JAI PRAKASH UNIVERSITY, CHAPRA
SARAN-BIHAR-841302 (INDIA)

SYLLABUS

(*Based on CBCS*)

FOR

M.Sc. Physics

Effective from
Session 2018-2020

DRAFT SYLLABUS

of

M.Sc. in PHYSICS

for

Effective from Academic session 2018-20

<u>OUTLINE OF THE CHOICE BASED CREDIT SYSTEM (CBCS) for PG degree courses:</u>

It consists of a number of courses, i.e., **Core Course (CC), Elective Course (EC), Discipline Specific Elective Course (DSE), Ability Enhancement Courses (AEC), and Ability Enhancement Compulsory Courses (AECC).** Each course is equivalent to a paper. The nature of these courses is defined below.

1.1 Core Course (CC):

A course which should compulsorily be studied by a candidate as a core requirement on the basis of subject of MSc studies and is termed as a Core course.

1.2. Elective Course (EC):

Generally, a course which can be chosen from a pool of courses (Basket) and which may be very specific or specialized or advanced or supportive to the subject/ discipline of study or which provides an extended scope or which enables an exposure to some other subject/discipline/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

1.3 Discipline Specific Elective Course (DSE):

Elective courses may be offered by the main discipline/subject of study is referred to as **Discipline Specific Elective**. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

1.4 Generic Elective (GE) Course:

An elective course chosen generally from an unrelated discipline/subject with an intention to seek exposure is called a **Generic Elective**.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other disciplines/subject and *vice versa* and such electives may also be referred to as Generic Elective.

1.5 Ability Enhancement Courses (AEC):

The Ability Enhancement Courses (AEC) / Skill Enhancement Courses (SEC). "AEC" courses are the courses based upon the content that leads to life skill enhancement.

1.6 Ability Enhancement Compulsory Courses(AECC):

University will run a number of **Ability Enhancement Compulsory Courses (AECC)** which is qualifying in nature and student from all faculties have to qualify in all such courses.

1.7 Dissertation/Project/ Internship/ Industrial Training/ Field Work:

Elective courses are designed to acquire advanced knowledge to supplement /support the main subject through project work/ internship/ industrial training/ fieldwork. A student studies such a course on his/her own with mentoring support by a teacher/faculty member called the guide/ supervisor. In case of internship/ industrial training, the student will work under the joint guidance of one teacher-supervisor from the parent department to be termed as Supervisor-1 and one suitably qualified personnel at the research institute/ research laboratory/ industrial organization, to be termed as Supervisor-2. A student may join any recognized research institute/ research laboratory/ industrial organization with the approval of the parent department. The student has to work for a minimum number of days/hours as decided by the parent department. On completion of the project work/ training at the research institute/ research laboratory/ industrial organization, student will submit a written project report certified by both supervisors to the parent department. Supervisor-2 will issue a letter certifying that the candidate has successfully completed the project and also award marks/grade to him/ her. The certificate will be submitted to the parent department, confidentially. The Board of Courses of Studies (BOCS) of the concerned subject/ department will draft and design the certificate and other documents as per requirement. The parent department will also assist the students to choose proper organizations for their project work/ industrial training/ field work etc.

2.0 CREDIT

The total minimum credits required for completing a PG program is 100.

The details of credits for individual components and individual courses are given in **Table.1**.

Table 1: Structure of the 2 Yrs (Four Semesters) Post Graduate Degree course under CBCS:

Semester	No of COURSE / Papers	Credit per COURSE/ paper	Total credit	Minimum No of Learning Hours#	No of CORE COURSE/ PAPER	No of ELECTIVE Course/ PAPER	Code & Nature of Elective Course/ paper
I	05	05	25	250	4	1	AECC-1
SEMESTER BREAK							
II	06	05	30	300	5	1	AEC-1
SEMESTER BREAK							
III	06	05	30	300	5	1	AECC-2
SEMESTER BREAK							
IV	03	05	15	150	0	3	EC -1* EC -2* DSE-1 or GE-1
Total	**20**		**100**	**1000**	**14**	**6**	

#For Tutorial (T)/ Practical (P)/ Field Work (FW)/ Internship etc. extra working hour to be added as per requirement and will be decided by the BOCS of the respective subject.

* The two **Elective Courses (EC)** to be studied in semester IV may be

Both theory papers
/ One Theory paper and One Practical paper
/ One Theory paper and One Project work
/ One Theory paper and One Field work
/ Both Project work/ Internship

IMP : It is desirable that all students of all courses be given adequate exposure over and above the classroom teaching to enhance the scope of skill development/ entrepreneurship and employability.

2.1. There shall be six elective courses - two EC, one DSE or one GE, two AECC, one AEC. Students may opt for any elective course out of a list of elective papers **(Basket)** offered by the parent department or any other department/s as per his/her choice with the prior permission of the parent department. The list of elective papers, syllabus, and prerequisite of the elective course will be as decided by the Board of Courses of Studies (BOCS) of the concerned subject/ department. All elective courses listed may not be available in all semesters. Based on the availability of resource persons and infrastructure, the parent department will assist the students to select elective courses of their choice.

2.2. The final CGPA/ class will be decided on the performance of the student in the 16 courses/papers, including the 14 Core Courses (CC) / papers and two EC / papers.

2.3 The one DSE or one GE, two AECC, one AEC papers will be qualifying in nature, and a student has to score at least 45% marks in these papers. Grade will be awarded separately for these courses, however, performance in these elective courses/ papers will not be considered for awarding the final CGPA/ class.

