SARDAR PATEL UNIVERSITY MANDI
District Mandi-175001, (H.P.)

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

FACULTY OF PHYSICAL SCIENCES

PROPOSED SYLLABI

FOR

B.Sc.-M.Sc. Five Year Integrated Course in Physics

CHOICE BASED CREDIT SYSTEM

(Effective from Session 2025-26 and Onwards)

Department of Physics
Sardar Patel University Mandi
Himachal Pradesh, India

CHOICE BASED CREDIT SYSTEM (CBCS): The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Open Elective Course: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study.

3. Skill Enhancement Courses (SECs): are skill-based courses in all disciplines and are aimed at providing hands-on training, competencies, proficiency and skills to students.

4. Ability Enhancement Course (AEC): are the courses based upon the content that leads to knowledge enhancement through various areas of study. They are Language and Literature and Environmental Science which are mandatory for all disciplines.

5. Value Added courses (VAC): are common pool of courses offered by different disciplines and aimed towards personality building, embedding ethical, cultural and constitutional values; promote critical thinking, Indian knowledge systems, scientific temperament, communication skills, creative writing, presentation skills, sports and physical education and team work which will help in all round development of students.

6. Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem.

Graduates in Physics should demonstrate the following key attributes:

- Proficiency in disciplinary knowledge and skills.
- Effective communication skills.
- Strong critical thinking and problem-solving abilities.
- A curious and inquisitive approach to learning.

- Capability to work collaboratively in teams.
- Competence in project management.
- Proficiency in digital and ICT (Information and Communication Technology) usage.
- Ethical awareness and reasoning skills.
- Appreciation for both national and international perspectives.
- A commitment to lifelong learning and continuous improvement.

Aims of Integrated (5 Yrs) program in Physics

The aims and objectives of our Integrated (5Yr) BSc/MSc programme are:

- Provide a conducive environment for students in educational institutions to reinforce their knowledge from the +2 level and cultivate a genuine interest in Physics. This includes developing a comprehensive understanding of physical concepts, principles, and theories.
- Encourage students to engage in hands-on learning by conducting experiments in laboratories that demonstrate the practical applications of the theoretical concepts learned in classrooms.
- Foster the ability to apply the acquired knowledge to tackle specific theoretical and experimental Physics problems effectively.
- Expose students to the vast scope of Physics as both a theoretical and experimental science, enabling them to address a wide range of natural phenomena, from the smallest subatomic scales (10^{-15} m) to the largest cosmic scales (10^{26} m) and from minute energy levels (10^{-10} eV) to extreme energy dimensions (10^{25} eV).
- Highlight the significance of Physics as a crucial branch of science, paving the way for pursuing interdisciplinary and multidisciplinary higher education and research.
- Emphasize the importance of Physics in sustaining existing industries and creating new ones, thereby generating job opportunities across various employment levels.
- The progressive curriculum of the program is structured to guide students from being novice problem solvers at the program's entry level to becoming expert problem solvers upon graduation, as outlined below:

➢ *By the end of the first year*: Students should have the ability to solve well-defined problems.

➢ *By the end of the second year*: Students should be capable of solving broadly defined problems.

➢ *By the end of the third year*: Students should possess the skills to tackle complex and ill-structured problems, which may require multidisciplinary approaches for solutions.

- *During the fourth year*: Students will gain practical problem-solving experience through internships or research experiences, preparing them for higher education, entrepreneurship, or employment in the workplace.
- *By the end of the fifth year*: Achieving Profound Mastery of the Subject with an Innate Research Temperament.

Sardar Patel University Mandi, Himachal Pradesh
Scheme & Syllabus of B.Sc.-M.Sc. Five Year Integrated Course in Physics

Semester	Course Type	Course Code	Title of paper	Credits
I	Core Course-I	PHYBM 101 TH	Mechanics (Theory)	4
		PHYBM 101 PR	Mechanics (Lab)	2
	SEC-I	PHYBM 102 TH	Electrical Circuits and Network Skills (Theory)	4
		PHYBM 102 PR	Electrical Circuits and Network Skills (Lab)	2
	Core Course-II	PHYBM 103 TH	Inorganic Chemistry (Theory)	4
		PHYBM 103 PR	Inorganic Chemistry (Lab)	2
	Core Course-III	PHYBM 104	Differential Calculus	6
	A.E.C. Course-I	PHYBM 105	Writing Skills	4
II	Core Course-IV	PHYBM 201 TH	Electricity, Magnetism and EMT (Theory)	4
		PHYBM 201 PR	Electricity, Magnetism and EMT (Lab.)	2
	SEC-II	PHYBM 202 TH	Physics Workshop Skills (Theory)	4
		PHYBM 202 PR	Physics Workshop Skills (Lab.)	2
	Core Course-V	PHYBM 203 TH	Organic Chemistry (Theory)	4
		PHYBM 203 PR	Organic Chemistry (Lab.)	2
	Core Course-VI	PHYBM 204	Differential Equations	6
	A.E.C. Course-II	PHYBM 205	Environment Science	4
III	Core Course-VII	PHYBM 301 TH	Wave Motion and Optics (Theory)	4
		PHYBM 301 PR	Wave Motion and Optics (Lab.)	2
	Core Course-VIII	PHYBM 302 TH	Elements of Modern Physics (Theory)	4
		PHYBM 302 PR	Elements of Modern Physics (Lab)	2
	Open Elective -I	PHYBM 303	1. Optical Instruments 2. Elements of Astronomy and Astrophysics 3. Energy source 4. Climate science	4
	SEC-III	PHYBM 304	Computational Physics Skills	3
	A.E.C. Course-III	PHYBM 305	Soft Skills	3
	Value Added Course	PHYBM 306	Community Connect Based Course	8

IV	Core Course-IX	PHYBM 401 TH	Statistical Physics and Thermodynamics (Theory)	4
		PHYBM 401 PR	Statistical Physics and Thermodynamics (Lab)	2
	Core Course-X	PHYBM 402	Analog Systems & Applications	4
	Open Elective-II	PHYBM 403	1. Medical Physics2. Nanotechnology3. Electrical Instruments	4
	SEC-IV	PHYBM 404 TH	Basic Instrumentation Skills (Theory)	2
		PHYBM 404 PR	Basic Instrumentation Skills (Lab)	2
	SEC-V	PHYBM 405 TH	Computer Programming	2
		PHYBM 405 PR	Computer Programming Laboratory	2
	Value added Course	PHYBM 406	Yoga and Meditation	2
V	Core Course-XI	PHYBM 501 TH	Quantum Mechanics-I (Theory)	4
		PHYBM 501 PR	Quantum Mechanics-I (Lab)	2
	Core Course-XII	PHYBM 502	Nuclear and Particle Physics	6
	Open Elective-III	PHYBM 503	1. Earth Sciences 2. Physics of Devices and Instruments 3. Bio Physics	4
	Open Elective-IV	PHYBM 504	1. Experimental Techniques 2. Atmospheric Physics 3. Solar Energy and Physics of Photovoltaics	4
	SEC-VI	PHYBM 505 TH	Applied Optics (Theory)	3
		PHYBM 505 PR	Applied Optics (Lab)	1
VI	Core Course-XIII	PHYBM 601 TH	Solid State Physics and Electronics (Theory)	4
		PHYBM 601 PR	Solid State Physics and Electronics (Lab)	2
	Core Course-XIV	PHYBM 602	Mathematical Physics-I	6
	Open Elective-V	PHYBM 603	1. Laser Physics 2. Introduction to Hydrogen Energy Systems 3. Introduction to Mocroprocessors	4
	Open Elective-VI	PHYBM 604	1. Cosmology 2.Spectroscopy 3. Radiation Physics	4
	Value added Course	PHYBM 605	Indian Knowledge System	4
VII	Core Course-XV	PHYBM 701	Mathematical Physics-II	4
	Core Course-XVI	PHYBM 702	Classical Mechanics	4
	Core Course-XVII	PHYBM 703	Electronics-I	4
	Core Course-XVIII	PHYBM 704	Computational Methods in Physics	4
	Core Course-XIX	PHYBM 705	Laboratory	6

VIII	Core Course-XX	PHYBM 801	Quantum Mechanics-II	4
	Core Course-XXI	PHYBM 802	Condensed Matter Physics	4
	Core Course-XXII	PHYBM 803	Statistical Physics	4
	Core Course-XXIII	PHYBM 804	Electrodynamics	4
	Core Course-XXIV	PHYBM 805	Laboratory	6
IX	Core Course-XXV	PHYBM 901	Quantum Mechanics-III	4
	Core Course-XXVI	PHYBM 902	Material Science	4
	Core Course-XXVII	PHYBM 903	Nuclear Physics	4
	Core Course-XXVIII	PHYBM 904	High Energy Physics	4
	Core Course-XXIX	PHYBM 905	Laboratory	6
X	Core Course-XXX	PHYBM 1001	Electronics-II	4
	Open Elective-VII	PHYBM 1002(a)	Advanced High Energy Physics	4
		PHYBM 1002(b)	Nuclear & Particle Astrophysics	
		PHYBM 1002(c)	Advanced Quantum Mechanics	
	Core Course-XXXI	PHYBM 1003	Project	18

Total Credits = 250

***TH = Theory, IA = Internal Assessment, PR = Practical, TU = Tutorials**

DETAILED SCHEME & SYLLABUS OF 1st SEMESTER

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
1st	Core Course-I	PHYBM 101 TH	Mechanics (Theory)	4 (TH+IA)	Theory = 50 IA = 30	100	28
		PHYBM 101 PR	Mechanics (Lab)	2	Lab. = 20		
	SEC-I	PHYBM 102 TH	Electrical Circuits and Network Skills (Theory)	4 (TH+IA)	Theory = 50 IA = 30	100	
		PHYBM 102 PR	Electrical Circuits and Network Skills (Lab)	2	Lab. = 20		
	Core Course-II	PHYBM 103 TH	Inorganic Chemistry (Theory)	4 (TH+IA)	Theory = 50 IA = 30	100	
		PHYBM 103 PR	Inorganic Chemistry (Lab)	2	Lab. = 20		
	Core Course-III	PHYBM 104	Differential Calculus	6 (TH+IA=5 ,TU=1)	Theory = 70 IA = 30	100	
	A.E.C. Course-I	PHYBM 105	Writing Skills	4 (TH+IA)	Theory = 70 IA = 30	100	

B. Sc.-M. Sc. Physics Five Year Integrated Course
1st Semester

MECHANICS

Name of the Course	**MECHANICS** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 101TH**
Semester Based Examination	**50 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A (compulsory, covering syllabus from all the units),section B (Unit I), section C (Unit II),section D (Unit III) and section E (Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1 (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*

2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit - I	**Ordinary Differential Equations:** 1st order homogeneous differential equations, 2nd order homogeneous differential equations with constant coefficients. **Coordinate systems and motion of a particle:** Volume, velocity and acceleration in Cartesian and Spherical co-ordinate systems, Solid angle. **(6 Lectures)** **Space Time Symmetry and Conservation Laws:** Relationship of conservation laws and symmetries of space and time. **(4 Lectures)** **Frames of Reference:** Inertial frames of reference, Galilean transformation and Galilean invariance, Non-inertial frames, Coriolis force and its applications. **(5 Lectures)**
Unit - II	**Gravitation and Inverse Square Force Law:** Newton's Law of Gravitation, Various forces in nature (qualitative), Central and non-central forces, Inverse square force, Centre of mass, Equivalent one body problem, Reduced mass, angular momentum in central force field, Equation of motion under a force law**,** Equation of orbit and turning points, Relationship between eccentricity and energy, Kepler's laws. **(15 Lectures)**
Unit - III	**Rotational Motion and Kinematics of Elastic and Inelastic Collisions :**Angular velocity, angular momentum, Torque, Conservation of angular momentum, Elastic and inelastic collisions, coefficient of restitution, Elastic collisions in laboratory and C. M. systems, Velocities, angle and energies in elastic collisions in C. M. and lab. Systems, Classical Scattering: Cross- section for elastic scattering, Rutherford scattering (with derivation). **(15 Lectures)**
Unit - IV	**Special Theory of Relativity:** Concept of stationary universal frame of reference and search for ether, Michelson-Morley experiment, postulates of special theory of relativity, Lorentz transformations, Observer in relativity, Relativity of simultaneity. **(8 Lectures)** **Effects of Relativity:** Length contraction, Time dilation, Relativistic addition of velocities, Relativistic Doppler effect, Variation of mass with velocity and mass energy equivalence, Increase of mass in an inelastic collision, Relativistic momentum and energies, Transformation of momentum, energy, Minkowsky space. **(7 Lectures)**

Reference Books:

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics course, V.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Mechanics, D.S. Mathur, S. Chand and Company Ltd.
- An Introduction to Mechanics, Kleppner, Tata Macgraw Hill.

LAB COURSE

Mechanics (Lab)

Name of the Course	**Mechanics (Lab)** **(Credits:-02)**
Code	**PHYBM 101PR**
Semester Based Examination	**20 Marks (3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills = **4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

List of Experiments to be performed in Lab I:

1. To determine the value of acceleration due to gravity 'g' at a place with Keter's Pendulum.
2. To plot a graph between distance of the knife-edges from the centre of gravity and time period of Bar pendulum. From the graph find
   (a) the acceleration due to gravity.
   (b) the radius of gyration and the moment of inertia of bar about an axis passing through the centre of gravity.
3. To find the moment of inertia of an irregular body about an axis through its centre of gravity with a Torsion pendulum.
4. To find the moment of inertia of Fly Wheel.
5. To find the angular acceleration and torque of a fly wheel and hence find the moment of inertia of fly wheel.
6. To determine the height of an accessible object using Sextant.
7. To determine the modulus of rigidity of copper by Maxwell's needle.
8. To study the law of conservation of linear momentum and law of conservation of kinetic energy using one dimensional collision apparatus of two hanging sphere.
9. To verify law of conservation of linear momentum and law of conservation of kinetic energy in case of elastic collision.
10. To find the Young's modulus of the material of a rectangular bar by bending.
11. To determine the diameter of a capillary tube using travelling microscope.
12. To study the motion of a spring. Calculate spring constant and value of 'g'.

Note: A minimum of EIGHT experiments to be carried out.

Reference Books for Laboratory Experiments:

1. Physics through experiments, B. Saraf, Vikas Publications, 2013
2. A laboratory manual of Physics for undergraduateclasses,1st Edition, DP Khandelwal Vikas Publications, 1985
3. B.Sc. Practical Physics (Revised Edition), C. L Arora, S. Chand & Co., 2007
4. An advanced course in practical physics, D. Chatopadhyay, P C Rakshit, B. Saha, New Central Book Agency Pvt Ltd., 2002

ELECTRICAL CIRCUITS AND NETWORK SKILLS

Name of the Course	**ELECTRICAL CIRCUITS AND NETWORK SKILLS** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	**PHYBM 102 TH**
Semester Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory:** Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks,*
2. *The candidate will be required to attempt five questions in all. The duration of the examination will be 3 hours.*

Syllabus:

Basic Electricity Principles: Voltage, Current, Resistance, and Power, Ohm's law, Series, parallel, and series-parallel combinations, AC Electricity and DC Electricity, Familiarization with multi-meter, voltmeter and ammeter. **(3 Lectures)**

Understanding Electrical Circuits: Main electric circuit elements and their combination, Rules to analyze DC sourced electrical circuits, Current and voltage drop across the DC circuit elements, Single-phase and three-phase alternating current sources, Rules to analyze AC sourced electrical circuits, Real, imaginary and complex power components of AC source, Power factor, Saving energy and money. **(4 Lectures)**

Electrical Drawing and Symbols: Drawing symbols, Blueprints, Reading Schematics, Ladder diagrams, Electrical Schematics, Power circuits, Control circuits, Reading of circuit schematics, Tracking the connections of elements and identify current flow and voltage drop. **(4 Lectures)**

Generators and Transformers: DC Power sources, AC/DC generators, Inductance, capacitance, and impedance, Operation of transformers. **(3 Lectures)**

Electric Motors: Single-phase, three-phase & DC motors, Basic design, Interfacing DC or AC sources to control heaters & motors, Speed & power of ac motor. **(4 Lectures)**

Solid-State Devices: Resistors, inductors and capacitors, Diode and rectifiers, Components in Series or in shunt, Response of inductors and capacitors with DC or AC sources. **(3 Lectures)**

Electrical Protection: Relays, Fuses and disconnect switches, Circuit breakers, Overload devices, Ground-fault protection, Grounding and isolating, Phase reversal, Surge protection, Interfacing DC or AC sources to control elements (relay protection device). **(4 Lectures)**

Electrical Wiring: Different types of conductors and cables, Basics of wiring-Star and delta connection, Voltage drop and losses across cables and conductors, Instruments to measure current, voltage, power in DC and AC circuits, Insulation, Solid and stranded cable, Conduit, Cable trays, Splices: wire nuts, crimps, terminal blocks, split bolts, and solder, Preparation of extension board. **(5 Lectures)**

Reference Books:

- A text book in Electrical Technology – B. L. Theraja – S. Chand & Co.
- A text book of Electrical Technology – A. K. Theraja
- Performance and design of AC machines – M. G. Say ELBS Edn.

LAB COURSE

Electrical Circuits and Network Skills (Lab)

Name of the Course	**Electrical Circuits and Network Skills (Lab)** **(Credits:-02)**
Course Code	**PHYBM 102 PR**
Maintain Project file or Dissertation to check Analytic Skill/Problem solving in skill exam.	
Semester Based Skill Examination	**20 marks (3Hrs)**
Distribution of Marks: Hands on Skill Test=**15 Marks**, Viva Voce =**5 Marks**.	

List of Experiments to be performed in Lab II:

1. To study Ammeter and Voltmeter.
2. To check continuity of a wire with the help of a Digital Multimeter.
3. To measure voltage of different batteries with the help of a Digital Multimeter.
4. To test LED's by using Digital Multimeter.
5. To find the resistance of carbon resistor by using Digital Multimeter and comparison with colour coding.
6. To find the resistance of parallel combination of resistors by using Digital Multimeter.
7. To find the resistance of series combination of resistors by using Digital Multimeter.
8. To test p-n diode using Digital Multimeter.
9. To measure current and voltage in a circuit with Digital Multimeter.
10. To check n-p-n and p-n-p transistor using parallel combination of resistors.
11. Practice of Soldering.
12. To measure current and voltage in a circuit with Digital Multimeter.
13. To study CRO.

Note: A minimum of EIGHT experiments to be carried out.

