential separation of instrinsic and centre-of-mass motion, the kinetic energy and the harmonic oscillator. Conserved quantum numbers, angular momentum, parity and isospin, Quantum number for the two nucleon system, two proton or two neutron, and proton and neutron.

The Hartree Fock Approximation Properties of single Slater determinants, Derivation of the Hartree-Fock equations, examples of single particle energies, Results with Skyrme Hamiltonian: Binding energy, single particle energies, Rms charge radii and charge densities.

Section: C

***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.

References:

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).

__NOTE__:- In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section

Course Code	**PHYMS-404 (b)**		**No. of hour per semester**	**52**
Name of the course	**Nuclear Technology**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Section: A

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

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

Section: B

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

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.

Section C:

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 p-p chains, Beyond hydrogen burning, and nucleosynthesis: Production of light elements (up to Fe), Production of the heavy elements - supernovae

Recommended Books and Course Materials

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

NOTE:- In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section

Course Code	**PHYMS-404 (C)**		**No. of hour per semester**	**52**
Name of the course	**Opto - Electronics**			
Duration of the Course	**One Semester (13 Weeks)**			
Lectures to be Delivered	**39 (13 X 3)**			
Tutorial	**13 (13 X 1)**			
Semester End Examination	**Total Maximum Marks = 100 Credits = 4**		**Pass Marks**	
	Theory	**MM 80**	**32**	
	Internal Assessment	**MM 15**	**06**	
	Attendance	**MM 5**	**----**	

Note: Internal Assessment on the basis of two house tests (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e. 14th week

Course Outcomes:

After completion of course, students will able (in) to

1. Understanding of Injection luminescence: The Internal Quantum Efficiency, The External Quantum Efficiency
2. Examining and comparing the condition for the laser action, Types of laser, Semiconductor lasers;, effect of refractive index , calculation of the gain coefficients , relation of the gain coefficient to current density

3. Semiconductor Injection Laser :Efficiency, Stripe geometry LED materials, commercial LED materials, LED construction, Response time of LED’s, LED derive circuitry
4. Optical Detectors: Device types, Optical Detection. Principles, Absorption, quantum efficiency, Responsivity, Long wavelength cut off
5. Application, analysis and discussion of Photoconductive Detectors, Characteristics of particular photoconductive materials. Solar cell, Holography and its applications,Liquid crystal displays

6. Application, analysis and criteria to access various The Optical Fiber , Multimode and Single Mode Fibers, Fabrication of Optical Fibers , Fiber Fabrication ,Free Space Optic
7. Application, analysis and criterion for Junction Detectors : detectors performance parameters Semiconductors p-i-n diodes, General Principle, quantum efficiency, Materials and design for p-i-n photodiodes.
8. Application, analysis and criterion for Impulse & frequency response of p-i-n photodiodes. Avalanche photodiodes detectors. The multiplication process. Avalanche photodiodes (APD) design, APD bandwidth, phototransistors

Section-A

Injection luminescence: Recombination processes, the spectrum of recombination radiations, Direct and Indirect band gap Semiconductors, The Internal Quantum Efficiency, The External Quantum Efficiency

The basic principles of laser actions: spontaneous and stimulated emission and absorption, the condition for the laser action, Types of laser, Semiconductor lasers;
Theory of Laser action in Semiconductors , condition for gain, The threshold conditions for oscillations, rates of spontaneous and stimulated emission , effect of refractive index , calculation of the gain coefficients , relation of the gain coefficient to current density , Semiconductor Injection Laser :Efficiency, Stripe geometry
LED materials, commercial LED materials, LED construction, Response time of LED's, LED derive circuitry.

Section-B

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

Section-C

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

References:

1.Optical communication systems. John Gowar (Prentice Hall of India Pvt.Ltd.New Delhi 1987.)
2.Optical fibre communications-Principles and practice John. M. Senior. Prentice Hall International (1985)
3.Optoelectronics-An Introduction(Second edition) J.Wilson. , J.F.B Hawkes Prentice Hall International (1989).
4.S.M.Sze Physics of the semiconductor devices. 2nd edition(1983) Wiley Eastern Ltd.
5 Fiber Optics And Lasers -The Two Revolutions Ajoy Ghatak and K Thyagarajan

NOTE:- In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of objective/short answer type. The remaining 9 questions will be three each from sections A, B and C. The students will attempt 5questions in all; including question No.1 (compulsory) and at least one from each section

Course Code	**PHYMS-405**	**No. of hour per semester**	**180**
Name of the course	**Project**		
Duration of the Course	**One Semester (13 Weeks)**		
Semester End Examination	**Total Maximum Marks = 100** **Credits = 10**	**Pass Marks =40**	

M.Sc. IV Semester
PHYMS-405
Project

Course Outcomes:

After completion of course, students will have hand on experience of

1. Literature survey on advanced research topics in Materials Science, Nuclear physics, High Energy Physics and Condensed Matter Physics
2. Planning and designing the experiment and theoretical modelling of the research problem
3. Analysis and evaluation of the experimental data/ theoretical & computational modeling

4. Deduction and systematic presentation of the results
5. Compilation of the results / information to produce written document
6. Defending the results of the project in an open viva–voice through power point presentation

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 (Condensed Matter Physics, Nuclear Physics, Particle Physics), Experimental Physics, Computational 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. 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

    i) Particle Physics/ Nuclear Physics
    ii) Condensed Matter Physics/ Material Sciences
    iii) Computational Physics
    iv) Electronics
    v) Experimental Physics

(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

<u>M.Sc. Project Report</u>

<u>On</u>

<u>Title of the Project</u>

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

Physics Department
Himachal Pradesh University
Summer Hill, Shimla-5
Session
Month Year

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(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 Physics Department, H.P. University, Shimla-5.

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

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Acknowledgements

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Preface

<u>Page 5</u>

Contents

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Abbreviations used

<u>Page 7</u>

List of Tables

<u>Page 8</u>

List of Graph and figures

<u>Page 9</u>

Introduction

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

<u>End of Report</u>

Appendices
Source code and other relevant appendices
Bibliography /References.

<u>Instructions for the Formatting and Presentation of Project Report</u>

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.