2.4 **Ability Enhancement Compulsory Courses (AECC):**

University will run two **Ability Enhancement Compulsory Courses** (AECC) which are qualifying in nature and a student has to qualify in both these courses. The courses are:

AECC-1 : Environmental Sustainability (3 Credit)
&Swachchha Bharat Abhiyan Activities (2 Credit)

AECC- 2 : Human Values & Professional Ethics (3 Credit)
& Gender Sensitization (2 Credit)

Students will do assignments/project work related to institutional social responsibilities, including Swachchha Bharat Abhiyan Activities during SEMESTER BREAK.

2.5 University will run a number of **Ability Enhancement Courses** (AEC) and Skill Enhancement Courses; a student can choose one from these. For example:

Basket Ability Enhancement Courses (AEC)

- Computers and IT Skill
- Web Designing
- Financial Risk Management/
- Solid waste Management/
- Mushroom Culture /
- Bio-fertilizer production/
- Environmental Law/
- Tourism & Hospitality Management/
- Life skill& skill development /
- Yoga Studies

etc.

2.6 Discipline Specific Elective (DSE):

In each subject the CC / paper -5 being taught in the second semester will be open to be selected as a DSE paper. In the first phase a student will be allowed to choose a paper from any subject other than his/ her Core Course (CC) from the same faculty in the same university.

2.7 Generic Elective (GE) Course:

University will run a number of **Generic Elective Courses** (GE); a student can choose one from these. For example:

Basket of GE courses

- Music
- Dramatics
- Fine Arts
- Graphic Design
- Inclusive Policies
- Human Rights
- Any course run by any department

M.Sc. PHYSICS
(Four Semester Course)

PROGRAM OBJECTIVES:

1. To develop strong student competencies in Physics and its applications in a technology-rich, interactive environment.
2. To develop strong student skills in the research, analysis, and interpretation of complex information
3. To prepare the students to successfully compete for employment in Electronics, Manufacturing and Teaching industry.
4. To develop human resource with a solid foundation in theoretical and experimental aspects of respective specializations as a preparation for career in academia and industry.

Course Structure

Semester I (July to December)					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYCC-1	Classical Mechanics	5	70	30	100
MPHYCC-2	Mathematical Physics	5	70	30	100
MPHYCC-3	Quantum Mechanics	5	70	30	100
MPHYCC-4	Lab-I	5	70	30	100
MPHYAECC-1	Environmental Sustainability (3 Credits) and Swachchha Bharat Abhiyan Activities (2 Credits)	5	70	30	100

Semester II (January to June)					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYCC-5	Modeling and Simulation	5	70	30	100
MPHYCC-6	Electrodynamics & Plasma Physics	5	70	30	100
MPHYCC-7	Electronics I	5	70	30	100
MPHYCC-8	Thermodynamics and Statistical Mechanics	5	70	30	100
MPHYCC-9	Lab-II	5	70	30	100

MPHYAEC-1	Any one of the followings: • Computers and IT Skill • Web Designing • Financial Risk Management/ • Solid waste Management/ • Mushroom Culture / • Bio-fertilizer production/ • Environmental Law / • Tourism & Hospitality Management/ • Life skill & skill development / • Yoga Studies	5	70	30	100

Semester III (July to December)					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYCC-10	Atomic and Molecular Physics	5	70	30	100
MPHYCC-11	Condensed Matter Physics	5	70	30	100
MPHYCC-12	Electronics II	5	70	30	100
MPHYCC-13	Nuclear and Particle Physics	5	70	30	100
MPHYCC-14	Lab-III	5	70	30	100
MPHYAECC-2	Human Values and Professional Ethics (3 Credit) and Gender Sensitization (2 Credit)	5	70	30	100
Semester IV (January to June)					
Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYEC-1	Elective Paper I	5	70	30	100
MPHYEC-2	Elective Paper II Part 1: Practical – 50 marks Part 2: Dissertation – 50 marks	5	70	30	100
MPHYDSE-1 Or MPHYGE-1	For MPHYDSE-1, in each subject the CC / paper -5 being taught in the second semester will be open to be selected as a DSE paper. In the first phase a student will be allowed to choose a paper from any subject other than his/ her Core Course (CC) from the same faculty in the same university. For MPHYGE-1, a student can choose any one from the following:	5	70	30	100

	• Music • Dramatics • Fine Arts • Graphic Design • Inclusive Policies • Human Rights • Any course run by any department				

Elective-I Code: PHYEC-1
Elective Theory Papers for Semester 4 (One to be selected from the following set of 05 options)

Code	Subject	Credits	E.S.E.	C.I.A.	Total
MPHYEC-1	Advanced Quantum Mechanics	5	70	30	100
	Advanced Condensed Matter Physics				
	Lasers and Photonics				
	Nano Science				
	Plasma Physics				

Elective-II Code: MPHYEC-2
Part 1: Practical on any one of the topics from the set of following options:
Part 2: Dissertation on any topic on Physics

Code		Subject	Credits	E.S.E.	C.I.A.	Total
MPHYEC-2	Part- 1	Advanced Condensed Matter Physics	2.5	35	15	50
		Advanced Condensed Matter Physics				
		Lasers and Photonics				
		Nano Science				
		Plasma Physics				
	Part- 2	Dissertation [On any Topic on Physics]	2.5	35	15	50

Marks and Workload Distribution

Each paper will be of 100 marks. End Semester Examination (ESE) will carry 70 marks.

Continuous Internal Assessment (CIA) will carry 30 marks

Pass marks in every semester paper is 45%.

Aggregate mark in a semester must be at least 45% for clearing the subject papers of each semester.

Total credit 100

Semester I- 25 credit

Semester II-30 credit

Semester III- 30 credit

Semester IV-15 credit

1 credit is equivalent to 10 theory hours or 20 laboratory hours.