INORGANIC CHEMISTRY

Name of the Course	**INORGANIC CHEMISTRY** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 103 TH**
Semester Based Examination	**50 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections A, B, C, D and E. Section A will be compulsory. Examiner will set nine questions in all, selecting two questions from section B, C, D and E of **10** marks each and may contain more than one part. Section A will be of **10** marks and consists of objective type questions (MCQ/true and false/fill in the blanks etc.)of **one** mark each covering the entire paper.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.*

Unit - I	**Atomic Structure:** Review of Bohr's theory and its limitations, dual behaviour of matter and radiation, de Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra, Need of a new approach to Atomic structure, Schrodinger wave equation and meaning of various terms in it, Significance of ψ and ψ^2, Radial and angular nodes and the significance, Radial distribution functions and the concept of the most probable distance with special reference to 1sand 2s atomic orbitals, Significance of quantum numbers, Shapes of s, p and d atomic orbitals, nodal planes. Rulesfor filling electrons in various orbitals, Electronic configurations of the atoms, Stability of half-filled and completely filled orbitals, concept to exchange energy, Relative energies of atomic orbitals, Anomalous electronic configurations, Slaterrules and applications. **(14 lectures)**
Unit - II	**Chemical Bonding and Molecular Structure:** ***Ionic Bonding***: General characteristics of ionic bonding, Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds, Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character, ***Covalent bonding- VB Approach***: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, Concept of resonance and resonating structures in various inorganic and organic compounds, MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding

	combination of orbitals, MO treatment of homonuclear diatomic molecules up to Ne (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+. Comparison of VB and MO approaches. **(16 Lectures)**
Unit - III	**Hydrogen:** Unique position of Hydrogen in the periodic table, isotopes, ortho and para hydrogen, Industrial production, Hydrides and their chemistry, Heavy water, Hydrogen bonding, Hydrates. **S-Block Elements:** Periodicity of elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electron gain enthalpy, electro-negativity (Pauling Scale), General characteristics of s-block elements like density, melting points, flame colouration and reducing character, solvation and complexation tendencies and solutions of metals in liquid ammonia**.** **(8 Hours)**
Unit - IV	**P- Block Elements:** Comparative studies including diagonal relationship of group 13 and 14 elements, Boro hydrides, Hydrides, oxide and oxy-acids and halides of boron, borax, Borazine, allotropic forms of carbon, fullerenes, carbides of calcium and silicon, Hydrides, oxides, oxo acids and halides of nitrogen, Allotropic forms of phosphorous, Hydrides, halides, oxides and oxy acids of phosphorous, Basic properties of halogens and inter halogen compounds, pseudo halogens and poly halides. **Noble Gases:** Occurrence of noble gases, History of discovery of noble gases and isolation of noble gases form air, Preparation properties and structure of important compounds of noble gases-flourides, oxides, oxyflorides of xenon (valence bond structure only), Krypton difloride and clatherate compounds of noble gases. **(12 Hours)**

Reference Books:

1. Lee, J. D. Concise Inorganic Chemistry ELBS, 1991.
2. Cotton, F. A., Wilkinson, G. & Gaus, P. L. Basic Inorganic Chemistry,3rd ed.,Wiley.
3. Douglas, B.E., McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry, John Wiley & Sons.
4. Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Education India, 2006.

LAB COURSE

INORGANIC CHEMISTRY (LAB)

Name of the Course	**INORGANIC CHEMISTRY (LAB)** **(Credits:-02)**
Code	**PHYBM 103 PR**
Semester Based Examination	**20 Marks (3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills = **4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

List of Experiments:

1. To estimate volumetrically the strength of sodium carbonate and sodium bicarbonate in a given solution. Provided N/10 HCl.
2. To determine molarity and percentage purity of given oxalic acid x gram of which has been dissolved per 250 ml of solution. Provided N/20 potassium permanganate solution.
3. To estimate the strength of given sample of potassium permanganate solution in g/l. Prepare standard solution of N/10 Mohr salt.
4. To determine volumetrically the percentage of copper in a sample of copper sulphate crystals. Provided 0.1 N sodium thiosulphate solution.

Reference Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Differential Calculus

Name of the Course	**Differential Calculus** **Credits = 6 (L-5,T-1,P-0)**
Course Code	**PHYBM 104**
Continuous Comprehensive Assessment: CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 Marks,** Attendance Theory = **05 Marks.**	**Max. Marks:30**
Tutorials: Solving Problems and exercises	15 hours
Semester Based Examination	**Max. Marks: 70** Maximum Times: 3 hrs.
Total Lectures to be Delivered (One Hour Each)	75

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of* ***two Sections A & B*** *of 70 marks.* ***Section A*** *will be* ***Compulsory*** *and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus.* ***Section B*** *of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.*

2. *Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.*

Unit - I	Limit and Continuity (epsilon and delta definition), Types of discontinuities, Differentiability of functions, Successive differentiation, Leibnitz's theorem. **(19 Hours)**
Unit - II	Indeterminate forms, Rolle's theorem, Lagrange's & Cauchy Mean Value theorems, Taylor's theorem with Lagrange's and Cauchy's forms of remainder, Taylor's series, Maclaurin's series of sin x, cos x, e^x, log (1+x), $(1+x)^m$. **(19 Hours)**
Unit - III	Concavity, Convexity & Points of Inflexion, Curvature, Radius of curvature, centre of curvature, Asymptotes, Singular points, Double point, Polar coordinates, Relation between Cartesian and polar coordinates. **(19 Hours)**
Unit - IV	Functions of several variables (upto three variables): Limit and Continuity of these functions Partial differentiation, Euler's theorem on homogeneous functions, Maxima and Minima with Lagrange Multipliers Method (two variables), Jacobian (upto three variables). **(18 Hours)**

Books Recommended:

1. H. Anton, I. Birens and S. Davis, *Calculus*, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, *Calculus*, Pearson Education, 2007.

Writing Skills

Name of the Course	**A. E. C. Course: Writing Skills (English)** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 105**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance **CCA**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of eight questions in all. All questions will be compulsory. However choices are to be provided in each question. Each question will carry marks as per pattern of testing given below.

For End Term Examination: 70 Marks (Three Hours)

1. Notice	6 Marks
2. Letter Writing	10 Marks
3. Resume Writing	10 Marks
4. Diary Writing	6 Marks
5. Paragraph Writing (80-100 words)	6 Marks
6. Report Writing	10 Marks
7. Summary or Note Making	10 Marks
8. Feature Article or Interview (200 words)	12 Marks

2. The candidate will be required to attempt eight questions in all. The duration of the examination will be 3 hours.

Syllabus of English [PHYBM 105]

Writing Skills

i) Diary Writing
ii) Paragraph Writing
iii) Summary/Note-making
iv) Formal and Informal Letter Writing
v) CV/Resume Writing
vi) Report Writing

vii) Interview/Feature Article
viii) Notice Writing

Classroom Activity:

Speaking Skills, Listening Skills, Mock Interview, Speech Making and Project Work

Suggested projects:

Sports writing, poetry about women/men, poetry in translation, translating a poem, telling a story, fantasy writing, chat shows, the menace of dowry, a success story, creative writing, theatre groups, interviewing a celebrity, writing a newspaper article on a current topic, today's youth icons, leadership and politics, examination system and benefits of reform, the epics, communalism, gender discrimination, social activism.

Recommended Reading:

1. *English Communication Skills: AECC under CBCS, HPU*. Meenakshi F. Paul and Madhumita Chakraborty. Macmillan,2017.

Suggested Readings:

1. *Fluency in English,*Part I. Macmillan, 2005.
2. *Fluency* in English. Part II. OUP, 2006. Unit 1-15.
3. *El Dorado: A Textbook of Communication Skills*. Orient Blackswan, 2014. Units 1-5.
4. *Interchange.* Workbook III, Fourth Edition. Cambridge University Press, 2015. Units 1-8.
5. *New Headway.* Intermediate Student's Book. 3rd Edition, Oxford University Press, 2012. Units 1-6.
6. *Write to be Read*: *Reading, Reflecting & Writing.* First South Asian edition, Cambridge University Press, 2014. Units 1-4.
7. *Business English*. Pearson, 2008. Units 4-6.

DETAILED SCHEME & SYLLABUS OF 2nd SEMESTER

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
2nd	Core Course-IV	PHYBM 201 TH	Electricity, Magnetism and EMT (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	28
		PHYBM201 PR	Electricity, Magnetism and EMT (Lab.)	2	Lab. = 20		
	SEC-2	PHYBM 202 TH	Physics Workshop Skills (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	
		PHYBM 202 PR	Physics Workshop Skills (Lab.)	2	Lab. = 20		
	Core Course-V	PHYBM 203 TH	Organic Chemistry (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	
		PHYBM 203 PR	Organic Chemistry (Lab.)	2	Lab. = 20		
	Core Course-VI	PHYBM 204	Differential Equations	6 (TH + IA=5,TU= 1)	Theory = 70 IA = 30	100	
	A.E.C. Course-II	PHYBM 205	Environment Science	4 (TH)	Theory = 100	100	

B. Sc.-M. Sc. Physics Five Year Integrated Course
2nd Semester

ELECTRICITY, MAGNETISM AND EMT

Name of the Course	**ELECTRICITY, MAGNETISM AND EMT** **(Credits:Theory-04)Theory:60** **Lectures**
Code	**PHYBM 201 TH**
Semester Based Examination	**50 Marks(3Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory**=05 marks. CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A (compulsory, covering syllabus from all the units), section B (Unit I), section C (Unit II), section D (Unit III) and section E (Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09marks.Question Number1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number1). The duration of the examination will be 3hours.

Unit - I	**Vector Analysis**: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem, Stokes's theorem, Green's theorem. **(5 Lectures)** **Electrostatics**: Significance of electrostatic force, Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet,

	charged conductor, electrostatic potential, electrostatic potential energy. Electric potential due to a dipole and quadrupole, long uniformly changed wire, charged disc. Electric potential energy. Electric field as a gradient of a scalar potential. Calculation of electric field due to a point charge and a dipole from potential. Method of Electrical Images. Poisson and Laplace equations. **(7 Lectures)** **Electric Current and Fields of Moving charges**: Current and current density. Continuity equation; $\vec{J} + \frac{\partial \rho}{\partial t} = 0$. Microscopic form of Ohm's law (**J** α **E**) and conductivity. Failure of Ohms law and its explanation. Invariance of charge. **(3 Lectures)**
Unit - II	**Magnetism:** Ampere circuital law and its applications. Hall Effect, Expression for Hall constant and its significance. Divergence and curl of magnetic field **B**. Vector potential: Definition of vector potential **A** and derivation. **(5 Lectures)** **Field of Moving Charges:** E in different frames of reference. Field of a point charge moving with constant velocity. Field of charge that starts or stops (qualitative). Interaction between moving charge and force between parallel currents. **(4 Lectures)** **Surface current density**: Definition. And its use in calculation of change in magnetic field at a current sheet. Transformation equations of E and B from one frame of reference to another. Dielectrics, parallel plate capacitor with a dielectric, dielectric constant, polarization and polarization vector, displacement vector **D**, molecular interpretation of Claussius- Mossotti equation, boundary conditions satisfied by **E** and **D** at the interface between two homogenous dielectrics, illustration through a simple example**.** **(6 Lectures)**
Unit - III	**Electrostatic Fields in Dielectrics:** Polarization of matter. Atomic and molecular dipoles, induced Dipole moment and atomic polarizability. Electric susceptibility and polarization vector, Capacity of a capacitor filled with Dielectrics. Dielectrics and Gauss's law Displacement vector-Establishment of relation $\nabla . \boldsymbol{D} = \rho_{free}$. Energy stored in a dielectric medium. **(7 Lectures)** **Magnetic Fields in Matter**: Behaviour of various substances in magnetic fields. Definition of M and H and their relation to free and bound currents. Magnetic permeability and susceptibility and their inter relation. Orbital motion of electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites. **(8 Lectures)**
Unit - IV	**Maxwell`s equations and Electromagnetic wave propagation:** Displacement current, Maxwell's equations and its physical interpretation, EM waves and wave equation in a medium having finite permeability and permittivity but with conductivity ρ = 0. Poynting vector, Poynting theorem, Impedance of a dielectric to EM waves, EM waves in conducting medium and skin depth. EM waves velocity in a conductor and anomalous dispersion. Reflection and Transmission of EM waves at a boundary of two dielectric media for normal and oblique incidence of reflection of EM waves from the surface of a conductor at normal incidence. **(15 Lectures)**

Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Electricity and Magnetism, J.H. Fewkes & J.Yarwood.Vol.I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, DC Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Introduction to Electrodynamics, D.J. Griffth, 3rdEdition, Prentice Hall of India.
- Electricity and Magnetism, Brij Lal and Subramanium, S.Chand & Co. Ltd.
- Electricity and Magnetism, A S Mahajan and A A Rangwala, Tata McGraw Hill Company.

LAB COURSE
ELECTRICITY, MAGNETISM AND EMT (LAB)

Name of the Course	**ELECTRICITY, MAGNETISM AND EMT (LAB) (Credits:-02)**
Code	**PHYBM 201PR**
Semester Based Examination	**20 Marks(3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills = **4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

PHYSICSLAB-DSC1B LAB: ELECTRICITY, MAGNETISM AND EMT

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer:

(i) Measurement of charge and current sensitivity
(ii) Measurement of CDR
(iii) Determine a high resistance by Leakage Method
(iv) To determine Self Inductance of a Coil by Rayleigh's Method.

3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determined B/dx).
5. To study the Characteristics of a Series RC Circuit.
6. To study a series LCR circuit and determine its (a) Resonant Frequency,(b) Quality Factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorem
10. To verify the Super position, and Maximum Power Transfer Theorem
11. To determine unknown capacitance by flashing and quenching method
12. To find frequency of ac supply using an electrical vibrator.
13. To study the induced emf as a function of the velocity of the magnet (simple method).

Reference Books:

- Advanced Practical Physics for students, B.L. Flint & H.T.Worsnop,1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Engineering Practical Physics, S.Panigrahi & B. Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Advanced level Physics Practicals, Michael Nelson and Jon M.Ogborn, 4th Edition, reprinted 1985,Heinemann Educational Publishers
- B.Sc. Practical Physics C.L. Arora, S. Chand and companyLtd.

PHYSICS WORKSHOP SKILL

Name of the Course	**PHYSICS WORKSHOP SKILL** **(Credits:Theory-04)** **Theory:30 Lectures**
Code	**PHYBM 202TH**
Semester Based Examination	**50 Marks (3Hrs)**
Continuous Comprehensive Assessment(CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory:** Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05marks,** Attendance Theory **= 05 marks. CCA Skill**: Project File or Dissertation Record +Seminar = **5 + 5marks.**	

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks.*
2. *The candidate will be required to attempt five questions in all.*
3. *The duration of the examination will be 3 hours.*

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode

Introduction: Measuring units. Conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc. **(4 Lectures)**

Mechanical Skill: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood. Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet. **(10 Lectures)**

Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switchusing transistor and relay.

(10 Lectures)

Introduction to prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. Braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment. **(6 Lectures)**

Reference Books:

- A text book in Electrical Technology-BL Theraja – S. Chand and Company.
- Performance and design of AC machines–M.G. Say, ELBSE dn.
- Mechanical workshop practice, K.C.John, 2010, PHIL earning Pvt. Ltd.
- Workshop Processes, Practices and Materials, Bruce J Black 2005,3rd Edn., Editor Newnes [ISBN:0750660732]
- New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN:0861674480]

LAB COURSE

PHYSICS WORKSHOP SKILL (LAB)

Name of the Course	**PHYSICS WORKSHOP SKILL (LAB)** **(Credits:-02)**
Course Code	**PHYBM 202 PR**
Maintain Project file or Dissertation to check Analytic Skill/Problem solving in skill exam.	
Semester Based Skill Examination	**20 Marks (3Hrs)**
Distribution of Marks: Hands on Skill Test=**15 Marks**, Viva Voce =**5 Marks**.	

1. To determine volume of a given cylindrical object using vernier calliper.
2. To determine thickness of torsional pendulum.
3. To determine the thickness of glass plate using spherometer.
4. To measure amplitude of time varuing signals.
5. To measure frequency of time varying signals.
6. To determine the moment of inertia of a sphere.
7. To determine the least count of sextant.
8. To determine height of a pole using Sextant.

ORGANIC CHEMISTRY

Name of the Course	**ORGANIC CHEMISTRY (Credits: Theory-04)**
Code	**PHYBM 203 TH**
Semester Based Examination	**50 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

Instructions for Paper Setters and Candidates:

*1. The question paper will consist of five sections A, B, C, D and E. Section A will be compulsory. Examiner will set nine questions in all, selecting two questions from section B, C, D and E of **10** marks each and may contain more than one part. Section E will be of **10** marks and consists of objective type questions (MCQ/true and false/fill in the blanks etc.) of **one** mark each covering the entire paper.*

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Unit - I	**Fundamentals of Organic Chemistry:** Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyper conjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals. Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel'srule. **Stereochemistry:** Conformations with respect to ethane, butane and cyclo hexane. Inter conversion of Wedge Formula, Newman, Saw horse and Fischer projections. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Dia stereomerism and Meso compounds). Threo and erythro; D and L; cis – trans nomenclature; CIP Rules: R/S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems) **(18 Hours)**

Unit-II	**Aliphatic Hydrocarbons:** **Alkanes:** (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation. **Alkenes:** (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydro halogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction).Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation. **Alkynes:** (Upto 5 Carbons) Preparation:Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetrahalides and dehydro halogenations of vicinal-dihalides. **Reactions:** Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alkaline $KMnO_4$. **(12 Hours)**
Unit - III	**Aromatic hydrocarbons:** Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene):Electrophilic substitution: nitration, halogenations and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene).Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene). **Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions. **Preparation**: from alkenes and alcohols. **Reactions:** hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation, Williamson's ether synthesis. Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. **Reactions (Chlorobenzene)**: Aromatic nucleo philic substitution (replacement by–OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides. **(15 Hours)**
Unit - IV	**Alcohols, Phenols and Ethers (Up to 5 Carbons):** **Alcohols:** Preparation: Preparation of 1^o, 2^o and 3^o alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. **Reactions:** With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc.HNO_3). Oppeneauer oxidation Diols: (Upto6 Carbons) oxidation of diols.Pinacol-Pinacolonerearrangement. **Phenols:** (Phenol case) Preparation: Cumenehydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer - Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten–Baumann Reaction. **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI. **Aldehydes and ketones (aliphatic and aromatic):**(Formaldehye, acetaldehyde, acetone and benzaldehyde) **Preparation:** From acid chlorides and from nitriles. **Reactions:** Reaction with HCN, ROH, $NaHSO_3$, NH_2-Gderivatives. Iodoformtest. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verleyreduction. **(15 Hours)**

Reference Books:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. Mc Murry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P.A Guide book to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Eliel, E.L. Stereochemistry of Carbon Compounds, Tata McGraw Hill education,2000.
5. Finar, I.L. Organic Chemistry (Vol. I &II), E.L.B.S.
6. Morrison, R.T. & Boyd, R.N., Organic Chemistry, Pearson, 2010.
7. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S.Chand, 2010.

LAB COURSE

ORGANIC CHEMISTRY (LAB)

Name of the Course	**ORGANIC CHEMISTRY (LAB)** **(Credits:-02)**
Code	**PHYBM 203 PR**
Semester Based Examination	**20 Marks(3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills = **4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

List of Experiments:

1. To prepare a pure organic sample of oxalic acid from impure sample of oxalic acid using water as a solvent.

2. To prepare a sample of urea from impure sample of urea using water as a solvent.

3. To study the effect of solvent Rf and the resolution for fluorescein dye by using thin layer chromatography.

4. To seperate a mixture of ethanol- water by simple distillation using water condensor.

5. Salt analysis (To detect presence of an organic compound).

Reference Books:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Text book of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.