Theory Paper		Credit – 05	Total Marks – 100		
Type of Examination	Duration	Question Papers and Details of Evaluation	No. of Questions to be set	Distribution of Marks	Total
End Semester Examination [Written] (70 Marks)	3 Hours	Group A: Multiple Choice type	10	2 X 10 = 20	20
		Group B: Short Answer type (5 questions, one from each unit)	05	4 X 5 = 20	20
		Group C: Long Answer Type (5 questions one from each unit)	05	6 X 5 = 30	30
Continuous Internal Assessment [CIA] (30 marks)	1 Hour	Mid-semester Test - 02 (written) (each of 7.5 mark)			7.5 X 2 = 15
		Group A: Multiple Choice Type	03	0.5 X 3	
		Group B: Short Answer Type	02	1.5 X 2	
		Group C: Long Answer Type	01	3 X 1	
		Assignment			05
		Seminar/Quiz			05
		Attendance, Punctuality & Conduct			05
Practical Paper		Credit – 05	Total Marks: 100		
End Semester Examination (ESE)	6 Hours	1 Experiment to be performed			70
Continuous Internal Assessment (CIA)					30
Elective Practical and presentation of Dissertation	6 Hours	1 Experiment to be performed plus Dissertation presentation		35+35	70
CIA of Practical and Dissertation				15+15	30

Program Outcomes:

The recent developments in Physics has been included in the enriched M.Sc.(Physics) Syllabus to meet the present day needs of Academic and Research Institutions and Industries. An important objective of the course is to develop an understanding of 'core physics' at deeper levels , each stage revealing new phenomena and greater insight into the behavior of matter and radiation. The various courses in the first two semesters, are designed to bridge the gap between college and university level physics and to bring all students to a common point. These courses also aim to consolidate the college level knowledge of physics by providing much more logical and analytical framework, which will be essential for the specialization courses in the third and fourth semesters. After the completion of their M.Sc. Students will have:

1. Strong analytical abilities.
2. Qualities needed for teaching of Science and doing research.
3. Knowledge of theoretical as well as experimental areas of Physics.
4. Capabilities to generate self-employment.
5. Computational Skill and ICT development.

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SEMESTER-I

MPHYCC-1: Classical Mechanics (5 Credits)

Course objectives:

1. To give students a solid foundation in classical mechanics.
2. To introduce general methods of studying the dynamics of particle systems.
3. To give experience in using mathematical techniques for solving practical problems.
4. To apprise the students of Lagrangian and Hamiltonian formulations and their applications.
5. To apprise the students regarding the concepts of electrodynamics and its use in various situations.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

UNIT 1. Lagrangian Dynamics and Hamiltonian formulation:
Constraints, Principle of Virtual Work, D'Alembert's principle and its applications, Lagrange's equation, and its applications. Jacobi integral and energy conservation, Concept of symmetry, velocity dependent potential. Variational calculus and Least Action principle, Hamilton's principle, Lagrange's equation from Hamilton's principle, Legendre transformations, Hamilton's function and Hamilton's equation of motion, configuration space and phase space Hamilton's equations from Variational principle.

UNIT 2. Canonical transformations and Hamilton Jacobi theory:
Generating function, canonical transformation and its examples, group property, Lagrange and Poisson brackets and other canonical invariants, equation of motions, Infinitesimal canonical theorem in Poisson bracket formalism, Jacobi identity, Angular momentum- Poisson bracket relations. The Hamilton-Jacobi equation for Hamilton's principal and characteristic functions with example; the harmonic oscillator, Separation of variable in Hamilton-Jacobi equation; Action-angle variables and its examples – the Kepler problem in action-angle variables.

UNIT 3. Central Force Motion and Rigid Body:
Reduction to one-body problem, General Properties of central force, Effective potential, Motion in a central force field – general solution, Inverse Square Law force. Kepler's Laws – laws of gravitation form Kepler's laws, Virial theorem. Scattering in a central force field and in Laboratory Co-ordinates. The rigid bodies, Kinematics of rigid body motion, Orthogonal transformations, Euler's theorem and its applications. Finite and infinitesimal rotations, rate of change of a vector, the rigid body equation of motion, Coriolis effect, angular momentum and kinetic energy of motion about a point, the inertia tensor and the moment of inertia, the principal axis transformation, the Euler equations of motion.

UNIT 4. Small Oscillation:
Formulation of the problem, the eigenvalue equation and the principal axis transformation, frequencies of free vibrations and normal coordinates, forced vibrations and the effect of dissipative forces, Resonance and beats.

UNIT 5. Relativity:
Review of special theory of relativity - Lorentz transformations; 4-vectors, 4-dimensional velocity and acceleration; 4-momentum and 4-force; Covariant equations of motion; Relativistic kinematics (decay and elastic scattering); Lagrangian and Hamiltonian of a relativistic particle; General theory of relativity: Curved space-time; Eotvos experiment and the equivalence principle.

Course Outcomes:

1. Know the difference between Newtonian mechanics and Analytic mechanics
2. Solve the mechanics problems using Lagrangian formalism, a different method from Newtonian mechanics
3. Understand the connection between classical mechanics and quantum mechanics from Hamiltonian formalism
4. Understanding of basic concepts of special and general theory of relativity

References:

1. N C Rana & P S Joag, Classical Mechanics, McGraw Hill, First Edition 2011.
2. Herbert Goldstein, Charles P. Poole, and John L. Safko, Classical Mechanics, Pearson, Third Edition 2011.
3. John R. Taylor, Classical Mechanics, University Science Books, First Edition 2005.
4. David Morin, Introduction to Classical Mechanics, Cambridge University Press, First Edition 2008.

MPHYCC-2 Mathematical Physics (5 Credits)

Course Objectives:

1. To develop knowledge in mathematical physics and its applications.
2. To develop expertise in mathematical techniques that are required in physics.
3. To enhance problem solving skills
4. To give the ability to formulate, interpret and draw inferences from mathematical solutions.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Linear Differential equations and special functions:
Linear Differential Equations, Power series solutions; Special Functions: Hermite, Legendre, Bessel, Lauguerre Polynomials; Fourier and Laplace Transforms.

Unit 2. Elements of Complex analysis:
Analytic functions, Taylor and Laurent series, calculus of residues, nature of singularities, Evaluation of definite integrals, Jordan's lemma

Unit 3. Green's Function
Green's Function, Dirac Delta Function, Properties and applications

Unit 4. Group Theory:
Groups, subgroups, cosets, invariant subgroups, factor groups, homomorphism and isomorphism, orthogonality theorems, Continuous groups with special reference to O(3), SU(2),SU(3).

Unit 5. Elementary Tensor Analysis
Coordinate transformations, Contravariant and covariant vectors, Contravariant, covariant and mixed tensors, tensor fields, symmetric and skew symmetric tensors, fundamental operations with tensors, metric tensor, conjugate tensors, and associated tensors

Course Outcome:

1. Master the basic elements of complex mathematical analysis
2. Solve differential equations that are common in physical sciences
3. Apply group theory and integral transforms to solve mathematical problems of interest in Physics
4. Understanding how to use special functions in various physics problems

References:

1. Arfken& Weber, Mathematical Methods for Physicists, Elsevier, Sixth Edition 2012.
2. Murray R. Spiegel, Schaum's Outline of Advanced Mathematics for Engineers and Scientists, McGraw Hill, First Edition 2009.
3. Mary L. Boas, Mathematical Methods in the Physical Sciences, John Wiley, Third Edition 2005.
4. Murray R. Spiegel, Seymour Lipschutz, John J. Schiller, and Dennis Spellman, Schaum's Outline of Complex Variables, McGraw Hill, Second Edition 2009.

MPHYCC– 3 Quantum Mechanics (5 Credits)

Course Objectives:

1. To illustrate the inadequacy of classical theories and the need for a quantum theory
2. To explain the basic principles of quantum mechanics
3. To develop solid and systematic problem solving skills.
4. To apply quantum mechanics to simple systems occurring in atomic and solid state physics

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Basics of Quantum Mechanics and Mathematical Foundations:
Origin of Quantum mechanics, particle and wave aspect of radiation, particle versus waves, intermediate nature of microphysical world, quantization rules and wave packets.

Linear vector spaces, dimensionality, basis, eigenvalue equations, orthogonality and completeness conditions; Observables, Dirac's Bra and Ket notations, Properties of Hermitian Operator, unitary and similarity transformation; Operators, Fourier Transform, Wave function as a vector in Hilbert space, Superposition principle; Representations, Relation between Ket and wave function, Eigenvalue spectrum of linear momentum and its wave functions; Transformation between coordinate and momentum representations, Ehrenfest Theorem.

Unit 2. Quantum Dynamics:
Schrodinger, Heisenberg and Interaction pictures; Linear Harmonic Oscillator solution using Schrodinger picture and Heisenberg picture (Matrix Mechanics),Angular Momentum, spin and parity operators: symmetry and conservation principle, definition of angular momentum, ladder operators, allowed values, construction of angular momentum matrices; Spin and Pauli spin matrices; Coupling of angular momentum, C.G. Coefficients.

Unit 3. Perturbation theory:
Time independent perturbation theory for discrete levels - non-degenerate and degenerate cases, removal of degeneracy, Spin-Orbit coupling, Fine Structure of Hydrogen, Variation method, Time-dependent perturbation theory, - constant and periodic perturbations, Fermi Golden rule, WKB approximation, sudden and adiabatic approximations.

Unit 4. Scattering theory:
Mutual scattering of two particles – Schrodinger equation in laboratory and center of mass frames, system of identical particles – symmetric and anti symmetric wave functions, Two electron atoms - exchange interactions, spin half particles in a box – Fermi gas, band structure, Quantum Scattering theory – Differential and total cross sections, scattering amplitude, Formal expression for scattering amplitude - Green's functions, Born approximation – Application to spherically symmetric potentials.

Unit 5. Relativistic quantum mechanics:
The Klein-Gordon (KG) equation – Charged particle in an electromagnetic field, Interpretation of the KG equation, Dirac equation, free particle solution, equation of continuity, Plane wave solutions of the Dirac equation, Non-relativistic limit of the Dirac equation, Fine structure of Hydrogen.

Course Outcome:

1. To have a working knowledge of the foundations, techniques and key results of quantum mechanics
2. To comprehend basic quantum mechanical applications at the research level
3. Gain an ability to competently explain/teach quantum physics to others

References:

1. B.H. Bransden and C.J. Joachain, Quantum Mechanics, Pearson, Second Edition 2007.
2. David J. Griffiths, Introduction to Quantum Mechanics, Pearson, Second Edition 2009.
3. Yoav Peleg, Reuven Pnini, ElyahuZaarur, and Eugene Hecht, Schaum's Outline of Quantum Mechanics, McGraw Hill, Second Edition 2010.
4. P.M. Mathews and K. Venkatesan, Quantum Mechanics, McGraw Hill, Second Edition 2010.