Differential Equations

Name of the Course	**Differential Equations** **(Credits:Theory-06 L-5, T-1, P-0)** **Theory:60 Lectures**
Code	**PHYBM 204**
Semester Based Examination	**70 Marks (3Hrs)**
Continuous Comprehensive Assessment(CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory = **05 marks.**	

Instructions for Paper Setters and Candidates:

1*. The question paper will consist of two Sections A & B of 70 marks. Section A will be Compulsory and will contain 8 questions of 16 marks (each of 2 marks) of short answer type having two questions from each Unit of the syllabus. Section B of the question paper shall have four Units I, II, III, and IV. Two questions will be set from each unit of the syllabus and the candidates are required to attempt one question from each of these units. Each question in Units I, II, III and IV shall be of 13.5 marks each.*

2. *Candidates are required to attempt five questions in all. Section A is Compulsory and from Section B they are required to attempt one question from each of the Units I, II, III and IV of the question paper.*

Unit - I	First order exact differential equations. Integrating factors, rules to find an integrating factor. First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations.
Unit - II	Basic theory of linear differential equations, Wronskian, and its properties. Solving a differential equation by reducing its order. Linear homogenous equations with constant coefficients, Linear non-homogenous equations, The method of variation of parameters.
Unit - III	The Cauchy-Euler equation, Simultaneous differential equations, Total differential equations. Order and degree of partial differential equations, Concept of linear and non-linear partial differential equations, Formation of first order partial differential equations (PDE), Linear partial differential equation of first order, Lagrange's method.
Unit - IV	Charpit's method for solving PDE, Classification of second order partial differential equations into elliptic, parabolic and hyperbolic through illustrations only.

Books Recommended:

1. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, 1984.
2. I. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, International Edition, 1967.

Environment Science

Name of the Course	**Environment Science** **(A.E.C. Course-II)** **(Credits: Theory-04)**
Code	**PHYBM 205**
Semester Based Examination	**100 Marks (3 Hrs)**

Instructions for Paper Setters and Candidates:

The Examiner will set a total of nine (9) questions covering all topics/units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions of two marks each that will cover entire course will compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit - I	Introduction to environmental studies & Ecosystems: Multidisciplinary nature of environmental studies: Scope and importance; what is an ecosystem? :Structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems; Levels of biological diversity: genetic, species and ecosystem diversity, Biogeographic zones of India, Biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, Endangered and endemic species of India, Threats to biodiversity, Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, Conservation of biodiversity, In-situ and Ex-situ conservation of biodiversity, Concept of sustainability and sustainable development. **(15 Lectures)**
Unit - II	Natural Resources & its management and conservation: Land resources and land use change: Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and overexploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. **(15 Lectures)**
Unit - III	Environmental Pollution & Management: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Solid waste management: Control measures of urban and industrial waste- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act, Air (Prevention & Control of Pollution) Act, Water (Prevention and control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD); Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context. **(15 Lectures)**
Unit - IV	Environment & Social Issues: Human population growth: Impacts on environment, human health and welfare; Re-settlement and rehabilitation of project affected persons; ease studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; Environmental

	communication and public awareness, case studies. ***Dangers and III Effects of Drug Consumption*** Introduction- Definition of addiction, addict and Mode of action of drugs on body organs. Types of Drugs - Sedatives and tranquillizers, opiate narcotics, stimulants, Hallucinogens, Examples and their harmful effects. Reasons for drug addiction- Curiosity, peer pressure, frustration and depression, family history, prolonged use of drugs for pain relief. Ill effects of drug addiction - on the health of the victim, family and society. Rehabilitation of Drug Addicts- Role of family, friends, society and rehabilitation centres. **(15 Lectures)**

Books Recommended:

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt,
2. Gadgil, M., &Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
4. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
7. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29-64). Zed Books.
8. Singh, J. S., Singh, S. P. & Gupta, S. R. 2014. Ecology, Environment Science and Conservation. S. Chand Publishing New Delhi

DETAILED SCHEME & SYLLABUS OF 3rd SEMESTER

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
3rd	Core Course-VII	PHYBM 301 TH	Wave Motion and Optics (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	30
		PHYBM 301 PR	Wave Motion and Optics (Lab.)	2	Lab. = 20		
	Core Course-VIII	PHYBM 302 TH	Elements of Modern Physics (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	
		PHYBM 302 PR	Elements of Modern Physics (Lab)	2	Lab. = 20		
	Open Elective -I	PHYBM 303	1. Optical Instruments 2. Elements of Astronomy and Astrophysics 3. Energy source 4. Climate science	4 (3TH + 1 TUT)	Theory = 70 IA = 30	100	
	SEC-III	PHYBM 304	Computational Physics Skills	3 (TH + IA)	End Term = 70 IA = 30	100	
	A.E.C. Course-III	PHYBM 305	Soft Skills	3	Internal = 100	100	
	Value Added Course	PHYBM 306	Community Connect Based Course	8	MT=100, IA= 100, ET = 200	400	

B. Sc.-M. Sc. Physics Five Year Integrated Course
3rd Semester
Wave Motion and Optics

Name of the Course	**Wave Motion and Optics** **(Credits:Theory-04)Theory:60 Lectures**
Code	**PHYBM 301 TH**
Semester Based Examination	**50 Marks(3Hrs)**
Continuous Comprehensive Assessment(CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory = **05 marks.CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A (compulsory, covering syllabus from all the units), section B (Unit I), section C (Unit II), section D (Unit III) and section E (Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number1). The duration of the examination will be 3hours.*

Unit - I	**Waves:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation (derivation), Wave Equation – Differential form (derivation). Particle and Wave Velocities - Relation between them, Energy Transport –Expression for intensity of progressive wave, Newton's Formula for Velocity of Sound. Laplace's Correction (Derivation). Brief account of Ripple and Gravity Waves. **Superposition of Harmonic Waves:** Linearity and superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats) – Analytical treatment. Superposition of two perpendicular harmonic oscillations: Lissajous Figures with equal and unequal frequency- Analytical treatment. Uses of Lissajous' figures. **(15 Lectures)**
Unit - II	**Standing Waves:** Velocity of transverse waves along a stretched string (derivation), Standing (Stationary) Waves in a String - Fixed and Free Ends (qualitative). Theory of Normal modes of vibration in a stretched string, Energy density and energy transport of a

	transverse wave along a stretched string. Vibrations in rods – longitudinal and transverse modes (qualitative). Velocity of Longitudinal Waves in gases (derivation). Normal Modes of vibrations in Open and Closed Pipes – Analytical treatment. Concept of Resonance, Theory of Helmholtz resonator. **Acoustics:** Absorption coefficient, Reverberation time -Sabine's Reverberation formula (derivation), Factors affecting acoustics in buildings, Requisites for good acoustics. Acoustic measurements – intensity and pressure levels. **(15 Lectures)**
Unit - III	**Nature of light:** Corpuscular theory- laws of reflections and refraction; The Wave model, Group velocity & wave velocity - relation between them, Maxwell's electromagnetic waves. **Interference of light by division of wave front:** Coherent source-Interference of light waves by division of wave-front, Young's double slit interference- theory and experiment, Fresnel Biprism- theory and experiment (determination of wavelength). **Interference of light by division of amplitude:** Interference at thin films – reflected and transmitted light, Colours of thin films; Theory of air wedge; Theory of Newton's rings (Reflection). Determination of Refractive index of a liquid, Michelson Interferometer-Determination of wavelength of light. **(15Lectures)**
Unit - IV	**Fraunhofer diffraction:** Introduction- Fraunhofer diffraction- Theory of single slit diffraction, Two slit diffraction pattern, Theory of diffraction Grating, Normal and oblique incidence – experimental determination of wavelength, Resolving power – Rayleigh criterion, Expression for resolving power of grating and telescope. **Fresnel Diffraction-** Concept of Fresnel half period zones, Comparison of Zone plate with lens, Theory of diffraction at a straight edge, Qualitative discussion on diffraction by a circular aperture and diffraction by an opaque disc. **Polarisation:** Production of polarized light, Malus' law, Phenomenon of double refraction in crystals, Quarter wave plate and half wave plate, Optical activity, Laurent's half shade polarimeter. **(15Lectures)**

Text Books:

1. The Physics of Waves and Oscillations, N K Bajaj Tata McGraw-Hill Publishing Company Ltd., Second Edition, 1984.
2. Waves and Oscillations, N Subramanyam and Brij Lal,Vikas Publishing House Pvt. Ltd., Second Revised Edition, 2010.
3. A Text Book of Sound, D R Khanna and R S Bedi, Atma Ram & Sons, Third Edition, 1952
4. Oscillations and Waves, Satya Prakash, Pragathi Prakashan, Meerut, Second Edition, 2003
5. A Text Book of Optics, Brij Lal, M N Avadhanulu & N Subrahmanyam S. Chand Publishing, 2012

References Books

1. Optics, Ajoy Ghatak McGraw Hill Education (India) Pvt Ltd, 2017

LABCOURSE

Wave Motion and Optics (Lab)

Name of the Course	**Wave Motion and Optics (Lab)** **(Credits:-02)**
Code	**PHYBM 301 PR**
Semester Based Examination	**20 Marks (3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills=**4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

List of Experiments to be performed in Lab:

1. Velocity of sound through a wire using Sonometer.
2. Frequency of AC using Sonometer.
3. Study of Lissajous' Figures
4. To verify the laws of transverse vibration using Melde's apparatus.
5. Helmholtz resonator using tuning fork.
6. Helmholtz resonator using electrical signal generator.
7. Study of Lissajous figures using CRO
8. To determine refractive index of the material of a prism using sodium source.
9. To determine refractive index of a liquid by parallax method.
10. To determine the dispersive power and Cauchy constants of the material of a prism using Hg source.
11. To determine wavelength of sodium light using Fresnel Biprism.
12. Determination of radius of curvature of a lens using Newton's rings.
13. To determine the thickness of a paper using air-wedge.
14. Study of Fraunhofer diffraction at single slit
15. Study of Diffraction at a straight edge.
16. To determine wavelength of spectral lines of Hg source using plane diffraction grating.
17. To determine dispersive power and resolving power of a plane diffraction grating.
18. To verify Brewster's law.
19. To determine specific rotation of a solution using Polarimeter.

Note: A minimum of EIGHT experiments to be carried out.

Elements of Modern Physics

Name of the Course	**Elements of Modern Physics (Theory)** **(Credits:Theory-04)Theory:60 Lectures**
Code	**PHYBM 302 TH**
Semester Based Examination	**50 Marks(3Hrs)**
Continuous Comprehensive Assessment(CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory = **05 marks. CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Instructions for Paper Setters and Candidates:

1. *The question paper will consist of five sections: Section A (compulsory, covering syllabus from all the units), section B (Unit I), section C (Unit II), section D (Unit III) and section E (Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*
2. *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory questionnumber1). The duration of the examination will be 3hours.*

Unit - I	Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra. **(15 Lectures)**
Unit - II	Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle. Two slit interference experiment with photons, atoms & particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension. **(15 Lectures)**
Unit - III	One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.

	Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy. **(15 Lectures)**
Unit - IV	Radioactivity: stability of nucleus; Law of radioactive decay; Mean life and half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission. Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions. **(15 Lectures)**

Suggested Reading:

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2009, PHI Learning
3. Six Ideas that Shaped Physics:Particle Behave like Waves, Thomas A. Moore, 2003, McGrawHill
4. Quantum Physics, Berkeley Physics, Vol. 4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning
6. Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

LAB COURSE

Elements of Modern Physics (Lab)

Name of the Course	**Elements of Modern Physics (Lab)** **(Credits:-02)**
Code	**PHYBM 302 PR**
Semester Based Examination	**20 Marks (3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills=**4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

List of Experiments to be performed in Lab:

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine the ionization potential of mercury.
4. To determine value of Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the absorption lines in the rotational spectrum of Iodine vapour.
7. To study the diffraction patterns of single and double slits using laser and measure its intensity variation using Photo sensor & compare with incoherent source – Na.
8. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
9. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
10. To setup the Millikan oil drop apparatus and determine the charge of an electron.
11. Determination of Eg in Si and Ge.
12. Determination of Planck's constant using photocell.
13. Dependence of scattering angle on kinetic energy and impact parameter in Rutherford scattering (mechanical analogue).
14. Verification of Rutherford- Soddy nuclear decay formula - mechanical analogue.
15. To find half-life period of a given radio-active substance using GM counter/ Characteristics of GM Counter.

Note: A minimum of EIGHT experiments to be carried out.

Books Recommended:

1. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal
2. Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
3. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.
4. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

OPEN ELECTIVE COURSE

1. Optical Instruments

Name of the Course	**Optical Instruments** **(Credits: Theory-04) Theory: 56 Lectures**
Code	**PHYBM 303**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Basics of Optics:** Scope of optics, optical path, laws of reflection and refraction as per Fermat's principle, magnifying glass, Lenses (thick and thin), convex and concave lenses, Lens makers formulae for double concave and convex lenses, lens equation. Focal and nodal points, focal length, image formation, combination of lenses, dispersion of light: Newton's experiment, angular dispersion and dispersion power. Dispersion without deviation. (No derivations; concepts to be discussed qualitatively). **(15 Lectures)**

Unit - II	**Camera and microscopes:** Human eye (constitution and working), Photographic camera (principle, construction and working), construction, working and utilities of (i) Simple microscopes (ii) Compound microscope (iii) Electron microscopes (iv) Binocular microscopes *Self study:* Experimental determination of magnifying power of a microscope. **(15 Lectures)**
Unit - III	**Telescopes:** Construction, working and utilities of (i) Astronomical telescopes (ii) Terrestrial telescopes (iii) Reflecting telescopes **(13Lectures)**
Unit - IV	**Spectrometer:** Construction, working and utilities of Eyepieces or Oculars (Huygen, Ramsden's, Gauss) Spectrometer – Construction, working and utilities, measurement of refractive index. **(13Lectures)**
	Activity for tutorial classes 01 lectures/week 1. Find position and size of the image in a magnifying glass and magnification. 2. Observe rain bows and understand optics. Create a rainbow. 3. Find out what makes a camera to be of good quality. 4. Observe the dispersion of light through prism. 5. Make a simple telescope using magnifying glass and lenses. 6. Learn principle of refraction using prisms. 7. Check bending of light in different substances and find out what matters here. 8. Learn about different telescopes used to see galaxies and their ranges.

Reference Books:

1. Galen Duree. Optics for Dummies. Wiley. 2011.
2. Blaker J W. Optics: An Introduction for Students of Engineering. Pearson, 2015.
3. Hecht E. Optics. Pearson. 5th Edition, 2019.
4. Khurana A K. Theory And Practice Of Optics & Refraction. Elsevier India. 2016.

2. Elements of Astronomy & Astrophysics

Name of the Course	**Elements of Astronomy & Astrophysics** **(Credits: Theory-04) Theory: 56 Lectures**
Code	**PHYBM 303**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Ancient Astronomy:** Greek Observations, Sumerian Observations, Mayan Observations, Arabic Observations ,Chinese Observations **Indian Astronomy:** Vedic Astronomy, Ancient Astronomy – Aryabhata, Varahamihira, Bhaskara, Astronomy in Indian Scriptures, Precession of the Equinox, Celebrations of Equinox **Medieval & Modern Astronomy:** Invention of Telescopes, Models of the Solar System & Universe, Observations by Tycho Brahe, Kepler, Galileo, Herschel and Other, Modern Astronomy **(15 Lectures)**

Unit - II	**Optical Tools for Astronomy:** Pin Hole, Binoculars, Telescopes & Imaging (1 hour) Mathematical Methods of Observations: Angular Measurement, Trigonometric functions, Stellar Parallax **Observational Terminologies:** Cardinal Directions, Azimuth, Altitude, Measurements using Compass and Hand. Equatorial Co-ordinates, Light years, Magnitude, Colors etc. **(10 Lectures)**
Unit - III	**Observations of the Solar System** **The Sun:** Ecliptic and the Orientation of the Earth, Seasons - Solstices and Equinox, Observations of the Sun from Earth during seasons. Eclipses, Zero-shadow day, Sunspots **The Moon:** Earth-Moon system – Phases, Lunar Eclipses, Ecliptic and Lunar Orbital Plane – Nodes, Lunar Month, Full Moon Names **Inner Planets:** Mercury & Venus - Observational History, Observational Windows, Appearance, Apparitions, Elongations, Superior Conjunctions, Inferior Conjunctions, Transits. **Outer Planets:** Mars, Jupiter & Saturn - Observational History. Observational Windows, Appearance, Frequency of Oppositions, Conjunctions, Moons Eclipses. Galilean Moons, Saturn's Rings. **(15 Lectures)**
Unit - IV	**Major Astronomy Observations** **March to June:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. **June to September:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. **September to December:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. **December to March:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. **(16 Lectures)**
	Activity for tutorial classes 01 lectures/week 1. Measuring Seasons using Sun's Position. 2. Measuring Distance using Parallax 3. Estimation of the Stellar Diameter using Pin Hole 4. Measuring Height of an Object Using Clinometer. 5. Star spotting using constellation maps 6. Constellation spotting using Skymaps 7. Estimation of 'Suitable Periods' to observe deep sky objects using Planisphere. 8. Estimation of the Size of the Solar System in using Light Years. 9. Identification of Lunar Phases across a year. 10. Measuring Constellation of the Sun using Night Sky maps or Planispheres.

Reference Books:

1The Stargazer's Guide - How to Read Our Night Sky by Emily Winterburn
2. A guide to the Night Sky – Beginner's handbook by P.N. Shankar
3. The Complete Idiot's guide to Astronomy by Christopher De Pree and Alan Axelro

3. Energy Sources

Name of the Course	**Energy Sources** **(Credits: Theory-04) Theory: 56 Lectures**
Code	**PHYBM 303**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Introduction:** Energy concept-sources in general, its significance & necessity. Classification of energy sources: Primary and Secondary energy, Commercial and Non-commercial energy, Renewable and Non-renewable energy, Conventional and Non-conventional energy, Based on Origin-Examples and limitations. Importance of Non-commercial energy resources. **Conventional energy sources:** Fossil fuels & Nuclear energy- production & extraction, usage rate and limitations. Impact on environment and their issues& challenges. Overview of Indian & world energy scenario with latest statistics- consumption & necessity. Need of eco-friendly& green energy & their related technology. **(13 Lectures)**
Unit - II	**Renewable energy sources:** Need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

	Solar energy: Solar Energy-Key features, its importance, Merits & demerits of solar energy, Applications of solar energy. Solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell -brief discussion of each. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(13 Lectures)**
Unit - III	**Wind and Tidal Energy harvesting:** Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy. **(10 Lectures)**
Unit - IV	**Geothermal and hydro energy** Geothermal Resources, Geothermal Technologies. Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Carbon captured technologies, cell, batteries, Power consumption. **(10Lectures)**
	Activity for tutorial classes 01 lectures/week 1. Demonstration of on Solar energy, wind energy, etc, using training modules at Labs. 2. Conversion of vibration to voltage using piezoelectric materials. 3. Conversion of thermal energy into voltage using thermoelectric (using thermo couples or heat sensors) modules. 4. Project report on Solar energy scenario in India 5. Project report on Hydro energy scenario in India 6. Project report on wind energy scenario in India 7. Field trip to nearby Hydroelectric stations. 8. Field trip to wind energy stations like Chitradurga, Hospet, Gadag, etc. 9. Field trip to solar energy parks like Yeramaras near Raichur. 10. Videos on solar energy, hydro energy and wind energy.