MPHYCC–4 Lab-I (5 Credits)

Course Objectives:

1. To make the student familiarize with the basics of experimental physics.
2. To enable the student to explore the concepts involved in the thermodynamics and heat
3. To make the student understand the basic concepts in modern optics
4. To allow the student to understand the fundamentals of instruments involved

List of experiments (minimum12):

1. Measurement of Hall Coefficient of given semiconductor: identification of type of semiconductor and estimation of charge carrier concentration
2. Young's modulus – Elliptical fringe method
3. Young's modulus – Hyperbolic fringe method
4. Four Probe Method – Determination of resistivity of semiconductor at different temperatures
5. Determination of Ultrasonic velocity in given liquid for a fixed frequency
6. Determination of optical absorption coefficient and determination of refractive index of the liquids using He-Ne / Laser
7. Measurement of laser parameters using He – Ne laser / diode laser
8. Refractive index of liquids / Using – He-Ne laser / Diode laser
9. Determination of wavelength of a laser by Michelson Interferometer method
10. Determination of semiconductor band gap
11. Thermistor – Determination of energy gap
12. Determination of numerical aperture of an optical fiber
13. Determination of wavelength of a laser source using diffraction grating.
14. Determination of operating voltage of a GM tube and determine the linear absorption coefficient and verify inverse square lane.
15. Determination of operating voltage of a GM tube and verify inverse – square law
16. Direct reading of Zeeman effect (e/m of an electron) with a laser source
17. Compact microwave training system Experiment
18. Stefan's constant.
19. Susceptibility – Guoy and Quincke's methods.
20. Hydrogen spectrum and solar spectrum – Rydberg's constant.

Course Outcome:

At the end of the course,

1. The student should have knowledge of the different experimental techniques.
2. The student should have understood the basics of physics involved in experiments
3. The student should be able to apply the concepts of physics and do the interpretation and acquire the result.

SEMESTER-II

MPHYCC-5 Modeling and simulation (5 Credits)

Interdisciplinary in nature. Recommended
to be selected by students of other programme as DSE 1/ GE)

Course Objectives:

1. To encourage students to "discover" physics in a way how physicists learn by doing research.
2. To address analytically intractable problems in physics using computational tools.
3. To enhance the various computational technique with programming basic in C++/Python/ Java to face the world of problems using high-performance iteration techniques.
4. To show how physics can be applied in a much broader context than discussed in the traditional curriculum.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Object oriented Programming language:
Object oriented paradigm with reference to C++: Objects and classes, Encapsulation and data abstraction, Delegation; Inheritance, Polymorphism: function and operator overloading, dynamic binding; message communication; Elementary idea about FORTRAN, Java and Python (Basic features only).

Unit 2. Programming with Python:
Program development, Variables, Expressions and statements, Functions, Conditionals and Recursion, Iteration, Strings, Lists, Dictionaries, Tuples, Files, Types of errors and Debugging, Function Libraries, Numpy, Scipy, Matplotlib, Use of Scilab and R for scientific programming.

Unit 3. ODE and PDE:
ODE: RK method, Leap Frog method; Application to electron motion in electric and magnetic fields; Non-linear equations; PDE: Elliptic equations: Poisson equation; Hyperbolic equations: wave equation; Parabolic equation: Diffusion equation for Lagrangian fluids.

Unit 4. Matrix Problems
Jacobi method for matrix inversion; Techniques for solving eigenvalue problems

Unit 5. Monte Carlo method and simulation

Random number generators, Monte Carlo integration, Metropolis algorithm, Ising model, Molecular dynamic.

Course Outcome:

At the end of this course, students will be able to

1. Learn how to interpret and analyze data visually, both during and after computation.
2. Gain an ability to apply physical principles to real-world problems.
3. Acquire a working knowledge of basic research methodologies, data analysis and interpretation.
4. Understand various simulation techniques which can be used in future by students to analyse the data.

References:

1. Rubin H. Landau, Manuel J. Paez, Computational physics-Problem solving with computers, John Wiley & sons, New York (1997).
2. P.L. DeVries, A First Course in Computational Physics, , John Wiley & sons, New York (1994).
3. G. Golub and J.M. Ortega Scientific Computing: An Introduction with Parallel Computing, Academic Press, San Diego (1993).
4. J. M. Thijssen, Computational Physics, , Cambridge University Press, Cambridge, 1999

MPHYCC-6 Electrodynamics and Plasma Physics (5 Credits)

Course Objectives:

1. To apprise the students regarding the concepts of electrodynamics and its use in various situations.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Electromagnetic wave equation and field vectors:
Maxwell's equations in free space, Plane wave in free space. Dispersion of electromagnetic waves, Poynting vector in free space. Polarization of electromagnetic waves, electric field vector in terms of scalar and vector potential, Wave equation in terms of scalar and vector potential.

Unit 2. Electromagnetic waves and its Interaction with matter on macroscopic scale: Electromagnetic waves(EMW) in free space, propagation of EMW-in isotropic, anisotropic dielectrics, in conducting media; Boundary conditions, reflection and refraction of EMW, Fresnel formulae, Brewster's law and degree of polarization, total internal reflection and critical angle, reflection from a metallic surface, Propagation of EMW between conducting planes, Wave guides: TE and TM mode, Transmission lines, Rectangular and cylindrical wave guides, cavity resonator

Unit 3. Fields of moving charges and Radiating System:
Retarded Potentials, Lienard Wiechert potentials, field of a point charge in uniform rectilinear motion, in arbitrary motion, Radiation from an accelerated charged particle at low and high velocity. Radiating System: Oscillating electric dipole, radiation from an oscillating dipole, from a small current element, from a linear antenna, Antenna arrays

Unit 4. Relativistic Electrodynamics:
Transformation equation for current density and charge density, vector potential and scalar potentials, the electromagnetic field tensor, transformation equation for electric and magnetic field, Covariance of Maxwell equation in four tensor form, covariance of Maxwell and transformation law of Lorentz force.

Unit 5. Plasma Physics:
Elementary concepts of plasma, derivation of moment equations from Boltzmann's equation. Plasma oscillation, Debye shielding, plasma confinement, magneto plasma. Fundamental equations, hydromagnetic waves: magnetosonic waves, Alfven waves, wave propagation parallel and perpendicular to magnetic field.

Course Outcomes:

Students will have understanding of:
1. Time-varying fields and Maxwell equations.
2. Various concepts of electromagnetic waves.
3. Radiation from localized time varying sources, and the charged particle dynamics.