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, NewDelhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing CompanyLtd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

4. Climate Science

Name of the Course	**Climate Science** **(Credits: Theory-04) Theory: 56 Lectures**
Code	**PHYBM 303**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Atmosphere** Atmospheric Science (Meteorology) as a multidisciplinary science. Physical and dynamic meteorology, Some terminology, difference between weather and climate, weather and climate variables, composition of the present atmosphere: fixed and variable gases, volume mixing ratio (VMR), sources and sinks of gases in the atmosphere. Green house gases. Structure (layers)of the atmosphere. Temperature variation in the atmosphere, temperature lapse rate, mass, pressure and density variation in the atmosphere. Distribution of winds. **(15 Lectures)**

Unit - II	**Climate Science** Overview of meteorological observations, measurement of: temperature, humidity, wind speed and direction and pressure. Surface weather stations, upper air observational network, satellite observation. Overview of clouds and precipitation, aerosol size and concentration, nucleation, droplet growth and condensation (qualitative description). Cloud seeding, lightning and discharge. Formation of trade winds, cyclones. **(13 Lectures)**
Unit - III	**Modelling of the atmosphere:** General principles, Overview of General Circulation Models (GCM) for weather forecasting and prediction. Limitations of the models. R and D institutions in India and abroad dedicated to climate Science, NARL, IITM, CSIR Centre for Mathematical Modeling and Computer Simulation, and many more. **(13 Lectures)**
Unit - IV	**Global Climate Change** Green house effect and global warming, Enhancement in concentration of carbon dioxide and other green house gases in the atmosphere, Conventional and non-conventional energy sources and their usage. EL Nino/LA Nino Southern oscillations. *Causes for global warming:* Deforestation, fossil fuel burning, industrialization. Manifestations of global warming: Sea level rise, melting of glaciers, variation in monsoon patterns, increase in frequency and intensity of cyclones, hurricanes, tornadoes. Geo-engineering as a tool to mitigate global warming? Schemes of geo-engineering. **(15 Lectures)**
	Activity for tutorial classes 01 lectures/week 1. What would have happened if ozone is not present in the stratosphere? 2. Visit a nearby weather Station and learn about their activities. 3. Design your own rain gauge for rainfall measurement at your place. 4. Learn to determine atmospheric humidity using wet bulb and dry bulb thermometers. 5. Visit the website of Indian Institute of Tropical Meteorology (IITM), and keep track of occurrence and land fall of cyclone prediction. 6. Learn about ozone layer and its depletion and ozone hole. 7. Keep track of melting of glaciers in the Arctic and Atlantic region through data base available over several decades. 8. Watch documentary films on global warming and related issues (produced by amateur film makers and promoted by British Council and BBC).

Reference Books:

1. Basics of Atmospheric Science – A Chndrashekar, PHI Learning Private Ltd. New Delhi, 2010.
2. Fundamentals of Atmospheric Modelling- Mark Z Jacbson, Cambridge University Press, 2000.

COMPUTATIONAL PHYSICS SKILLS

Name of the Course	**Computational Physics Skills** **(Credits: 03)** **45 Lectures**
Code	**PHYBM 304**
Semester Based Examination	**70 Marks**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA report:** Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

*The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics. • Highlights the use of computational methods to solve physical problems • Use of computer language as a tool in solving physics problems (applications) • Course will consist of hands on training on the Problem solving on Computers***.**

Note:

The students in the class will be divided in to groups. There will be regular teaching of the theoretical aspects along with the Practical training of the students in various skill Development Subjects. Students shall submit a report of nearly 20 pages about the work done (giving details, highlighting innovation and future prospectus) by the end-semester.

Projects/Jobs will be allocated to the students and will be evaluated by a Committee during (i) the midterm interaction with weightage 30%, (ii) end-semester evaluation based on the presentation and project report, and innovation will be given extra credits.

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor. **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. **(6 Lectures)**

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment

Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems. **(8 Lectures)**

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical IF, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:

1. Exercises on syntax on usage of FORTRAN
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1 **(10 Lectures)**

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages.

Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. **(9 Lectures)**

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices.
4. To find a set of prime numbers and Fibonacci series.

5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

(12 Lectures)

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77". V. Rajaraman (Publisher: PHI).
3.LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
4.Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
5.Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
6. Computational Physics: An Introduction, R. C. Verma et al. New Age International Publishers, New Delhi (1999)
7. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
8. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

SOFT SKILLS

Name of the Course	Soft Skills (Credits: 03)
Code	**PHYBM 305**

After the successful completion of the course, students will learn:

- the dynamics of effective and professional communication skills and put them intodaily use
- to write a Professional resume using creative methods of online platforms
- the dynamics of interview skills and GD preparations and presentations in public platforms and present the best of themselves as job seekers
- to understand, analyze and express their personality styles and personal effectiveness in various environments
- to learn and update themselves with the required knowledge in Numerical ability and Test of Reasoning for competitive examinations

Module I: Effective Communication & Professional communication

Effective communication: Definition of communication, Process of Communication, Barriers of Communication, Non-verbal Communication. JOHARI Window as a tool of effective communication.

Professional Communication: The Art of Listening, The passage, Kinesthetic, Production of Speech, Speech writing , Organization of Speech, Modes of delivery, Conversation Techniques, Good manners and Etiquettes, Different kinds of Etiquettes, Politeness markers.

Module II: Resume Writing & Interview Skills

Resume Writing: Meaning and Purpose. Resume Formats. Types of s Resume. Functional and Mixed Resume, Steps in preparation of Resume, Model resumes for an IT professional Chronological, Types of interviews, Creative resumes using online platforms

Interview Skills: Common interview questions, Dos and Don'ts for an interview, Attitude, Emotions, Measurement, Body Language, Facial expressions, Different types of interviews, Telephonic interviews, Behavioral interviews and Mock interviews (Centralized).

Module III: Group Discussion & Team Building

Group Discussion: Group Discussion Basics, GD as the first criterion for selecting software testers, Essentials of GD, Factors that matter in GD, GD parameters for evaluation, Points for GD Topics, GD Topics for Practice, Tips for GD participation. Video shooting of GD presentation & Evaluation (Centralized)

Team Building: Characteristics of a team, Guidelines for effective team membership, Pedagogy of team building, Team building skills. Team Vs Group – synergy, Types of synergy, Synergy

relates to leadership ,Stages of Team Formation, Broken Square-Exercise, Leadership, Leadership styles, Conflict styles, Conflict management strategies & Exercises

Module IV: Personal Effectiveness

Personal Effectiveness: Self Discovery: Personality, Characteristics of personality, kinds of self, Personality inventory table, measuring personality, intelligence and Exercises
Self Esteem: Types -High & Low self esteem, Ways of proving self esteem, Hypersensitive to criticism, activities. Goal setting: Goal setting process, Decision making process & Exercises.
Stress Management: Identifying stress, Symptoms of stress, Responding to Stress, Sources of stress, Coping with stress and Managing stress.

Module V: Numerical Ability

Average, Percentage, Profit and Loss, Problems of ages, Simple Interest, Compound Interest, Area, Volume and Surface Area, Illustration, Time and Work, Pipes and Cisterns, Time and Distance, Problems on Trains, Illustrations, Boats and Streams, Calendars and Clocks.

Module VI: Test of Reasoning

Verbal Reasoning: Number series, letter series, coding and decoding, logical sequence of words, Assertion and Reasoning, Data Sufficiency, Analogy, Kinds of relationships.
Non-Verbal Reasoning: Completion of Series, Classification, analogical, Pattern comparison, Deduction of figures out of series, Mirror Reflection Pattern, Hidden figures, Rotation pattern, Pattern completion and comparison, Sense of direction, Blood relations.

Reference books:

- Melchias G, Balaiah John, John Love Joy (Eds), 2018. Winners in the Making: A primer on soft skills. SJC, Trichy.
- Aggarwal, R.S. Quantitative Aptitude, S.Chand& Sons.
- Aggarwal, R.S. (2010). A Modern Approach to Verbal and Non Verbal Reasoning. S.Chand & Co., Revised Edition.
- Covey, Stephen. (2004). 7 Habits of Highly effective people, Free Press.
- Egan, Gerard. (1994). The Skilled Helper (5th Ed). Pacific Grove, Brooks/Cole.
- Khera , Shiv (2003). You Can Win. Macmillan Books, Revised Edition.

COMMUNITY CONNECT BASED COURSE

Name of the Course	**Community Connect Based Course** **(Credits: 08)**
Code	**PHYBM 306**

Under Unnat Bharat Abhiyan, to actively engage students, one 8 credit elective open course has been proposed for B.Sc. student to be taken in 3rdSemester. This course shall encourage young minds to explore the creative ideas to contribute for sustainable development of rural India. Under this course the students have to take individual projects or a collaborative group under the supervision of faculty member/s from department.

The projects should be around physics discipline such as mentioned below:

1. Awareness on efficient energy usage.
2. Awareness on energy harvesting techniques such as electricity using solar/wind/water energy.
3. Energy storage devices and their usage for common public.
4. Awareness on E-Waste and its management.
5. Innovative projects which ease day to day life of people.
6. Making audio-visual demonstrations for awareness on various areas.
7. Practicing innovative methods of teaching physics concepts to school students.
8. Awareness on technologies such as remote sensing, weather forecast etc. and their usage for common public.

The duration of the project will be for one semester (3rdSemester), during which student have to work on any of the identified problem. The project should be directly concerned with community.

Identifying the problem

Students can identify a problem based upon following:

1. Day to day observations of community around their living place.
2. One of the government schemes for welfare of community.
3. Some creative idea/device/model which may be useful for community.

Literature Review

Once the problem is identified, student should do a systematic literature review in first month and should submit the report of the same to the faculty supervisor. Under literature review, student should explore the available view points, options and schemes related to the stated problem. At the end of the literature review various aspects of the choice of the project and plan of execution of the project should be clearly defined.

Scope for implementation

The student should explore possibilities of implementation of available options in reference to the problem identified on the basis of community chosen. The amendments can be suggested for optima impact of the schemes/model.

Coordination with local representatives

The students with the help of community connect cell and faculty supervisor shall arrange for public interactions where he/she can educate people on the project, its importance in their life and benefits that can be extracted from the solutions proposed.

Final report

At the end of the semester, student shall submit a consolidated report of the project to the department. The report can include a short movie of the whole project including statement, importance and benefits of the project.

Financial implications

As the project is associated with community welfare and may involve financial liabilities such as visiting the field areas, preparing some experimental demonstration etc. To avail financial support from department, student has to submit a proposal to the department, which will be screened by a departmental committee. Based upon recommendations of the screening committee full financial assistance may be provided to the student for pursuing the project.

Evaluation

The overall course will be for 400 marks (8 credits) divided as follows.

Midterm exam (100M)

The midterm exam will be for 100 marks. In midterm exam student has to present progress of his work before departmental committee. In presentation the student should clearly state:

- Objectives of the project
- Community survey and identification of target community
- Plan of action with methodology of study
- Timeline for execution of the project

End term Exam (200M)

The final exam shall be of 200 marks in which student have to submit overall report and presentation before committee of examiners (including external examiner).Out of total 200 marks for end term marks, final report shall be of 100 marks, presentation for 50 marks and assessment of overall impact of the project for 50 marks.

Internal Assessment (100M)

The internal assessment shall be for 100 marks and shall be accessed by concerned supervising faculty. The marks can be split into following categories:

- Attendance (in terms of number of hours spent in community): 25 Marks
- Number of presentations made before supervisor: 25 Marks
- Analysis of outcome: 25 Marks
- Community feedback: 25 Marks

Attendance

- Student have to maintain minimum attendance of 75%.

DETAILED SCHEME & SYLLABUS OF 4th SEMESTER

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
4th	Core Course-IX	PHYBM 401 TH	Statistical Physics and Thermodynamics (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	24
		PHYBM 401 PR	Statistical Physics and Thermodynamics (Lab)	2	Lab. = 20		
	Core Course-X	PHYBM 402	Analog Systems & Applications	4 (TH + IA)	Theory = 70 IA = 30	100	
	Open Elective-II	PHYBM 403	1. Medical Physics2. Nanotechnology3. Electrical Instruments	4 (3TH + 1 TUT)	Theory = 70 IA = 30	100	
	SEC-IV	PHYBM 404 TH	Basic Instrumentation Skills (Theory)	2 (TH + IA)	Theory = 50 IA = 30	100	
		PHYBM 404 PR	Basic Instrumentation Skills (Lab)	2	Lab = 20		
	SEC-V	PHYBM 405 TH	Computer Programming	2 (TH + IA)	Theory = 50 IA = 30	100	
		PHYBM 405 PR	Computer Programming Laboratory	2	Lab = 20		
	Value Added Course	PHYBM 406	Yoga and Meditation	2	Internal =100	100	

STATISTICAL PHYSICS AND THERMODYNAMICS

Name of the Course	**Statistical Physics and Thermodynamics (Credits:Theory-04) Theory:60 Lectures**
Code	**PHYBM 401 TH**
Semester Based Examination	**50 Marks(3Hrs)**
Continuous Comprehensive Assessment(CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory = **05marks. CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III), and section E(Unit IV). The examiner will set nine questions in all, question number 1 (One) will be compulsory, and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D, and E and seven sub-questions from section A (Compulsory questionnumber1). The duration of the examination will be 3hours.

Unit - I	**Basic Ideas of Statistical Physics:** Scope of statistical physics, basic ideas about probability, distribution of four distinguishable particles in two compartments of equal sizes. Concept of macro-states, micro-states, thermodynamic probability, effect of constraints on the system. **(8 Lectures)** **Distribution of Particles in Compartments:** Distribution of n particles in two compartments, Deviation from the state of maximum probability. Equilibrium state of a dynamic system, distribution of n distinguishable particles in k compartments of unequal sizes. **(7 Lectures)**
Unit - II	**Types of Statistics in Physics:** Phase space and division into elementary cells. Three kinds of statistics. The basic approach in the three statistics. M-B. Statistics applied to an ideal gas in equilibrium, experimental verification of Maxwell Boltzmann's law of distribution of molecular speeds. Need for quantum statistics, h as a natural constant and its implications, indistinguishability of particles and its implications. B-E statistics, **(8 Lectures)** **Bose Einstein and Fermi Dirac Statistics:** Derivation of Planck's law of radiation, deduction of Wien's distribution law and Stefan's law from Planck's law. Fermi-Dirac statistics. Applications to liquid helium, free electrons gas (Fermi level and Fermi Energy), Comparison of M-B, B-E, F-D statistics. **(7 Lectures)**

	Entropy and Laws of Thermodynamics: Application of thermodynamics to the thermoelectric effect, change of entropy along a reversible path in a p-v diagram, entropy of a perfect gas, equation of state of ideal gas from simple statistical considerations, heat death of the universe**.** **(7 Lectures)**
Unit - III	**Statistical Interpretation of entropy:** Statistical definition of entropy, change of entropy of system, additive nature of entropy, law of increase of entropy. Reversible and irreversible processes, example of reversible and irreversible processes. Work done in a reversible process, the example of entropy in the natural process, entropy, and disorder. **(8 Lectures)**
	Maxwell's Thermodynamic Relations and Their Applications: Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Derivation of Maxwell's thermodynamic relations. **(7 Lectures)**
Unit - IV	**Applications of the thermodynamics relations**. Cooling produced by adiabatic stretching, adiabatic compression, adiabatic Stretching of a wire, stretching of thin films, and change of internal energy with volume. Clausius-Clapeyron Equation, Thermodynamical treatment of Joule-Thomson effect for liquification of Helium. Production of very low temperatures by adiabatic demagnetization, TdS equations. **(8 Lectures)**

Reference Books:

- Statistical Physics and Thermodynamics, V.S.Bhatia, Sohan Lal Nagin, Chand & Co, 1986, Jalandhar.
- Statistical Mechanics, R. K. Patharia, 2nd Edition, Butterworth-Heinemann.
- Introduction to Statistical Mechanics, B. B. Laud,(1988),Macmillan India Limited
- Statistical Physics, Berkley Physics Course, Vol. 5, F. Rief, Mc-Graw Hill Book Company.
- Thermal Physics, S. Garg, R. Bansal and C.Ghosh,1993,Tata McGraw-Hill.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F. W. Sears & G. L. Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003,Thomson Brooks/Cole.
- Thermal and Statistical Physics, Brij Lal and Subrahmanyam, S. Chand & Co.Ltd.
- Introduction to Statistical Mechanics, B. B. Laud, (1988), Macmillan India Limited

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LAB COURSE

STATISTICAL PHYSICS AND THERMODYNAMICS (LAB)

Name of the Course	**Statistical Physics and Thermodynamics (Lab) (Credits:-02)**
Code	**PHYBM 401 PR**
Semester Based Examination	**20 Marks(3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills = **4 Marks** Viva Voce = **4 Marks**, Practical Record Book= **4 Marks.**	

1. To determine the Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.

2. Measurement of Planck's constant using black body radiation.

3. To determine Stefan's Constant.

4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.

5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.

6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.

7. To determine the temperature coefficient of resistance by Platinum resistance thermometer.

8. To study the variation of thermo emf across two junctions of a thermocouple with temperature.

9. To record and analyze the cooling temperature of a hot object as a function of time using a thermocouple and suitable data acquisition system

10. To calibrate the Resistance Temperature Device (RTD) using the Null Method/Off-Balance Bridge.

11. To prove the law of probability by using one coin, two coins, and10 or more coins.

12. To determine the coefficient of increase of volume of air at constant pressure.

13. To determine the coefficient of increase of pressure of air at constant volume.

14. To study the spectral characteristics of a photovoltaic cell.

15. To study the current voltage, power load, a real, azimuthal and spectral characteristics of a photovoltaic cell.

16. To verify the inverse square law of radiation using a photo electric cell.

Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H. T. Worsnop, 1971, Asia Publishing House.

2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers

3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition,2011, Kitab Mahal, New Delhi.

4. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985,Vani Publication.

5. B.Sc. Practical Physics C.L. Arora, S. Chand and company Ltd.

ANALOG SYSTEMS & APPLICATIONS

Name of the Course	**Analog Systems & Applications** **(Credits:Theory-04)Theory:60 Lectures**
Code	**PHYBM 402**
Semester Based Examination	**70 Marks(3Hrs)**
Continuous Comprehensive Assessment(CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10marks,** Attendance Theory = **05marks.**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A (compulsory, covering syllabus from all the units), section B (Unit I), section C (Unit II), section D (Unit III) and section E (Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12.5 marks. Question Number1. (Section A),will consist of ten sub-questions each of 2marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory questionnumber1). The duration of the examination will be 3hours

Unit - I	**Network theorems:** Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits. **(4 Lectures)** **Semiconductor Diodes:** P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow, Mechanism in Forward and Reverse Biased Diode. **(9 Lectures)**
Unit - II	**Two-terminal Devices and their Applications**: (1) Rectifier Diode: Half-wave Rectifiers. Centre tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell. **(6 Lectures)** **Bipolar Junction transistors:** n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cut off and Saturation Regions. **(6 Lectures)**

Unit - III	**Amplifiers:** Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers**.** **(8 Lectures)** Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. **(4 Lectures)** **Feedback in Amplifiers:** Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise**.** **(4 Lectures)**
Unit - IV	**Sinusoidal Oscillators:** Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **(4 Lectures)** **Operational Amplifiers** (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **(4 Lectures)** **Applications of Op-Amps**: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Substractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. **(8 Lectures)** **Conversion:** Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) **(3 Lectures)**

Reference/Textbooks:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn., 2009, PHI Learning
4. Electronic Devices & circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
7. Electronic circuits: Handbook of design & applications, U. Tietze, C. Schenk, 2008, Springer
8. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
9. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
10. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

OPEN ELECTIVE COURSE

1. Medical Physics

Name of the Course	**Medical Physics** **(Credits: Theory-04) Theory: 56 Lectures**
Code	**PHYBM 403**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Overview of human anatomy** - cells, cell structure, type of cells and their functions, tissues, organs, and their functions. Different systems in the human body, their structure and function, physiological properties of the circulatory system, digestive system, respiratory system, reproductive system, excretory system, endocrine system and nervous system. **(13 Lectures)**
Unit - II	**Physics of Medical Diagnostics:** Principle of production of X-rays. Use of X-rays in medical diagnosis, X-ray imaging systems. **Computed Tomography (CT):** principle and generation of CT. **(11 Lectures)**
Unit - III	**Magnetic Resonance Imaging (MRI):** basic principle and image characteristics. **Ultrasound Imaging:** Interaction of sound waves with body tissues, production of ultrasound, transducers, acoustic coupling, image formation, modes of image display and color Doppler. **(11 Lectures)**
Unit - IV	**Physics of Radiotherapy** **Clinical aspects of radiation therapy:** Biological basis of radiotherapy, radiation sources, radiation dose, time dose fractionation. External beam radiation therapy, radiation therapy modalities, production of radioisotopes, use of radioisotopes in therapy, particle and ion beam radiotherapy. Brachy therapy – principle of brachy therapy and classification of brachy therapy techniques. **(13 Lectures)**
	Activity for tutorial classes 01 lectures/week Unit I: Students may demonstrate the shape, size, positions and functions of different organs in the body with the help of models. Unit II: The use of X-rays in the diagnosis of the fractured bone can be demonstrated with the help of a gamma source and a gamma ray survey meter. As the density of materials between the source and the detector changes the reading on the meter (or intensity of the beefing sound) changes. Unit III: (i) Students can be asked to list out different type of cancers and possible causative factors. They can be asked to list out the healthy practices to reduce the risk of cancers. (ii) As there will be students from different disciplines in the OE course, group discussion can be arranged to discuss about their programme and outcome.