References:

1. Introduction to Electrodynamics, David J.Griffths, Prentice-Hall of India, 3rd Edition, 2009
2. Classical Electrodynamics, J.D.Jackson, Wiley Publishing, Newyork, 3rd Edition, Eight Print, 2002.
3 J.A. Bittencourt, Fundamentals of Plasma Physics, Third edition, Springer Publication, 2004.

MPHYCC-7 Electronics I (5 Credits)

Course Objectives:

1. To make the student familiarize with the basics of electronics.
2. To enable the student to explore the concepts involved in the oscillators
3. To make the student understand the basic concepts in IC and digital devices
4. To allow the student to understand the fundamentals of multivibrators
5. To provide in-depth theoretical base of Digital Electronics

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Semiconductor Devices:
BJT, JFET, MOSFET (Enhancement and depletion types), UJT, SCR, TUNNEL Diode, Zener Diode: Structure, working and characteristics.

Unit 2. Amplifiers and Feedback:

BJT biasing, design of a CE transistor amplifier, small signal model, emitter follower, Negative feedback and its properties (effect of feedback on different parameters), types of feedback; Oscillators: Principles, Barkhausen criterion, frequency stability, phase shift oscillator, Wien bridge oscillator.

Unit 3. Operational Amplifiers

Operational amplifier and its block diagram, ideal and practical op-amp characteristics; Op-amp circuits: inverting and non-inverting amplifier, adder, subtractor, differentiator, integrator, current to voltage converter, first-order active filters.

Unit 4.Digital Electronics
Number systems and codes, binary arithmetic, logic gates: AND, OR, NAND, NOR, NOT, XOR. Boolean algebra theorems, De-Morgan`s theorems, Minterm and Maxterm representations, simplification using Boolean algebra theorems and K- maps, half and full adders, flip-flops - RS and JK. Elementary ideas of Registers, Counters, Comparators

Unit 5: Microprocessor and Microcontroller
Microcomputer Block Diagram, System Buses, 8086 Microprocessors, architecture and operation, Assembly language Instructions (classification only). 8051 Microcontroller Architecture, Ports and elementary idea of interfacing.

Course Outcomes:

Students will have understanding of:

1. Fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.
2. Designing of different types of the Digital circuits, and to give the computational details for Digital Circuits.
3. Characteristics of devices like PNP, and NPN junction diode and truth tables of different logic gates.
4. Basic elements and to measure their values with multimeter and their characteristic study.
5. How to construct electronic circuit

References:

1. J. Millman,and H. Taub, Pulse Digital and Switching Wave forms, Tata McGraw Hill, (1991).
2. R. L. Boylestad, and L. Nashelsky, Electronic Devices and Circuit Theory, Prentice Hall of India, (2007).
3. D. A. Bell, Electronics Devices and Circuits, Oxford University, (2008).
4. Ben.G.Streetman, Solid state electronic devices, Printice Hall, Englewood cliffs, NJ (1999).
5. R.A.Gayakwad, Op-Amps & Linear integrated circuits, Printice Hall India Pvt. Ltd.(1999).

MPHYCC-8 Statistical Mechanics (5 Credits)

Course Objectives:

1. The course is to understand the basics of Thermodynamics and Statistical systems.
2. Understand the various laws of thermodynamics
3. Acquire the knowledge of various statistical distributions.
4. To comprehend the concepts of Enthalpy, phase transitions and thermodynamic functions.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit-1. The statistical basis of thermodynamics:
Postulates of classical statistical mechanics, macroscopic and microscopic states, Phase space, Ensemble- microcanonical, canonical and grand canonical, Statistical equilibrium, density distribution of phase point, Liouville's theorem.

Unit-2. Ideal classical gas:
Partition function of a classical ideal gas, thermodynamical potentials in terms of partition function for an ideal monoatomic gas in microcanonical and grand canonical ensembles, entropy of mixing and Gibbs paradox, Maxwell-Boltzmann distribution law, entropy of monoatomic gas.

Unit-3. Quantum statistics and Applications I:
Density matrix, quantum ensembles, ideal Bose gas, Bose condensation, liquid He II, superfluidity and Landau's theory.

Unit-4. Quantum statistics and Applications II:
Ideal Fermi gas, specific heat and Pauli paramagnetism, Principle of detailed balance, Landau diamagnetism, white dwarfs and Chandrasekhar limit.Ising model, Random walk and Brownian motion;

Unit-5. Non-equilibrium processes:
Features of Equilibrium and Non-Equilibrium Thermodynamics, Linear theory of Non-Equilibrium Thermodynamics, Current and Affinity, Onsager relation, Fluctuations, Microsystems

Course Outcome:

At the end of this course, students will be able to

1. Basic knowledge of thermodynamic systems
2. Understand the basic idea about statistical distributions
3. Impart the knowledge about the phase transitions and potentials
4. Understand the applications of statistical laws

References:

1. Introduction to Thermodynamics, Classical and Statistical, 3rd Edition Richard E. Sonntag (Univ. of Michigan), Gordon J. Van Wylen (Hope College) ISBN: 978-0-471-61427-2, 1997
2. Pathria R.K., Statistical Mechanics, 2nd Edition, Elsevier, 1996.
3. Thermodynamics and Statistical mechanics, author by John m. seddon and Julian d. gale, 3rd edition, RSC publication, 2001, UK.

MPHYCC–9 Lab-II (5 Credits)

Course Objectives:

1. To encourage students to "discover" physics in a way how physicists learn by doing research.
2. To address analytically intractable problems in physics using computational tools.
3. To enhance the various computational technique with programming basic in C to face the world of problems using high performance iteration techniques.
4. To show how physics can be applied in a much broader context than discussed in traditional curriculum.