Text Books:

1. C. H. Best and N. B. Taylor. A Test in Applied Physiology. Williams and Wilkins Company, Baltimore, 1999.
2. C. K. Warrick. Anatomy and Physiology for Radiographers. Oxford University Press, 2001.
3. Jerrold T. Bushberg. The Essential Physics for Medical Imaging (2nd Edition). Lippincott Williams & Wilkins, 2002.
4. Jean A. Pope. Medical Physics: Imaging. Heinemann Publishers, 2012.
5. Faiz M. Khan and Roger A. Potish. Treatment Planning in Radiation Oncology. Williams and Wilkins, USA, 2003.
6. D. Baltas. The physics of modern brachytherapy for oncology. Taylor and Francis, 2007.

Reference Books:

1. J. R. Brobek. Physiological Basis of Medical Practice. Williams and Wilkins, London, 1995.
2. Edward Alcamo, Barbara Krumhardt. Barron's Anatomy and Physiology the Easy Way. Barron's Educational Series,
2004.
3. Lippincott, Anatomy and Physiology. Lippincott Williams & Wilkins, 2002.
4. W. E. Arnould Taylor. A textbook of anatomy and physiology, Nelson Thornes, 1998.
5. G. S. Pant. Advances in Diagnositc Medical Physics. Himalaya Publishing House, 2006.
6. Sabbahaga, Diagnositc Ultrasound applied to OBG. Maryland, 1980

2. Nanotechnology

Name of the Course	**Nanotechnology** **(Credits: Theory-04) Theory: 56 Lectures**
Code	**PHYBM 403**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Introduction to nanomaterials** Length scales in physics, Nanostructures: 1D, 2D and 3Dnanostructures (nano dots, thin films, nano wires, nano rods), Band structure and density of states of materials at nano scale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D,2D, 1D nanostructures and its consequences. **(11 Lectures)**
Unit - II	**Synthesis of nanostructure materials** Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapour deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods, MBE growth of quantum dots. **(13 Lectures)**

Unit - III	**Characterization of nanostructure materials** X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunnelling Microscopy. **(11 Lectures)**
Unit - IV	**Properties and applications of nanomaterials** Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nano crystals. Quantitative treatment of quasi particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of hetero structures and nanostructures. Applications of nanoparticles, quantum dots, nano wires and thin films for photonic devices (LED, solar cells). Nano material Devices: Quantum dots hetero structure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. **(13 Lectures)**

Reference Books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
7. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

3. Electrical Instruments

Name of the Course	**Electrical Instruments** **(Credits: Theory-04) Theory: 56 Lectures**
Code	**PHYBM 403**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Ammeters, voltmeters: (DC/AC) Representation of sinusoidal waveforms, peak and rms values, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. Watt meters: Induction type, single phase and three phase wattmeter, Energy meters: AC. Induction type single phase and three phase energy meter Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications. **(13 Lectures)**

Unit - II	**Galvanometers:** General principle and performance equations of D'Arsonval Galvanometers, Vibration Galvanometer and Ballistic Galvanometer. **Potentiometers:** DC Potentiometer, Crompton potentiometer, construction, standardization, application. AC Potentiometer, Drysdale polar potentiometer; standardization, application **(11 Lectures)**
Unit - III	**DC/AC Bridges:** General equations for bridge balance, measurement of self-inductance by Maxwell's bridge (with variable inductance & variable capacitance), Hay's bridge, Owen's bridge, measurement of capacitance by Schearing bridge, errors, Wagner's earthing device, Kelvin's double bridge. **Transducer:** Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer. **(13 Lectures)**
Unit - IV	**CRO:** Block diagram, Sweep generation, vertical amplifiers, use of CRO in measurement of frequency, phase, Amplitude and rise time of a pulse. Digital Multi-meter: Block diagram, principle of operation Basics of lead acid batteries, Lithium-Ion Battery, Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. **(11 Lectures)**

Reference Books:

1. A. K. Sawhney, A Course in Electrical and Electronic Measurements & Instrumentation, Dhanpat Rai & Sons, 1978
2. A. D. Helfrick, W. D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, Prentice HallIndia, 1992.
3. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications, 2019
4. David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
5. Vincent Del Toro, Electrical Engineering Fundamentals Prentice Hall India, 2009

BASIC INSTRUMENTATION SKILLS

Name of the Course	**Basic Instrumentation Skills** **(Theory)** **(Credits: 04)** **30 Lectures**
Code	**PHYBM 404 TH**
Semester Based Examination	**50 Marks**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA report:** Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This course is to get exposure with various aspects of instruments and their usage through hands on mode. Experiments listed below are to be done in continuation of the topics.

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks,*
2. *The candidate will be required to attempt five questions in all. The duration of the examination will be 3 hours.*

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. **(4 Lectures)**

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.
AC milli voltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance. **(4 Lectures)**

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only-no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. **(6 Lectures)**
Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. **(3 Lectures)**

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. **(4 Lectures)**

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges. **(3 Lectures)**

Digital Instruments: Principle and working of digital meters. Comparison of analog& digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

(3 Lectures)

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. **(3 Lectures)**

LAB COURSE

BASIC INSTRUMENTATION SKILLS (LAB)

Name of the Course	**Basic Instrumentation Skills (Lab)** **(Credits:-02)**
Course Code	**PHYBM 404 PR**
Maintain Project file or Dissertation to check Analytic Skill/Problem solving in skill exam.	
Semester Based Skill Examination	**20 Marks (3Hrs)**
Distribution of Marks: Handson Skill Test = **15 Marks**, Viva Voce = **5 Marks**.	

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter. 8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope

2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

1.A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

COMPUTER PROGRAMMING

Name of the Course	**Computer Programming (Theory)** **(Credits: 02)** **30 Lectures**
Code	**PHYBM 405 TH**
Semester Based Examination	**50 Marks**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA report:** Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A (compulsory, covering syllabus from all the units), section B (Unit I), section C (Unit II), section D (Unit III) and section E (Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit I	Programming Fundamentals Introduction to computer, block diagram and organization of computer, number system and binary arithmetic, processing data, hardware, software, firmware, types of programming language -Machine language, Assembly level language, higher level language, source file, object file, translator-assembler, compiler, interpreter. Evolution and classification of programming languages. **(07 Lectures)**
Unit II	Unit II Programming Techniques Steps in program development, algorithm, flowchart, pseudo code. C Language: 'C' character set, literals, keywords, identifiers, data types and size, variable declaration, expression, labels, statements, formatted input output statements, types of operators, data type conversion, mixed mode arithmetic's, control structures. **(08 Lectures)**
Unit III	Data Structures Storage classes, scope rules and visibility, arrays, pointers, dynamic storage allocation, structures and unions, self-referential structures. Relationship between pointers and arrays, dynamic arrays: Introduction to dynamic data structures linked lists, stack, and binary trees. **(07 Lectures)**
Unit IV	Functions and File Handling 'C' functions, library functions, parameter passing, recursion, 'C' files, function for file handling, 'C' pre-processors and command line arguments, macros and conditional compiler directives. **(08 Lectures)**

Suggested Reading:

1. C Programming Language by Briain W. Kenigham and Dennis Ritchie, Prentice Hall ofIndia.
2. Programming with C by Byron Gottfried, Tata McGraw Hill.
3. The Complete Reference C by Herbert Schildt, Tata McGraw Hill.
4. Let us C by Yashwant Kanetkar, BPB Publication.
5. A Structured Programming Approach in C by B.A. Forouzan and R.F. Gilberg, Cengage Learning.

LAB COURSE

COMPUTER PROGRAMMING (LAB)

Name of the Course	**Computer Programming (Lab)** **(Credits:-02)**
Course Code	**PHYBM 405 PR**
Maintain Project file or Dissertation to check Analytic Skill/Problem solving in skill exam.	
Semester Based Skill Examination	**20 Marks(3Hrs)**
Distribution of Marks: Handson Skill Test = **15 Marks**, Viva Voce = **5Marks**.	

Using C, the students have to write:

- Programs on elementary problems
- Programs on conditional control constructs.
- Programs on loops (while, do-while, for).
- Programs using user defined functions and library functions.
- Programs on arrays, matrices (single and multi-dimensional arrays).
- Programs using pointers (int pointers, char pointers).
- Programs on string processing
- Programs on structures.

YOGA AND MEDITATION

Name of the Course	**YOGA AND MEDITATION (Credits: 02)**
Code	**PHYBM 406**
Continuous Comprehensive Assessment (CCA)	**100 Marks**
CCA: Based on Midterm Practical Exam, Class Test/Seminar/Assignments/Quiz and Attendance, Knowledge, Participation, etc.	

Learning Objectives (LO)

The objective of this course is:

LO-1. Comprehensive Exploration: Provide a thorough exploration of yoga, covering physical postures, breath control, meditation, and philosophical foundations.

LO-2. Daily Integration: Enable students to incorporate yoga and meditation practices into their daily lives to enhance physical health, mental clarity, and overall well-being.

LO-3. Holistic Understanding: Foster a holistic understanding of the interconnectedness between body, mind, and spirit through yoga and meditation practices.

LO-4. Cultural and Historical Context: Educate students on the cultural and historical contexts of yoga and meditation, appreciating their origins and evolution.

LO-5. Health and Wellness: Highlight the benefits of yoga and meditation for stress management, emotional regulation, and overall mental and physical health.

Course Outcomes (CO)

By the end of this course, students will be able to:

CO-1. Yoga Asana Proficiency: Demonstrate proficiency in various yoga asanas (postures) to enhance flexibility, strength, and balance, adapting these poses to individual capabilities.

CO-2. Pranayama Techniques: Utilize pranayama techniques to regulate and deepen their breath, promoting relaxation, focus, and energy management.

CO-3. Meditation Practices: Apply meditation methods to cultivate mindfulness, reduce stress, increase emotional resilience, and improve concentration.

CO-4. Understanding Yoga Philosophy: Explain the fundamental principles of yoga philosophy, including concepts like the Eight Limbs of Yoga, and discuss their relevance to modern living.

CO-5. Personalized Practice Development: Develop a personalized yoga and meditation practice that suits their individual needs, goals, and lifestyle, incorporating elements like asana, pranayama, and meditation.

CO-6. Cultural Awareness: Demonstrate an understanding of the cultural and historical contexts of yoga and meditation, recognizing the importance of respecting and preserving these traditions.

CO-7. Mind-Body Connection: Articulate the connection between yoga and meditation practices and overall health, including mental, emotional, and physical well-being.

Course Content/Syllabus:

Yoga and Meditation (Theory):

Unit – I

Foundation of Yoga:

- Yoga: Etymology, definition, aim, objectives and misconceptions;
- Origin, history and development of Yoga;
- Eight limbs (Ashtanga) of yoga and their significance - Yama, Niyama, Asana, Pranayama, Pratyahara, Dharana, Dhyanaand Samadhi;
- Principles and practices of Jnana Yoga, Bhakti Yoga, Karma Yoga;
- Introduction to Yogic text (Hatha Yoga Pradeepka, Gher and Samhita, Patanjali Yoga Sutra);
- Principles of Health Yoga

Unit –II

Suryanamaskarand Asana's:

- Meaning of Asana's, Guidelines for Practicing Asanas;
- Create a sequence of asanas targeting specific areas of the body;
- Do's &don't of Asana's, Difference between Asana's&Physical Exercise- techniques and benefits

Pranayama and Mudra's:

- Describe the connection between breath and prana (life force);
- Concept OfPuraka, Rechaka & Kumbhaka;

- Practice different pranayama techniques, such as Ujjayi, Nadi Shodhana, and Kapalabhati;
- Understand the physiological and psychological effects of pranayama.
- Incorporate pranayama into asana practice to enhance focus and relaxation.

Unit – III

Yoga Therapy for Common Diseases:

- Yoga for Holistic Health, Panchkosha
- Diabetes and obesity related disorders and treatment
- Stress related disorders and treatment
- Yoga Management for – Arthritis, Cervical Spondylosis, Back pain, Sciatica pain, Hernia, Gynaecology
- Kidney disease, thyroid, Liver related problems, constipation, asthma

Unit –IV

Meditation and Yoga Philosophy:

- Define meditation and its benefits for stress relief and mental clarity.
- Explore different meditation techniques like mindfulness and loving-kindness meditation.
- Discuss the concepts of Dhyana (meditation) and Samadhi (deep absorption) in yoga philosophy.
- Reflect on the ethical principles of yoga, such as Yamas and Niyamas, and their relevance in daily life.

Yoga and Meditation (Practical):

The practical training programinvolves the study and practice of thefollowing yogictechniques or practices:

- Prayer
- Warm up exercises
- Surya namaskar
- Yoga Asan: a) Standing position
  b) Sitting position
  c) Lie down on back position
  d) Lie down on stomach position
- Relaxation technique
- Breathing Practices & Pranayama-
  Breathing practices: Hands in and out, Hands stretch, Ankle stretch, Rabbit, Dog.
  Pranayama – Nadi Shodhan Pranayama, Bhramari Pranayama

- Shatkarmas(Cleansing Techniques)
- Meditation - Om Chanting

Reading Recommendations:

Text Books:

1. Singh S.P. & Yogi Mukesh : Foundation of Yoga, Standard Publication, New Delhi, 2010.

2. Swami Dhirendra Bhramhachari: Yogic Sukshma Vyayama, Dhirendra Yoga Publications, New Delhi, 1980.

3. Light on Yoga by B.K.S. Iyengar: A classic guide that covers yoga philosophy, asanas (postures), pranayama (breath control), and meditation.

References Books:

1. T.K.V. Desikachar: The Heart of Yoga: Developing a Personal Practice.
2. Kumar Kamakhya: Super Science of Yoga.
3. Dr. R. Nagarathna and Dr. H.R. Nagendra: Yoga and Health, Swami Vivekananda Yoga Prakashana, 2002.
4. Swami Satyananda Saraswati : Asana, Pranayama, Bandha, Mudra, Bihar School of Yoga, Munger, 2006.

DETAILED SCHEME & SYLLABUS OF 5th SEMESTER

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
5th	Core Course-XI	PHYBM 501 TH	Quantum Mechanics-I (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	24
		PHYBM 501 PR	Quantum Mechanics-I (Lab)	2	Lab. = 20		
	Core Course-XII	PHYBM 502	Nuclear and Particle Physics	6 (TH + IA)	Theory = 70 IA = 30	100	
	Open Elective-III	PHYBM 503	1. Earth Sciences 2. Physics of Devices and Instruments 3. Bio Physics	4 (3TH + 1 TUT)	Theory = 70 IA = 30	100	
	Open Elective-IV	PHYBM 504	1. Experimental Techniques 2. Atmospheric Physics 3. Solar Energy and Physics of Photovoltaics	4 (3TH + 1 TUT)	Theory = 70 IA = 30	100	
	SEC-VI	PHYBM 505 TH	Applied Optics (Theory)	3 (TH + IA)	Theory = 50 IA = 30	100	
		PHYBM 505 PR	Applied Optics (Lab)	1	Lab = 20		

B. Sc.-M. Sc. Physics Five Year Integrated Course
5th Semester

QUANTUM MECHANICS-I

Name of the Course	**QUANTUM MECHANICS-I** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 501TH**
Semester Based Examination	**50 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1 (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Time dependent Schrodinger equation**: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigen values and Eigen functions. Position, momentum & Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(6 Lectures)** **Time independent Schrodinger equation**-Hamiltonian, stationary states and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen function s; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to the spread of Gaussian wave packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle. **(10 Lectures)**
Unit - II	**General discussion of bound states in an arbitrary potential**- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem- square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method. **(14 Lectures)**
Unit - III	**Quantum theory of hydrogen-like atoms**: time independent Schrodinger equation in spherical polar coordinates; separation of variables for the second order partial differential equation; angular momentum operator and quantum numbers; Radial wave functions from Frobenius method; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells (idea only) **(9 Lectures)** **Atoms in Electric and Magnetic Fields**:- Electron Angular Momentum. Space Quantization. Electron Spin and Spin Angular Momentum. Larmor‟s Theorem. Spin Magnetic Moment. Stern- Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. **(7 Lectures)**
Unit - IV	**Atoms in External Magnetic Fields**:- Zeeman Effect, Normal and Anomalous Zeeman Effect. **(4 Lectures)** **Many electron atoms**:- Paul's Exclusion Principle. Symmetric andAntisymmetricWave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total Angular Momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J-J couplings. **(10 Lectures)**

Reference Books:

- A Text book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2ndEdn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4thEdn., 2001, Springer

LAB COURSE

Quantum Mechanics-I (Lab)

Name of the Course	Quantum Mechanics-I (Lab) (Credits:-02)
Code	**PHYBM 501 PR**
Semester Based Examination	**20 Marks (3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills = **4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

List of Experiments to be performed in Lab:

Use C/C++/Sci lab /FORTRAN for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom

$$\frac{d^2y}{dt^2} = A(r)u(r),\ \ A(r) = \frac{2m}{\hbar^2}[V(r) - E] = -\frac{e^2}{r}$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$,ħc = 1973 (eV Å) and m = 0.511x10^6eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom

$$\frac{d^2y}{dt^2} = A(r)u(r),\ \ A(r) = \frac{2m}{\hbar^2}[V(r) - E] = -\frac{e^2}{r}$$

Here m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r) = -\frac{e^2}{r}e^{-r/a}$$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits, Also, plot the corresponding wave function. Take e = 3.795 $(eVÅ)^{1/2}$,m=0.511x10^6eV/c^2, and a = 3 Å. In these Units hc =1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dt^2} = A(r)u(r),\ \ A(r) = \frac{2m}{\hbar^2}[V(r) - E] = -\frac{e^2}{r}$$

for the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c_2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} In theseħ=197units,30MeV fm^{-3}. The ground state energy I expected to lie

between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule

$$\frac{d^2y}{dt^2} = A(r)u(r),\ \ A(r) = \frac{2m}{\hbar^2}[V(r) - E] = -\frac{e^2}{r}$$

Where is the reduced mass of the two atom system for the Morse potential

$$V(r) = D(e^{-2\alpha r'} e^{-\alpha r'}), \qquad r' = \frac{r - r_0}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant edigits. Also plot the corresponding wave function.