PROGRAMMING NUMERICAL METHODS USING C LANGUAGE (any 8):

1. To find mean, standard deviation and frequency distribution of an actual data set from any physics experiment.
2. Successive approximation (Method of Iteration), Newton Raphson method
3. The Bisection method
4. Gauss Elimination method
5. Matrix Inversion, Lagrange’s Interpolation formula
6. Trapezoidal Rule, Simpson’s 1/3-rule
7. Euler’s method, Runge Kutta method(Fourth Order)
8. Predictor corrector methods
9. To find mean, standard deviation, and frequency distribution of an actual data set from any physics experiment.
10. To find the area of a unit circle by Monte Carlo integration.
11. To simulate the random walk.

Course Outcome:

At the end of this course, students will be able to

1. Understand the basic idea about finding solutions using computational methods basics.
2. Learn how to interpret and analyze data visually, both during and after computation.
3. Gain an ability to apply physical principles to real-world problems.
4. Acquire a working knowledge of basic research methodologies, data analysis, and interpretation.
5. Realize the impact of physics in the global/societal context.

SEMESTER III

MPHYCC-10 Atomic and Molecular Physics, Lasers (5 Credits)

Course Objectives:

1. Objective of this course is to learn atomic, molecular and spin resonance spectroscopy.
2. To understand mechanism and working of lasers.
3. To be able to understand atomic and molecular transitions and selection rules.
4. To understand the Raman effect and its applications

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Atomic Physics:
Vector Atom Model (LS, JJ Coupling), Fine Structure and Hyperfine Structure, Zeeman Effect, Paschen-Back and Stark Effect,

Intensity, Shape and width of spectral lines, Independent particle model, He atom as an approximation for many-electron atomic systems, Slater determinants to write possible multiplets.

Unit 2. Electronic and Molecular Spectra:
Molecule as non-rigid rotator, Anharmonic Oscillator (vibration-rotation system), Frank Condon Principle, NMR and ESR, Spectra/Vibration of Polyatomic molecule, Electronic spectra of polyatomic molecules, Chemical analysis by electronic spectroscopy, Spectra of Hydrogen Molecule

Unit 3. Molecular Potential:
Concept of Molecular Potential, Separation of electronic and nuclear wave function, Born-Oppenheimer approximation and its breakdown, Analysis by infrared techniques, Molecular orbital theory, LCAO approximation theories.

Unit 4. Raman and Spin Resonance Spectroscopy:
Vibrational and pure rotational Raman spectra, Structure determination, Raman and Infrared spectroscopic Technique and instrumentation

Unit 5. Laser:
Significance of Einstein's A and B coefficients, pumping schemes, Characteristics of Laser beams, Principles of Fiber Communication, Numerical Aperure – Maridional and Axial.

Laser Operation: Oscillator versus Amplifier, Laser Resonators, Laser rate equations for three and four level Laser systems, Liquid (Dye) Lasers, Gas (CO_2, Nitrogen and Excimer) lasers, Laser applications in industry, Nuclear science, Spectroscopy. Light detection and Ranging (LIDAR), scanning laser beam devices, Laser communication (injection photodiode and Avalanche Photodiode), optical computing, and medical applications.

Course Outcomes:

Students will have understanding of:

1. Atomic spectroscopy of one and two valance electron atoms.
2. The change in behavior of atoms in external applied electric and magnetic field.
3. Rotational, vibrational, electronic, and Raman spectra of molecules.
4. Electron spin and nuclear magnetic resonance spectroscopy.
5. Principle, working, and applications of laser

References:

1. H. E. White, Introduction to Atomic Spectra, McGraw Hill, (1934).
2. C. N. Banwell, and E. M. McCash, Fundamentals of molecular spectroscopy, Tata McGraw Hill, (2007).
3. Molecular structure and Spectroscopy, G. Aruldhas, Prentice Hall of India, New Delhi, 2001.

MPHYCC-11 Condensed Matter Physics (5 Credits)

Course Objectives:

1. To study some of the basic properties of the condensed phase of materials especially solids.
2. To study electrical and magnetic properties of solids
3. To understand superconductivity and various properties of semiconductors

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus with 2 from each unit (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit-1. Crystal structure:
Reciprocal lattice and applications, Brillouin Zones, Laue equations and Bragg`s law. Laue and powder diffraction; Structure factor, atomic form factor, Intensity of diffraction maxima, extinctions due to Lattice centering.

Unit-2. Electronic Properties:
Motion of electron in periodic lattice, Bloch theorem, nearly free electron model, tight binding and cellular methods, effective mass, intrinsic and extrinsic semi-conductors, Fermi Surface, Cyclotron resonance and de Haas--van Alphen effect

Unit-3. Magnetic Properties:
Heisenberg model, molecular field theory, Spin waves and magnons, Curie-Weiss law for susceptibility, Theories of ferromagnetism, anti-ferromagnetism and ferrimagnetism.

Unit-4. Superconductivity:
Meissner effect, London equation, Flux quantisation, Josephson effect, Crystal Defects: Point defects, line defects, planar faults, role of dislocations in Plastic deformation and crystal growth, color centers

Unit-5. Dielectric Properties:
Microscopic concept of Dielectric polarisation, Langevin theory of polarisation, Claussius-Mossotti equation, Dielectrics in Alternating Field, Complex Dielectric constant and Dielectric loss, ferroelectricity, optical properties of crystals.

Course Outcomes:

Students will have understanding of:

1. Structures in solids and their determination using XRD.
2. Behavior of electrons in solids including the concept of energy bands and effect of the same on material properties.
3. Electrical, thermal, magnetic and dielectric properties of solids.