Take: m = 940 x10_6e V/C_2, D= 0.755501 eV, α= 1.44, r_0= 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To study the quantum tunnelling effect with solid state device, e.g. tunnelling current in backward diode or tunnel diode.

Reference Books:

- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Publications.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al. 3rdEdn, 2007, Cambridge University Press
- Elementary Numerical Analysis, K.E. Atkinson, 3rdEdn, 2007, Wiley India Edition.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rdEdn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C.V. Fernández.2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf2012ISBN: 978-1479203444
  Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand and Company, New Delhi ISBN: 978-8121939706
  Scilab Image Processing: Lambert M. Surhone. 2010Betascript Publishing ISBN: 978-6133459274A
- Quantum Mechanics, Leonard I. Schiff, 3rdEdn. 2010, Tata McGraw Hill.
- Quantum Mechanics, Bruce Cameron Reed, 008, Jones and Bartlett Learning.

NUCLEAR AND PARTICLE PHYSICS

Name of the Course	**NUCLEAR AND PARTICLE PHYSICS** **(Credits: Theory-06) Theory: 72 Lectures**
Code	**PHYBM 502**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**General Properties of Nuclei**: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. **Nuclear Models**: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force. **(18 Lectures)**

Unit - II	**Radioactivity decay**: (a) Alpha α decay: basics of -decay processes, theory of α-emission, Gamow α factor, Geiger Nutt all law, -decay spectroscopy. (b) β-decay: energy kinematics for β- decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **Nuclear Reactions:** Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(18 Lectures)**
Unit - III	**Nuclear Detectors and Accelerators:** Interaction of nuclear radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Detector for Nuclear Radiations: Gas detectors, estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility).Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. **(18 Lectures)**
Unit - IV	**Particle Physics:** Particle interactions; basic features. Classification of elementary particles and its families. Conservation Laws: energy and momentum, angular momentum, parity, Baryon number, Lepton number, Iso spin, Strangeness, Gell-Mann-Nishijima Scheme, CPT theorem, parity violation in weak interactions. Particle Symmetries. Quarks Model, quantum number of quarks and gluons. Quark Model of Hadrons: Quark structure of non strange and strange hadrons, Mesons and baryon scontaining charm and bottom quarks, explanation of their quantum numbers in terms of their constituents quarks, Quark wave function of Mesons and nucleons, need of color quantum number. Cosmic Rays; origin of cosmic rays. primary and secondary cosmic rays, hard component and soft component, the altitude effect, the latitude effect, East– west asymmetry, cosmic rays showers. **(18 Lectures)**

Reference Books:

- Introductory Nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of Nuclear Physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K.Heyde (IOP- Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991).
- Nuclear Physics, D.C. Tayal, Himalaya Publishing House.
- Introduction to Nuclear and Particle Physics, V.K. Mittal, R.C. Verma, S.C.Gupta, Prentice Hall of India (N.Delhi).
- Introduction to Particle Physics, M.P. Khanna, Prentice Hall of India (N.Delhi).
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.

OPEN ELECTIVE COURSE-III

EARTH SCIENCES

Name of the Course	**EARTH SCIENCES** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 503**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**The Earth and the Universe:** (a) Origin of universe, creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. Introduction to various branches of Earth Sciences. (b) General characteristics and origin of the Universe. The Milky Way galaxy, solar system, Earth's orbit and spin, the Moon's orbit and spin. The terrestrial and Jovian planets. Meteorites & Asteroids. Earth in the Solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age. (c) Energy and particle fluxes incident on the Earth. (d) The Cosmic Microwave Background. **(15 Lectures)**

Unit - II	**Structure:** (a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy. How do we learn about Earth's interior? (b) The Hydrosphere: The oceans, their extent, depth, volume, chemical composition. River systems. (c) The Atmosphere: variation of temperature, density and composition with altitude, clouds. (d) The Cryosphere: Polar caps and ice sheets. Mountain glaciers. (e) The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms **(15 Lectures)**
Unit - III	**Dynamical Processes:** (a) The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convection in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics; sea- floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches, transform faults and island arcs. Origin of oceans, continents, mountains and rift valleys. Earthquake and earthquake belts. Volcanoes: types products and distribution. (b) The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend – air-sea interaction; wave erosion and beach processes. Tides. Tsunamis. (c) The Atmosphere: Atmospheric circulation. Weather and climatic changes. Earth's heat budget. Cyclones. (d) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle. The role of cycles in maintaining a steady state **(15 Lectures)**
Unit - IV	**Evolution:** Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geo chronological methods in their application in geological studies. History of development in concepts of uniformitarianism, catastrophism and neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent. 1. Time line of major geological and biological events. 2. Origin of life on Earth. 3. Role of the biosphere in shaping the environment. 4. Future of evolution of the Earth and solar system: Death of the Earth. **Disturbing the Earth – Contemporary dilemmas** (a) Human population growth. (b) Atmosphere: Green house gas emissions, climate change, air pollution. (c) Hydrosphere: Fresh water depletion. (d) Geosphere: Chemical effluents, nuclear waste. (e) Biosphere: Biodiversity loss. Deforestation. Robustness and fragility of ecosystems. **(15 Lectures)**

Reference Books:

- Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
- Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books
- Holme's Principles of Physical Geology. 1992. Chapman & Hall.
- Emiliani, C, 1992.Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

PHYSICS OF DEVICES AND INSTRUMENTS

Name of the Course	**PHYSICS OF DEVICES AND INSTRUMENTS (Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 503**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

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Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Devices:** Characteristic and small signal equivalent circuits of UJT and JFET. Metal semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode. **(15 Lectures)**
Unit - II	**Power supply and Filters:** Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection. Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters. **Multivibrators:** Astable, Monostable and Bistable Multivibrators using transistors. **Phase Locked Loop (PLL):** Basic Principles, Phase detector (XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046). **(15 Lectures)**

Unit - III	**Processing of Devices**: Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation **(15 Lectures)**
Unit - IV	**Introduction to communication systems:** Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK. **(15 lectures)**

Reference Books:

- Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons.
- Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
- Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd.
- Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
- Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill.
- PC based instrumentation; Concepts•& Practice, N. Mathivanan, 2007, Prentice-Hall of India.

BIO PHYSICS

Name of the Course	**BIO PHYSICS** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 503**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Overview:** The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self- replication as a distinct property of biological systems. Time scales and spatial scales. Universality of microscopic processes and diversity of macroscopic form. Types of cells. Multicellularity. Allometric scaling laws. **(15 Lectures)**
Unit - II	**Molecules of life:** Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling. Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell. Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways. Random walks and applications to biology. Mathematical models to be studied analytically and computationally

	(15 Lectures)
Unit - III	**The complexity of life:** At the level of a cell: The numbers of distinct metabolites, genes and proteins in a cell. Complex networks of molecular interactions: metabolic, regulatory and signaling networks. Dynamics of metabolic networks; the stoichiometric matrix. Living systems as complex organizations; systems biology. Models of cellular dynamics. The implausibility of life based on a simplified probability estimate, and the origin of life problem. At the level of a multicellular organism: Numbers and types of cells in multicellular organisms. Cell types as distinct attractors of a dynamical system. Stem cells and cellular differentiation. Pattern formation and development. Brain structure: neurons and neural networks. Brain as an information processing system. Associative memory models. Memories as attractors of the neural network dynamics. **(15 Lectures)**
Unit - IV	**Evolution:** The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map. Examples. **(15 Lectures)**

Reference Books:

- Physics in Molecular Biology; Kim Sneppen& Giovanni Zocchi (CUP 2005) 18.
- Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004).
- Physical Biology of the Cell (2nd Edition), Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013).
- An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013).
- Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)

OPEN ELECTIVE COURSE-IV

EXPERIMENTAL TECHNIQUES

Name of the Course	**EXPERIMENTAL TECHNIQUES** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 504**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Measurements:** Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution. **Signals and Systems:** Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise. **Shielding and Grounding:** Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. **(15 Lectures)**

Unit - II	**Transducers & industrial instrumentation (working principle, efficiency, applications**): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75) and signal conditioning. Linear Position transducer: Strain gauge, Piezoelectric. Inductance change transducer: Linear variable differential transformer (LVDT), Capacitance change transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector. **(15 Lectures)**
Unit - III	**Digital Multimeter:** Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement. **Impedance Bridges and Q-meter:** Block diagram and working principles of RLC bridge. Q-meter and its working operation. Digital LCR bridge. **(15 Lectures)**
Unit - IV	**Vacuum Systems:** Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization). **(15 Lectures)**

Reference Books:

- Electronic circuits: Handbook of design and applications, U. Tietzeand C. Schenk, 2008, Springer.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw Hill.
- Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.

ATMOSPHERIC PHYSICS

Name of the Course	**ATMOSPHERIC PHYSICS** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 504**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

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Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**General features of Earth's atmosphere:** Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Potential temperature, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze. Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms. **(15 Lectures)**
Unit - II	**Atmospheric Dynamics:** Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Quasi biennial oscillation, annual and semi- annual oscillations, Mesoscale circulations, The general circulations, Tropical dynamics.

	Atmospheric Waves: Surface water waves, wave dispersion, acoustic waves,buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and 19 3 its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration. **(15 Lectures)**
Unit - III	**Atmospheric Radar and Lidar:** Radar equation and return signal, Signal processing and detection, Various type of atmospheric radars, Application of radars to study atmospheric phenomena, Lidar and its applications, Application of Lidar to study atmospheric phenomenon. Data analysis tools and techniques. **(15 Lectures)**
Unit - IV	**Atmospheric Aerosols:** Spectral distribution of the solar radiation, Classification and properties of aerosols, Production and removal mechanisms, Concentrations and size distribution, Radiative and health effects, Observational techniques for aerosols, Absorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Bouguert-Lambert law, Principles of radiometry, Optical phenomena in atmosphere, Aerosol studies using Lidars. **(15 Lectures)**

Reference Books:

- Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996.
- The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3rd edn. 2002.
- An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004.
- Radar for meteorological and atmospheric observations – S Fukao and KHamazu, Springer Japan, 2014

SOLAR ENERGY AND PHYSICS OF PHOTOVOLTAICS

Name of the Course	**SOLAR ENERGY AND PHYSICS OF PHOTOVOLTAICS** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 504**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

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Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Solar Radiation:** origin, solar constant, spectral distribution of solar radiation, absorption of solar radiation in the atmosphere, global and diffused radiation, seasonal and daily variation of solar radiation, measurement of solar radiation, sun tracking systems, photo thermal conversion, solar energy collectors, collector efficiency and its dependence on various parameters. **(15 Lectures)**
Unit - II	**Solar energy:** storage of solar energy, solar pond, solar water heater, solar distillation, solar cooker, solar green houses, solar dryers, absorption air conditioning. solar fuels: electrolysis of water, photoelectron chemical splitting of water. **(15 Lectures)**

Unit - III	**Fundamentals of solar cells**: Photovoltaic effect, semiconductor properties, energy levels, basic equations, p-n junction its characteristics, fabrication steps, thermal equilibrium condition, depletion capacitance, junction breakdown, heterojunction. Silicon based solar cells: single crystal, polycrystalline and amorphous silicon solar cells.**(15 Lectures)**
Unit - IV	**Device physics:** Solar cell device structures, construction, output power, efficiency, fill factor and optimization for maximum power, surface structures for maximum light absorption, current voltage characteristics in dark and light, operating temperature vs conversion efficiency, charge carrier generation, recombination and other losses. Cadmium telluride solar cells, copper indium gallium selenide solar cells, organic solar cells, perovskite solar cells, Advanced concepts in photovoltaic research. **(15 Lectures)**

Reference Books:

- Solar Energy: Principles of Thermal Collection and Storage, S P Sukhatme, Tata McGraw Hill, 1996.
- Solid State Electronic Devices, Ben. G. Streetman, S. K. Banerjee, PHI Leaning Pvt. Ltd, 2000.
- Principles of Solar Engineering, D. Yogi Goswami, Frank Kreith, Jan F. Kreider, Taylor and Francis, 2000.
- Semiconductor Devices, Basic Principles, Jasprit Singh, Wiley, 2001
- Solar Cell Device Physics, Stephen J.Fonash, 2nd edition, Academic Press, 2003.
- Solar energy fundamentals and applications, H P Garg, J Prakash, Tata McGraw Hill publishing Co. Ltd, 2006.

SKILL ENHANCEMENT COURSE-VI
APPLIED OPTICS

Name of the Course	**APPLIED OPTICS** **(Credits: Theory-03)** **Theory: 30 Lectures**
Code	**PHYBM 505 TH**
Semester Based Examination	**50 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory:** Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

The aim of this course is not just to impart theoretical knowledge to the students but to enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques.

Instructions for Paper Setters and Candidates:

1. *Examiner will set seven questions in all covering the entire syllabus each of 10 marks.*
2. *The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.*

Unit-I	**Sources and Detectors:** Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers. **(9 Lectures)**
Unit-II	**Fourier Optics:** Concept of Spatial frequency filtering, Fourier transforming property of a thin lens, Applications: Fourier optics and image processing: Optical image addition/subtraction, Optical image differentiation, Fourier optical filtering, Construction of an optical 4f system, Fourier Transform Spectroscopy (FTS) **(6 Lectures)**
Unit-III	**Holography:** Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, applications of holography in microscopy, interferometry, and character recognition. **(6 Lectures)**
Unit-IV	**Photonics:** Fibre Optics Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating **(9 Lectures)**

Reference Books:

- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- ASERS: Fundamentals & applications, K.Thyagrajan&A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

LAB COURSE

APPLIED OPTICS (LAB)

Name of the Course	**Applied Physics (Lab)** **(Credits:-02)**
Course Code	**PHYBM 505 PR**
Maintain Project file or Dissertation to check Analytic Skill/Problem solving in skill exam.	
Semester Based Skill Examination	**20 Marks (3Hrs)**
Distribution of Marks: Handson Skill Test = **15 Marks**, Viva Voce = **5 Marks**.	

List of Experiments to be performed in Lab:

Experiments on Lasers:

1. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne or solid state laser.
2. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
3. To find the polarization angle of laser light using polarizer and analyzer
4. Thermal expansion of quartz using laser

Experiments on Semiconductor Sources and Detectors:

1. V-I characteristics of LED
2. Study the characteristics of solid state laser
3. Study the characteristics of LDR
4. Photovoltaic Cell e. Characteristics of IR sensor

Experiments on Fourier Optics:

Fourier optic and image processing:

1. Optical image addition/subtraction
2. Optical image differentiation
3. Fourier optical filtering
4. Construction of an optical 4f system

Fourier Transform Spectroscopy: Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

1. To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

Experiments on Holography and interferometry:

1. Recording and reconstructing holograms
2. Constructing a Michelson interferometer or a Fabry Perot interferometer
3. Measuring the refractive index of air
4. Constructing a Sagnac interferometer
5. Constructing a Mach-Zehnder interferometer
6. White light Hologram

Experiments on Photonics: Fibre Optics

1. To measure the numerical aperture of an optical fibre
2. To study the variation of the bending loss in a multimode fibre
3. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern
4. To measure the near field intensity profile of a fibre and study its refractive index profile
5. To determine the power loss at a splice between two multimode fibre

DETAILED SCHEME & SYLLABUS OF 6th SEMESTER

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
6th	Core Course-XIII	PHYBM 601 TH	Solid State Physics and Electronics (Theory)	4 (TH + IA)	Theory = 50 IA = 30	100	24
		PHYBM 601 PR	Solid State Physics and Electronics (Lab)	2	Lab. = 20		
	Core Course-XIV	PHYBM 602	Mathematical Physics-I	6 (TH + IA)	Theory = 70 IA = 30	100	
	Open Elective-V	PHYBM 603	1. Laser Physics 2. Introduction to Hydrogen Energy Systems 3. Introduction to Mocroprocessors	4 (3TH + 1 TUT)	Theory = 70 IA = 30	100	
	Open Elective-VI	PHYBM 604	1. Cosmology 2.Spectroscopy 3. Radiation Physics	4 (3TH + 1 TUT)	Theory = 70 IA = 30	100	
	Value Added Course	PHYBM 605	Indian Knowledge System	4 (TH + IA)	Theory = 70 IA = 30	100	

B. Sc.-M. Sc. Physics Five Year Integrated Course
6th Semester

SOLID STATE PHYSICS AND ELECTRONICS

Name of the Course	**SOLID STATE PHYSICS AND ELECTRONICS (Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 601TH**
Semester Based Examination	**50 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1 (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Crystal Structure:** Periodicity, Lattice and basis, Fundamental translation vectors, transnational symmetry, unit cell, primitive cell, Wigner Seitz cell, allowed rotations, lattice types, packing fraction, Miller indices and lattice planes, simple structures NaCl, diamond. **Diffraction Methods:** Bragg's Law, experimental arrangements, Laue pattern, Laue equation, reciprocal lattice, atomic scattering factor, geometrical structure factors. **(15 Lectures)**
Unit - II	**Crystal bonding:** Potential between a pair of atoms, Lennard-Jones potential, Ionic, Covalent, Vander - Waal's. Calculation of cohesive energy for ionic and inert gas system. **Lattice Vibration:** Vibrations of one dimensional monoatomic chain under haromonic and nearest neighbour interaction approximation, Concept of phonons, density of modes (1-D), specific heat Einstein and Debye's models of specific heat. Extension to 3-D conceptual. **(15 Lectures)**
Unit - III	**Free electron theory of metals:** Classical picture, Fermi gas, density of states, Fermi energy and fermi velocity, electronic contribution to specific heat of metals. **Band Theory of Metals:** Kronig Penny model, Brillouin zones, electrons in periodic structure, energy bands, energy gaps, effective mass of electrons and holes, metals, insulators, semiconductors. **Superconductivity:** Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. cooper pairs, BCS theory. **(15 Lectures)**
Unit - IV	**Digital Fundamentals:** Binary, Decimal, Octal and Hexadecimal number systems and their inter conversion, Binary arithmetic (addition, subtraction, multiplication and division 1's and 2's complements, **Basic logic gates:** OR, AND, NOT, NAND, NOR, XOR, XNOR, positive and negative logic, Boolean algebra theorems, De Morgan's Theorem examples of IC gates. Code (straight Binary code, BCD code, Gray code) Error detection, correction and Hamming codes. **(15 Lectures)**

Reference Books:

- Introduction to Solid State Physics, C. Kittle, 7th Edition, John Wiley and Sons.
- Introduction to Solids, L .V. Azaroff, Tata Mc-Graw Hill Co. New Delhi(1977)
- Solid State Physics, C.M. Kachhava, 2nd Reprint(1993), Tata Mc-Graw Hill Co., New Delhi.
- Solid State Physics, J.S. Blackmore, 2nd Edition, Cambridge University press, Cambridge.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, Holt, Rinehart and Winston, New York
- Basic Electronics, D.C. Tayal, Himalya Publishing House.
- Principle of Electronics, VK Mehta, S Chand and Company

LAB COURSE

SOLID STATE PHYSICS AND ELECTRONICS (LAB)

Name of the Course	**Solid State Physics and Electronics (Lab) (Credits:-02)**
Code	**PHYBM 601 PR**
Semester Based Examination	**20 Marks (3Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/Skills = **4 Marks** Viva Voce = **4 Marks**, Practical Record Book = **4 Marks.**	

List of Experiments to be performed in Lab:

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of iron using a Solenoid and determine the energy loss from Hysteresis.
9. Verify the truth tables of (a) AND (b) OR, (c) NOT, (d) NAND (e) NOR (f) XOR (g) EXTOR gates)

Reference Books:

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal, New Delhi
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India
- Practical Physics, CL Arora (S.Chand)

MATHEMATICAL PHYSICS-I

Name of the Course	**MATHEMATICAL PHYSICS-I** **(Credits: Theory-06) Theory: 72 Lectures**
Code	**PHYBM 602**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	Function of complex variables. Cauchy- Riemann conditions. Analytic functions. Singularities. Differentiation and intergration of a complex variable. Cauchy's theorem. Cauchy's integral formula. Morera's theorem of algebra. The argument theorem, Power series of a complex variable, absolute and uniform convergence tests. Tayler and Laurant's series, residue and Residue Theorem, contour integration and its application to evaluation of integrals and series (simple exercises). **(18 Lectures)**
Unit - II	**Fourier Series:** Fourier series, Dirichlet conditions (Statement only) sine and cosine series and their ortheogojality and complete Distinctive features of Fourier expansions Applications: Square wave triangular wave output of full wave rectifier. Summing of infinite series Gibb's phenomenon. **Integral Transform:** Fourier Integral theorem, Fourier integral transform, sine and cosines transform conservation theorem conservation theorem. **(18 Lectures)**

Unit - III	**Laplace Transforms**: Laplace transform of elementary function of derivative integrals and unit step function and of periodie functions, translation, substitution and convolution theorem, laplace inverse transform, Application of Laplace transform for solving first and second order differential equations with constant coefficients. **Special functions:** Dirac Delta function and its properties. **(18 Lectures)**
Unit - IV	Legendre, Bessel, Hermite and laguerre functions, Generating function. Recurrence relations. Legendre, Bessel and Hermitedifferntial equations. Orthogonality, Gamma functions and their properties. **(18 Lectures)**

Reference Books:

- Applied Mathematics for Engineers and Physicists – Pipes.
- Advanced Engineering Mathematics – Kryszig
- Mathematical Physics- E.Bulkov (Addison Wosley)
- Mathematical Methods of Physicists – Arfken
- Mathematical Methods in Physics – Mathews and Walker.
- Advanced Engineering Mathematics, Erwin Kreyszing, John Wiley & Sons, Inc
- Schaum outline series (Vector analysis, complex variable, Fourier Analysis), tata Mc Graw-Hill.
- Mathematical Physics; a modern introduction to its foundation, Sadri Hassani, Springer-Verlag.
- Advance Engineering Mathematics, C. Ray Wylie and Louis C. Barrett, Tata McGraw- Hill Edition.
- Mathematical Physics, A.K.Ghatak, I.C. Goyal, S.C.Chua.Macmillan India Ltd., 1995

OPEN ELECTIVE COURSE-V

LASER PHYSICS

Name of the Course	**LASER PHYSICS** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 603**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 Marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 Marks.**	

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Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	Light waves and photons, optical directionality, interactivity, monochromacity and coherence, quantum transitions in absorption and Emission of light. The active medium, creating population inversion, Laser oscillation in optical Resonant cavity (quality factor, losses), Basic laser characteristics (gain coefficient out put power). **(15 Lectures)**
Unit - II	Laser gain curve, Einstein's quantum theory of Radiation, Einstein coefficients and their relationship momentum transfer and possibility of amplification. Type of Lasers on the basis of pumping methods: solid state laser, organic dye laser, photo dissociation lasers, Ion and Atomic lasers, Molecular Lasers , Electro ionization

	Lasers, Gas Dynamic Lasers, Chemical Lasers, Plasma Lasers, Semiconductor Lasers. **(15 Lectures)**
Unit - III	Optical resonators of various kinds and their role in confinement of laser beam. Control of laser out put: Interactivity, control of spectral characteristics, method of Q switching, Pulsed Lasing , mode locking for ultra short pulses, modifying the spatial structure of laser output, Frequency transformations in non-linear media, wave front correction of laser output, Light beam manipulation. **(15 Lectures)**
Unit - IV	**Applications of Lasers:** Material working, Lasers in medicine isotope separation, holography, optical communications by laser, ranging and measurement; environmental measurements, quality control, thermonuclear fusion. Holography: Principle of holography, principle identity, holography of point objects, holography of three dimensional objects. **(15 Lectures)**

Reference Books:

- Lasers and Non-Linear optics, B.B. Laud, Second edition , New Age International (P) Limted , New Delhi-2005.
- Lasers: Theory and Applications, K. Thyagarajan, A.K.Ghatack, Macmillan India Ltd, 1981.
- Laser Physics, L.V. Tarasov, Mir Publishers, Moscow, 1983.
- Laser Age in Optics, L.V. Tarasov Mir Publishers, Moscow, 1981.
- Essentials of Lasers, L. Allen, Pergamon Press, Oxford 1969
- Laser Physics and Applications, L Tarasov, Mir Publishers, Moscow, 1986.
- Lasers and Holography, Winston E. Kock, Dover Publications, New York,1981.

INTRODUCTION TO HYDROGEN ENERGY SYSTEMS

Name of the Course	**INTRODUCTION TO HYDROGEN ENERGY SYSTEMS** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 603**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

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Instructions for Paper Setters and Candidates:

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2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Hydrogen Energy Pathways:** Properties of hydrogen, Global and Indian hydrogen energy scenario, need for hydrogen, current uses, environmentally sustainable hydrogen, hydrogen as part of Climate Neutral Strategy. Hydrogen for mobility applications & vehicles, Overview of Hydrogen utilization: I.C. Engines, gas turbines, hydrogen burners, power plant, refineries, domestic and marine applications. **(15 Lectures)**
Unit - II	**Hydrogen Production:** Production of hydrogen from hydrocarbons oxidative and nonoxidative processes, coal. Hydrogen production using nuclear energy and renewables-wind, biomass, solar. **Hydrogen separation and purification:** Pressure swing adsorption, Solvent based absorption, membrane separation, cryogenic separation etc. **(15 Lectures)**

Unit - III	**Hydrogen Storage:** Types of hydrogen storage (Gaseous, Liquid, Solid hosts), Gibbs Phase Rule, Pressure-Composition-Temperature plots; Van't Hoff plots for absorption desorption enthalpies, Gravimetric capacities, Hysteresis in cycling, Joule-Thomson Effect, Non-ideal treatment of hydrogen gas Kinetics: Hydrogen absorption/desorption phenomena (chemisorption, nucleation and growth and diffusion), Kinetic models, Kissinger analysis for activation energy estimation, Hydrogen adsorption isotherms-BET, design and applications of storage systems, materials for hydrogen storage, Hydrogen storage for automobiles. **(15 Lectures)**
Unit - IV	**Hydrogen sensing:**Traditional methods of hydrogen sensing using thermal conductivity measurements or Gas Chromatography, Mass Spectroscopy or laser gas analysis; Solid state sensors- their working principle and applications at industrial scale. **Hydrogen Safety:** Physiological, physical and chemical hazards, hydrogen properties associated with hazards, Hazard spotting, evaluation and safety guidelines, Hydrogen safety codes and standards. Hydrogen safety barrier diagram, risk analysis, safety in handling and refueling station, safety in vehicular and stationary applications, fire detecting system, safety management. **(15 Lectures)**

Reference Books:

- F. Peter, Fuels and Fuel Technology, A.Wheatan& Co. Ltd., 1st edition, 1965.
- JOM Bockris, Energy options: Real Economics and the Solar Hydrogen System, Halsted Press and London publisher, 1980.
- S. Sarkar, Fuels and Combustion, Orient Longman, 2nd edition, 1990.
- J Twidell and T Weir, Renewable Energy Resources, Taylor and Francis (Ed), New York, USA, 2006.
- J. G. Speight, The chemisty& Technology of Petroleum, 4th edition, CRC Press, 2006.
- M. Ball and M. Wietschel, The Hydrogen Economy Opportunities and Challenges, Cambridge University Press, 2009.
- J.G. Speight and B. Ozum, Petroleum Refining Process, CRC Press, 2009.
- W. Lyons, Working Guide to Petroleum and Natural Gas Production Engineering, Elsevier Inc, 2009.
- Ke Liu, C. Song and V. Subramani, Hydrogen and Syngas Production and Purification Technologies, John Wiley & Sons, 2010.
- M.K.G. Babu, K.A. Subramanian, Alternative Transportation Fuels: Utilization in Combustion Engines, CRC Press, 2013.
- J. G. Speight, The Chemistry and Technology of Coal, CRC Press, 2013.

INTRODUCTION TO MICROPROCESSORS

Name of the Course	**INTRODUCTION TO MICROPROCESSORS (Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 603**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

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1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Number systems and Computer Math:** Binary number system, decimal binary conversion, binary fractions, hexadecimal, binary arithmetic, carrys and overflow, fixed length binary numbers, 2's complement number, signed overflow, sign extension, representing character in binary, logical functions Microprocessors, Microcomputers, and assembly language: microprocessors, microprocessor indtructionset and computer languages, from large computers to single chip microcontrollers, applications: microprocessor controlled temperature systems**.** **(15 Lectures)**
Unit - II	**8085 assembly language programming:** The 8085 programming model, instruction classification, instruction, data format and storage, writing, assemblying and executing a simple program, overview of the 8085 instruction set, writing and hand assembling a program. **Microprocessor architecture and microcomputer systems:** Microprocessor architecture and operations, memory, input output devices, example of a microcomputer system, logic devices for interfacing, microcomputer based system applications: MCTS **(15 Lectures)**
Unit - III	**8085 Microprocessor architecture and memory interfacing:** The 8085 MPU, example of an 8085 based microcomputer, memory interfacing, interfacing the 8155 memory segment, designing memory for the MCTS, testing and trouble shooting memory interfacing circuits, working of a single board microcomputer **Interfacing I/O Devices:** Basic interfacing concepts, interfacing output displays, interfacing output displays, interfacing input devices, memory mapped I/O, Testing and Troublr shooting I/O interfacing circuits **(15 Lectures)**
Unit - IV	**Introduction to 8085 instructions**: Data transfer (copy) operations, arithmetic operations, logic operations, branch operations, writing assembly language program. **Programming techniques and instructions:** Programming techniques: looping, counting and indexing, additional data transfer and 16 bit arithmetic instructions, arithmetic operations related to memory, logic operations: rotate, logic operations: compare, dynamic debugging. **(15 Lectures)**

Reference Books:

- Micrprocessors architecture, programming and applications with the 8085, Ramesh Gaonkar, penram interational publishing (india) private ltd.
- Microprocessor X86 Programming, Venugopal (BPB Publication).
- 8085 Microprocessor Fundamentals & Application, Vol-1, Boyet H (BPB Publication).Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)

OPEN ELECTIVE COURSE-VI

COSMOLOGY

Name of the Course	**COSMOLOGY** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 604**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

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Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Principles of Relativity:** Overview of Special Relativity - spacetime interval and Lorentz metric- four vectors - Introduction to general relativity (GR) - equivalence principle - notions of curvature covariance of physical laws. **(15 Lectures)**
Unit - II	**Gravitation as a manifestation of the curvature of space time:** Gravitational red shift and clock corrections - orbits in strong gravity, light bending and gravitational lensing - concept of horizon and ergosphere, hydrostatic equilibrium in GR - gravitational radiation. **(15 Lectures)**

Unit - III	**Cosmological Models:** Universe at large scales – Homogeneity and isotropy – distance ladder –Newtonian cosmology - expansion and red shift - Cosmological Principle - Hubble's law - Robertson- Walker metric - Observable quantities – luminosity and angular diameter distances - Horizon distance- Dynamics of Friedman- Robertson-Walker models: Friedmann equations for sources with p = wu and w =−1, 0, 1/3, discussion of closed, open and flat Universes. **(15 Lectures)**
Unit - IV	**Physical Cosmology and Early Universe:** Thermal History of the Universe - distribution functions in the early Universe – relativistic and nonrelativistic limits - Decoupling of neutrinos and the relic neutrino background - Nucleosynthesis - Decoupling of matter and radiation – Cosmic microwave background radiation (CMB)- Anisotropies in CMB - Inflation – Origin and growth of Density Perturbations - Formation of galaxies and large scale structures - Accelerating universe and type-Ia supernovae - The Intergalactic medium and reionization. **(15 Lectures)**

Reference Books:

- CosmologicalPhysics, Cambridge UniversityPress, J . A. Peacock
- An Introduction to Relativity, J. V. Narlikar, Cambridge UniversityPress, 2010
- TheoreticalAstrophysics, Volume III: Galaxies and Cosmology, T. Padmanabhan,CambridgeUniversityPress, 2002 (for lectures on Cosmology)
- Classical Theory of Fields, Vol. 2, L. D. Landau and E. M. Lifshitz, Oxford : PergamonPress, 1994 (For more material on General Relativity).
- Introduction to Cosmology, J. V. Narlikar, Cambridge UniversityPress, 1993 (For the lectures on Cosmology).
- First course in generalrelativity, B. F. Schutz, Cambridge universitypress, 1985 (For material on General Relativity).
- Structure Formation in the Universe. T. Padmanabhan, Cambridge UniversityPress, 1995 (for material on Cosmology and Structure formation).

SPECTROSCOPY

Name of the Course	**SPECTROSCOPY** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 604**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Raman Spectroscopy:** Vibrational and Rotational Raman spectra – Mutual Exclusion principle – Raman spectrometer – Polarization of Raman Scattering light. Structure Determination through IR and Raman spectroscopy – Phase transitions – Resonance Raman Scattering **(15 Lectures)**
Unit - II	**UV Spectroscopy:** General principles, Introduction to absorption and emission spectroscopy. Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α, β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers. **(15 Lectures)**

Unit - III	**IR Spectroscopy:** Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis. **(15 Lectures)**
Unit - IV	**NMR Spectroscopy:** Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. **(15 Lectures)**

Reference Books:

- Organic spectroscopy Principles and Applications, Second Edition, Jag Mohan., Narosa Publishing House.
- Elementary Organic spectroscopy, Principles and chemical Applications, Y.R. Sharma, S. Chand.
- Advanced Organic Chemistry, Jagdamba singh, L.D.S Yadav
- D. A. Lang, Raman Spectroscopy, McGraw-Hill International.
- Raymond Chang, 1980, Basic Principles of Spectroscopy McGraw- Hill Kogakusha, Tokyo.

RADIATION PHYSICS

Name of the Course	**RADIATION PHYSICS** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 604**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Ionizing Radiations and Radiation Quantities:** Types and sources of ionizing radiation, fluence, energy fluence, kerma, exposure rate and its measurement- The free air chamber and air wall chamber, Absorbed dose and its measurement ; Bragg Gray Principle, Radiation dose units- rem, rad, Gray and sievert dose commitment, dose equivalent and quality factor. **(15 Lectures)**
Unit - II	**Dosimeters:** Pocket dosimeter, films, solid state dosimeters such as TLD, SSNTD, chemical detectors and neutron detectors. Simple numerical problems on dose estimation. **(15 Lectures)**

Unit - III	**Radiation Effects and Protection:** Biological effects of radiation at molecular level, acute and delayed effects, stochastic and non stochastic effects, Relative Biological Effectiveness (RBE), Linear energy transformation (LET), Dose response characteristics. Permissible dose to occupational and non-occupational workers, maximum permissible concentration in air and water, safe handling of radioactive materials, The ALARA, ALI and MIRD concepts, single target, multitarget and multihit theories, Rad waste and its disposal, simple numerical problems. **(15 Lectures)**
Unit - IV	**Radiation Shielding:** Thermal and biological shields, shielding requirement for medical, industrial and accelerator facilities, shielding materials, radiation attenuation calculations-The point kernal technique, radiation attenuation from a uniform plane source. The exponential point-Kernal. Radiation attenuation from a line and plane source. Practical applications of some simple numerical problems. **(15 Lectures)**

Reference Books:

- Nuclear Reactor Engineering-Van Nostrand Reinhold, S. Glasstone and A. Sesonke, 1981
- Radiation Theory, Alison. P. Casart
- Radiation Biology-Radiation Bio/Prentice Hall, A. Edward Profio, 1968
- Introduction to Radiological Physics and Radiation, F.H. Attix, Dosimetry-Wiley-VCH, 1986..

INDIAN KNOWLEDGE SYSTEM

Name of the Course	**INDIAN KNOWLEDGE SYSTEM** **(Credits: Theory-04) Theory: 60 Lectures**
Code	**PHYBM 605**
Semester Based Examination	**70 Marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 Marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **15 marks,** Class Test/Seminar/Assignments/Quiz = **10 marks,** Attendance Theory **= 05 marks.**	

This foundational course is of paramount importance as it serves as an introduction to fundamental concepts and mechanics, initiating students into college-level problem-solving in physics. It sets the learning paradigm and establishes the fundamental principles that will form the basis for the entire study of physics.

Instructions for Paper Setters and Candidates:

1. The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.

Unit - I	**Bharatiya Civilization and Development of Bhartiya Knowledge System:** Genesis of the land, Antiquity of civilization, On the Trail of the Lost River, Discovery of the Saraswati River, the Saraswati-Sindhu Civilization, Traditional Knowledge System, The Vedas, Main Schools of Philosophy (6+3), Ancient Education System, the Takṣasila University, the Nālanda University, Alumni, Knowledge Export from Bharata. **(15 Lectures)**
Unit - II	**Arts, Literature, and Scholars in Ancient Bharat**: Art, Music, and Dance, Naṭaraja– A Masterpiece of Bharatiya Art, Literature, Life and works of Agastya, Lopamudra, Ghoṣa, Valmiki, Patanjali, Vedavyasa, Yajnavalkya, Gargi, Maitreyi, Bodhayana,

	Caraka, Susruta, Jivaka, Nagarjuna, Kaṇada, Patanjali, Kauṭilya, Paṇini, Thiruvalluvar, Aryabhaṭa, Varahamihira, AdiSaṅkaracarya, Bhaskaracarya, Madhavacarya. **(15 Lectures)**
Unit - III	**Ancient Bhartiya Contribution towards Science & Mathematics**: Concept of Matter, Life and Universe, Gravity, Sage Agastya's Model of Battery, Velocity of Light, Vimana: Aeronautics, Vedic Cosmology and Modern Concepts, BharatiyaKala-gaṇana, Kerala School for Mathematics and Astronomy, History and Culture of Astronomy, Sun, Earth, Moon, and Eclipses, Earth is Spherical and Rotation of Earth, Archaeostronomy; Concepts of Zero and Pi, Number System, Pythagoras Theorem, and Vedic Mathematics. **(15 Lectures)**
Unit - IV	**Ancient Bhartiya Engineering, Technology & Architecture**: Pre-Harappan and Sindhu Valley Civilization, Laboratory and Apparatus, Juices, Dyes, Paints and Cements, Glass and Pottery, Metallurgy, Engineering Science and Technology in the Vedic Age and Post-Vedic Records, Iron Pillar of Delhi, Rakhigarhi, Mehrgarh, Sindhu Valley Civilization, Marine Technology, and Bet Dwarka. **(15 Lectures)**

Reference Books:

- Textbook on The Knowledge System of Bhārata by Bhag Chand Chauhan, Under Publication (2021).
- History of Science in India Volume-1, Part-I, Part-II, Volume VIII, by Sibaji Raha, et al. National Academy of Sciences, India and The Ram krishan Mission Institute of Culture, Kolkata (2014).
- Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati (2006).

B.Sc-M.Sc. FIVE YEAR INTEGRATED COURSE IN PHYSICS
(7th to 10th SEMESTER)

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
7th	Core Course-XV	PHYBM 701	Mathematical Physics-II	04	Theory = 80 IA = 20	100	22
	Core Course-XVI	PHYBM 702	Classical Mechanics	04	Theory = 80 IA = 20	100	
	Core Course-XVII	PHYBM 703	Electronics-I	04	Theory = 80 IA = 20	100	
	Core Course-XVIII	PHYBM 704	Computational Methods in Physics	04	Theory = 80 IA = 20	100	
	Core Course-XIX	PHYBM 705	Laboratory	06	Practical = 80 IA = 20	100	
8th	Core Course-XX	PHYBM 801	Quantum Mechanics-II	04	Theory = 80 IA = 20	100	22
	Core Course-XXI	PHYBM 802	Condensed Matter Physics	04	Theory = 80 IA = 20	100	
	Core Course-XXII	PHYBM 803	Statistical Physics	04	Theory = 80 IA = 20	100	
	Core Course-XXIII	PHYBM 804	Electrodynamics	04	Theory = 80 IA = 20	100	
	Core Course-XXIV	PHYBM 805	Laboratory	06	Practical = 80 IA = 20	100	

Semester	Course Type	Course Code	Title of Paper	Credits	Max. Marks	Total Marks	Total Credits
9th	Core Course-XXV	PHYBM 901	Quantum Mechanics-III	04	Theory = 80 IA = 20	100	22
	Core Course-XXVI	PHYBM 902	Material Science	04	Theory = 80 IA = 20	100	
	Core Course-XXVII	PHYBM 903	Nuclear Physics	04	Theory = 80 IA = 20	100	
	Core Course-XXVIII	PHYBM 904	High Energy Physics	04	Theory = 80 IA = 20	100	
	Core Course-XXIX	PHYBM 905	Laboratory	06	Practical = 80 IA = 20	100	
10th	Core Course-XXX	PHYBM 1001	Electronics-II	04	Theory = 80 IA = 20	100	26
	Open Elective-VII	PHYBM 1002(a)	Advanced High Energy Physics	04	Theory = 80 IA = 20	100	
		PHYBM 1002(b)	Nuclear & Particle Astrophysics	04	Theory = 80 IA = 20	100	
		PHYBM 1002(c)	Advanced Quantum Mechanics	04	Theory = 80 IA = 20	100	
	Core Course-XXXI	PHYBM 1003	Project	18	100	100	

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 10th semester is given 18 credits for 36 hours of engagement per week. Therefore PG Programme in B.Sc.-M.Sc Five Year Integrated Course in Physics is given 92 credits. Student will have to earn 92 credits to pass PG Programme in B.Sc.-M.Sc Five Year Integrated Course in Physics.

Program Outcomes:

1. Becoming Masters of Physics by gaining advanced knowledge of the courses proposed in the syllabi.
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 lead 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 applications 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 benefits 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 PG Programme in B.Sc.-M.Sc Five Year Integrated Course in 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 modeling 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 contribute to the professional development of aspirants

B. Sc.-M. Sc. Physics Five Year Integrated Course
7th Semester

MATHEMATICAL PHYSICS-II

Name of the Course	**MATHEMATICAL PHYSICS-II** **Credits: 04**		
Course Code	**PHYBM 701**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester-Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of the 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. The duration of the examination will be 3 hours.

Course Outcomes:

After completion of the course, students will be able to

1. Have a good understanding of the basic elements of complex analysis and make use of the Cauchy Integral Theorem and the Residue Theorem to compute certain types of integrals.
2. Build vector spaces and matrices, identify their properties, and solve 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 familiar 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:

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

CLASSICAL MECHANICS

Name of the Course	**CLASSICAL MECHANICS** **Credits: 04**		
Course Code	**PHYMS 702**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester-Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

In all, 10 questions will be set. Question No.1 will cover the entire syllabus and will be of the 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. The duration of the examination will be 3 hours.

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 the 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 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

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

ELECTRONICS- I

Name of the Course	**ELECTRONICS- I** **Credits: 04**		
Course Code	**PHYMS 703**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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, Travelling 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

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

COMPUTATIONAL METHODS IN PHYSICS

Name of the Course	**COMPUTATIONAL METHODS IN PHYSICS Credits: 04**		
Course Code	**PHYBM 704**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester-Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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 Laplace 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

- Rubin Landau, M Paez: Computational Physics (John Wiley).
- Tao Pang: Computational Physics (Cambridge University Press).
- V. Rajaraman: Computer Oriented Numerical Methods (PHI).
- E Balagurusamy: Numerical Methods (Tata Mcgraw Hill).
- S. E. Koonin: Computational Physics (Addison Wesley).
- Vetterming, Teukolsky, Press and Flannery: Art of Computing, Numerical Recipes (in C, C++, Fortran) (Cambridge University Press).

LABORATORY

Name of the Course	**LABORATORY** **Credits: 06**		
Course Code	**PHYBM 705**		
No. of hours per semester	**156**		
Duration of Course	**One Semester (13 weeks)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Practical	**80**	**32**
	Internal Assessment	**20**	**08**
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 seminar, number of experiments performed and checked after thorough viva and attendance.			

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

1. e/m of electron by helical method.
2. Plank's constant by photocell.
3. Millikan's oil drop experiment.

4. Cauchy's Constant.
5. Verification of Fresnel's amplitude relations.
6. Ultrasonic wave velocity in liquids by ultrasonic diffraction.
7. Constant Deviation Spectrometer.
8. 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++:

1. Statistical and error analysis of (a) given data (b) error estimation in computation.
2. (a) Roots of a quadratic/ cubic equation (b) summation of a series.
3. Numerical differentiation and integration of simple functions.
4. Operations on a matrix (a) inversion (b) diagonalisation (3x3 matrix) (c) solution of simultaneous equations.
5. Plotting and interpolation of a function.
6. Finding the value of Pi using Monte Carlo method.

M. Sc. PHYSICS (1st SEMESTER): LABORATORY/ 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 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 the 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-Thevenin 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.

B. Sc.-M. Sc. Physics Five Year Integrated Course
8th Semester

QUANTUM MECHANICS-II

Name of the Course	**QUANTUM MECHANICS-II** **Credits: 04**		
Course Code	**PHYBM 801**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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-degenerate and degenerate systems.
6. Make use of variational principle to ground state of helium atom.

Section-A	**Matrix formulation of Quantum Mechanics**: Matrix Algebra: Matrix addition and multiplication, Null unit and Constant Matrices, Trace, Determinant and Inverse of a Matrix, Hermitian and unitary Matrices, Transformation and diagonelization of Matrices, Function of Matrices 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 spins 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:

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

CONDENSED MATTER PHYSICS

Name of the Course	**CONDENSED MATTER PHYSICS** **Credits: 04**		
Course Code	**PHYBM 802**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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 specific heat of lattice. Inelastic scattering of neutrons by phonons and conservation laws. A harmonic crystal interaction, thermal expansion and Gruneissen parameter. Thermal conductivity; lattice thermal conductivity, Umklapp process. **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. Matthiessen's rule and experimental viewpoint. 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} and H_{c2}. Josephson tunnelling, 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-Mossotti 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, phases diagrams.

Books Recommended:

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

STATISTICAL PHYSICS

Name of the Course	**STATISTICAL PHYSICS** **Credits: 04**		
Course Code	**PHYBM 803**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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.

Section-A	**The Fundamental Principles of Statistical Physics**: Statistical Distributions, Statistical independence, Liouville's theorem, The significance of energy, The statistical matrix, Statistical distribution in quantum statistics, entropy, the law of increase of entropy. **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.
Section-B	**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. **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. **Non-Ideal 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 degenerate plasma.
Section-C	**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. **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.

Books Recommended:

- L. D. Landau and I. M. Lifshitz: Statistical Physics Third Edition (Part-I) (Pergamon).
- R. K. Pathria, Statistical Physics (Pergamon).
- David Chandler: Introduction to Modern Statistical Mechanics (Oxford University Press).
- R. P. Feynman: Statistical Mechanics (Addison Wesley).
- F. Mandl, Statistical Physics (Wiley).
- C. Kitlle, Elementary Statistical Physics (John Willey & Sons)

ELECTRODYNAMICS

Name of the Course	**ELECTRODYNAMICS** **Credits: 04**		
Course Code	**PHYBM 804**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

Course Outcomes:

After completion of course, students will able to

1. Make use of four-vector formulation of electrodynamics and understand 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. Langrangian 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 Boltzmann equation, Plasma Oscillations, Debye Shielding, Plasma parameter, Magneto plasma, Plasma confinement. Hydrodynamical Description of Plasma: Fundamental equations. Hydromagnetic waves: Magneto sonic and Alfven waves. Wave Phenomena in Magneto plasma: Polarization, phase velocity, Group velocity, cut-offs, resonance for Electromagnetic wave propagating parallel and perpendicular to the Magnetic field.

Books Recommended:

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

LABORATORY

Name of the Course	**LABORATORY** **Credits: 06**		
Course Code	**PHYBM 805**		
No. of hours per semester	**156**		
Duration of Course	**One Semester (13 weeks)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Practical	**80**	**32**
	Internal Assessment	**20**	**08**
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 seminar, number of experiments performed and checked after thorough viva and attendance.			

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

1. Semi classical quantization of molecular vibration.
2. Scattering by a central potential.
3. Solution of ordinary differential equation and application to order and Chaos in two-dimensional motion.
4. Structure of white dwarf stars.
5. Particle motion in infinitely deep square well potential.
6. Scattering states in step potential and tunneling effect.
7. Study of Ising model using Monte Carlo method

M.Sc. PHYSICS (8th 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 semiconductor: 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 (8th 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 its relevance in diffraction.
10. Identification of charge type by Hall voltage measurement.
11. How does four probe method solve the problem of contact resistance?

B. Sc.-M. Sc. Physics Five Year Integrated Course
9th Semester

QUANTUM MECHANICS - III

Name of the Course	**QUANTUM MECHANICS -III** **Credits: 04**		
Course Code	**PHYBM 901**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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 Schrodinger equation, second quantization, N-representation creation and annihilation operators.

Books Recommended:

- P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics (TMH).
- A. S. Davydov, Quantum Mechanics (Pergamon).
- L. I. Schiff, Quantum Mechanics (McGraw Hill).
- J. D. Bjorken and S. D. Drell, Relativistic Quantum Mechanics (McGraw Hill).
- J. J. Sakurai, Advanced Quantum Mechanics (Addison Wesley).

MATERIAL SCIENCE

Name of the Course	**MATERIAL SCIENCE** **Credits: 04**		
Course Code	**PHYBM 902**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

Course Outcomes:

After completion of course, students will able to

1. Explain 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. Explain 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. Learn 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. Learn Binary eutectic systems and development of microstructure in eutectic alloys, ceramic and ternary phase diagram, the application of Gibbs phase rule.
6. Explain the phase transformations: the kinetics of phase transformations, metastable versus equilibrium states, isothermal and continuous cooling transformation diagrams and tempered martensite transformations.
7. Learn 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. Explain the 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. Explain the 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:

- C. Kittel: Introduction to Solid State Physics 6th Edition (Wiley).
- A. 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).
- William D. Callister, Jr.: Callister's Materials science and Engineering, Wiley India (P) Ltd.
- S. Somiya et al. : Hand Book of Advanced Ceramics Vol. I & II.
- Sam Zhang, Lin Li and Ashok kumar: Materials Characterization Techniques.

NUCLEAR PHYSICS

Name of the Course	**NUCLEAR PHYSICS** **Credits: 04**		
Course Code	**PHYBM 903**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

Course Outcomes:

After completion of course, students will able to

1. Analyze the nuclear masses, nuclear mass formula, stability of nuclei, beta decay and double beta decay
2. Illustrate the properties of nuclear states: quantum numbers, angular momentum. Parity. Isotopic spin (isobaric spin, isospin), solving deuteron problem.
3. Explain exchange forces and tensor forces, Meson theory of nuclear forces, analyze Nucleon-Nucleon scattering, Spin dependences of nuclear forces
4. Explain the 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, analyze Spin-Orbit couplings, Valence Nucleons and Ground State Spin of Nuclei, justification of collective structure of Odd-A nuclei
6. Explain the Nuclear Collective Model: Nuclear Collective Vibrations, analyzing Nuclear Collective Rotation, Single-particle motion in a deformed potential
7. Classify and analyze 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. Explain the modelling and analysis of optical potential- average interaction potential for nucleons, energy dependence of potential
9. Identify the 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).

Books Recommended:

- B. L. Cohen, Concepts of Nuclear Physics, (TMH).
- K. S. Krane, Introductory Nuclear Physics (John Wiley & Sons).
- S. S. M. Wong, Introductory Nuclear Physics (Printice Hall of India).
- R. R. Roy and B.P. Nigam, Nuclear Physics (New Age International, 2000).

HIGH ENERGY PHYSICS

Name of the Course	**HIGH ENERGY PHYSICS** **Credits: 04**		
Course Code	**PHYBM 904**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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 for Semi-leptonic Decays, ΔS= ΔQ Selection 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 Semi-leptonic 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.

Books Recommended:

- A Modern Introduction to Particle Physics, Riazuddin and Fayyazudi.
- Particle Physics, S. Gasiorowkz.
- Particle Physics: An Introduction, M. Leon (Academic Press).
- Unitary Symmetry P. Carruthers.
- Nuclear and Particle Physics W.E. Burcham and M. Jobes (Addision – Wisely)

LABORATORY

Name of the Course	**LABORATORY** **Credits: 06**		
Course Code	**PHYBM 905**		
No. of hours per semester	**156**		
Duration of Course	**One Semester (13 weeks)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Practical	**80**	**32**
	Internal Assessment	**20**	**08**
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 seminar, number of experiments performed and checked after thorough viva and attendance.			

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 Op-Amp: characteristic and parameter measurements. Op-Amp as (a) an active filter and frequency response (b) basic mathematical operations using Op-Amp.
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 Op-Amp: characteristic and parameter measurements.
4. Op-Amp as (a) an active filter and frequency response (b) basic mathematical operations using Op-Amp.
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 glass plate, 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 Fastfourier transforms of some simple functions.
5. Simulation of an order disorder phase transition for a three states potts model

B. Sc.-M. Sc. Physics (9th 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 temperature.
6. To measure the cleavage step height of crystal by Multiple Fizeaue fringes.
7. To obtain multiple beam fringes of equal chromatic order. To determine crystal step height and study birefringence.
8. To determine magneto-resistance of a Bismuth crystal as a function of magnetic field.
9. To study hysteresis in the electrical Polarization of a TGS crystal and measure the Curie temperature.
10. To measure the dislocation density of a crystal by etching.

(a1) 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 superconductivity 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.

(c1) 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. Neutron 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.
- K. Siegbah, Alpha, Beta and gamma Ray Spectroscopy, 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.

B. Sc.-M. Sc. Physics Five Year Integrated Course
10th Semester

ELECTRONICS-II

Name of the Course	**ELECTRONICS-II** **Credits: 04**		
Course Code	**PHYBM 1001**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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-Electro Mechanical 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).

Books Recommended:

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

ADVANCED HIGH ENERGY PHYSICS

Name of the Course	**ADVANCED HIGH ENERGY PHYSICS** **Credits: 04**		
Course Code	**PHYBM 1002(a)**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

Course Outcomes:

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

1. Explain the fundamental principles of symmetries and conservation laws in particle physics, including the application of Noether's theorem**.**
2. Distinguish between global and local gauge invariance and assess their implications in quantum field theory.
3. Analyze the concepts of spontaneous symmetry breaking and Goldstone bosons, and apply the Higgs mechanism to mass generation.
4. Describe the structure and unification of electroweak interactions via the Weinberg-Salam model**,** including the roles of SU(2) × U(1) gauge symmetries.

5. Apply group theory concepts (e.g., SU(2), SU(3)) in understanding particle multiplets and interaction symmetries.

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) × 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).

Books Recommended:

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

NUCLAR &PARTICLE ASTROPHYSICS

Name of the Course	**NUCLAR &PARTICLE ASTROPHYSICS** **Credits: 04**		
Course Code	**PHYBM 1002(b)**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

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 PP I 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.

Books Recommended:

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

ADVANCED QUANTUM MECHANICS

Name of the Course	**ADVANCED QUANTUM MECHANICS** **Credits: 04**		
Course Code	**PHYBM 1002(c)**		
No. of hours per semester	**52**		
Duration of Course	**One Semester (13 weeks)**		
Lectures to be delivered	**39 (13 × 3)**		
Tutorial	**13 (13 × 1)**		
Semester Based Examination	**Total Marks = 100**		
	Time: 03 Hrs	**Max. Marks**	**Pass Marks**
	Theory	**80**	**32**
	Internal Assessment	**20**	**08**
Note: Internal Assessment on the basis of two Midterm Exams (one in the middle of the semester i.e. 7th week and the second at the closing of the semester i.e., 14th week. **Midterm Exam** = 15 marks, **Attendance Theory** = 05 marks			

Instructions for Paper Setters and Candidates:

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 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. The duration of the examination will be 3 hours.

Course Outcomes:

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

1. Formulate and quantize neutral and complex scalar fields, and explain the significance of U(1) gauge invariance in field theory.
2. Apply the principles of canonical quantization to the Dirac field and electromagnetic field**,** including covariant commutation and anti-commutation relations.
3. Construct and interpret interaction Lagrangians for scalar, spinor, and vector fields, particularly the QED Lagrangian.
4. Explain the formalism of the S-matrix and derive scattering amplitudes using Wick's theorem**,** Furry's theorem**,** and covariant perturbation theory**.**
5. Identify and classify divergences in quantum field calculations and understand their physical implications.
6. Perform renormalization procedures for mass, charge, and wave functions in QED, including self-energy corrections, vacuum polarization**,** and vertex corrections.

7. Critically evaluate the renormalizability of QED and understand its foundational role in modern quantum field theory.

Section A	Quantization of fields: Quantization of neutral and complex scalar fields, U (1) gauge invariance Quantization of Dirac field covariant anti-commutation 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 .

Books Recommended:

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

PROJECT

Name of the Course	**PROJECT** **Credits: 18**	
Course Code	**PHYBM 1003**	
No. of hours per semester	**234**	
Duration of Course	**One Semester (13 weeks)**	
Semester Based Examination	**Total Marks**	**Pass Marks**
	100	**40**

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 modelling.
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.

Instructions for Candidates:

All the B.Sc-M.Sc. Five Year Intergraded (Physics) Students will do a supervised Physics Project in 10th 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, and Particle Physics), Experimental Physics, and 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 will be allotted project in B.Sc-M.Sc. 10th Semester in consultation with their supervisors well in advance but not later than middle of 9th semester i.e. 31st October 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 10th semester i.e. February/ March about the progress made by them during vacations. The presentation should be preferably in the forms of a power point presentation.

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

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

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

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

Title Page

M.Sc. Project Report

On

Title of the Project

Supervised by:

Name of the Group

Submitted by:

Name 1
Name 2
Name 3

Physics Department
Sardar Patel University
Mandi, Himachal Pradesh
Session
Month, Year

Page 2

(Preferably on Guide's letter head)

Certificate

This is to certify that the project entitled "**Title of Project**" aimed at " Project purpose" was worked upon by the following students under my supervision at Physics Laboratory in Physics Department, Sardar Patel University, Mandi, Himachal Pradesh..

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

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

Chairman Name of Guide

Page 3

Acknowledgements

Page 4

Preface

Page 5

Contents

Page 6

Abbreviations used

Page 7

List of Tables

Page 8

List of Graph and figures

Page 9

Introduction

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

End of Report

Appendices
Source code and other relevant appendices
Bibliography/References

Instructions for the Formatting and Presentation of Project Report

The following instructions are 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 text size……. 12pt
- Chapter headings …… 18 pt Bold
- Section heading ……16 pt Bold
- 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: 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 10th Semester for regular students.