References:

1. Introduction to Solid State Physics, 3rd& 6th Editions. C. Kittel,Wiley Publishing.
2. Condensed Matter in a Nutshell, WilG.D. Mahan, Princetyon Univ. Press 2011.
3. Solid State Physics, W. Ashcroft, N.D. Mermin Holt-Rinehart-Winston 1976.
4. Elementary Solid State Physics, Principles and Applications, Ali Omar. M Addison Wesley Publishing, 2011.

MPHYCC-12 Electronics II (Analog and Digital Electronics) (5 Credits)

Course Objectives:

1. To understand the working of advanced semiconductor devices and digital circuits and the utility of OP-AMP
2. To learn the basics of integrated circuit fabrication, applications of timer IC-555 and building block of digital systems.

The End Semester Examination will be of 3 hour duration and will carry 70 marks (Pass Marks-28). The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with at least one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with at least one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit-1. Operational Amplifiers construction and other linear devices:
Building blocks of an OP-AMP : Differential amplifier – dual input, balanced and unbalanced output amplifiers, current sources, current mirror, level translator, complementary symmetry output. 555 IC timer and its applications, Schmitt trigger. VCO and phase locked loops and their important applications.

Unit 2. OP-AMP applications:
Instrumentation amplifier, logarithmic and exponential amplifiers, analog multiplication, comparators, a stable and monostable multivibrators, half wave and full wave precision rectifiers, Active Filters – Second order Butterworth filters – LPF, HPF, narrow band and wide band, band-pass and band-reject filters.

Unit 3. Digital Circuits and Combinatorial logic I:
Logic Families – TTL and CMOS, construction of basic gates, characteristics.
Combinatorial Circuits – 2's complement adder and subtractor.

Unit 4. Combinatorial logic II:
Decoder, encoder, multiplexer, demultiplexer, D/A and A/D convertors.

Unit 5. Sequential Circuits:
Master-slave JK flip-flop, D and T flip-flops, edge triggered flip-flops; Registers and Counters – Shift registers, Bidirectional registers, ripple counter, synchronous counter, up-down counter, decade counter, Johnson and Ring counter.

Course Outcomes:

Students will have understanding of:

1. Fundamental designing concepts of different types of Logic Gates, Minimization techniques etc.
2. Designing of different types of the Digital circuits, and to give the computational details for Digital Circuits.
3. Characteristics of devices like PNP, and NPN junction diode and truth tables of different logic gates.
4. Basic elements and to measure their values with multimeter and their characteristic study.
5. Working of Flip-flops, registers and counters.

References:

1. T.F.Schubert and E.M.Kim, "Active and Nonlinear Electronics", John Wiley Sons, New York (1996).
2. L.Floyd, Electronic Devices, "Pearson Education" New York (2004)
3. Dennis Le Crissitte, Transistors, Prentice Hall India Pvt. Ltd (1963)
4. J. Milman and C.C. Halkias, Integrated Electronics, McGraw Hill (1972)
5. A. Mottershed, Semiconductor Devices and Applications, New Age Int Pub
6. M. Goodge, Semiconductor Device Technology Mc Millan (1983)
7. S.M. Sze, Physices of Semiconductor Devices , Wiley-Eastern Ltd.,
8. Milman and Taub, Pulse, digital and switching Waveforms, McGrew Hiil (1965)
9. Ben. G. Streetman, Solid state electronic devices, Prentice Hall, Englewood cliffs, NJ (1999).
10. R.A. Gayakwad, Op-Amps & Linear integrated circuits, Prentice Hall India Pvt. Ltd. (1999).

MPHYCC-13 Nuclear and Particle Physics (5 Credits)

Course Objectives:

1. To study the general properties of nucleus.
2. To study the nuclear forces and nuclear reactions.
3. To introduce the concept of elementary particles.
4. To impart knowledge about basic nuclear physics properties and nuclear models for understanding of related reaction dynamics.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Nuclear forces:
Exchange forces and tensor forces. Low energy nucleon- nucleon scattering, Effective range theory; Deuteron problem, high energy nucleon-nucleon scattering (Qualitative Discussion), Charge independence, spin dependence and charge symmetry of nuclear forces, Isospin formalism; Yukawa interactions

Unit 2. Nuclear reactions:
Kinematics and conservation laws, Nuclear Reactions and Cross sections, Theory of Compound nucleus, Breit-Wigner single level formula, Mechanism of nuclear fission and fusion, Nuclear reactors

Unit 3. Nuclear models:
(a) Single particle Shell model: Magic numbers, spin, parity, magnetic dipole moment, electric dipole moment, (b) The Nilsson unified model, (c) Collective model: vibrational and rotational states, β and γ bands

Unit 4. Nuclear decay:
(a) Fermi theory of β decay, allowed and forbidden transitions, Parity violation in β decay and Helicity of neutrino. (b) Radiative transitions in nuclei (γ-decay), Spontaneous decay, internal conversion, Mossbauer Effect

Unit 5. Elementary Particle Physics:
Conservation Laws and Symmetry, Strangeness, hypercharge, CPT invariance, Classification of elementary particles, SU(2) symmetry and its application to decay and scattering processes, SU(3) symmetry and the Quark model, Elementary idea of chromodynamics.

Course Outcomes:

At the end of the course, the students can able to

1. Acquire basic knowledge about nuclear and particle physics
2. Develop the nuclear reactions and neutron physics.
3. Understand the nuclear fission and fusion reactions.
4. Impart the knowledge about the nuclear forces and elementary particles

References:

1. Kenneth S. Krane, Introductory nuclear physics, Wiley India, New Delhi (2008).
2. J. Basdevant, J. Rich, M. Spiro, Fundamentals in nuclear physics, Springer, New York (2005).
3. D. Griffiths, Introduction to elementary particles, Wiley VCH, Weinheim (2008).
4. D.C. Tayal, Nuclear Physics, 4thedition, Himalaya House, Bombay (1980).

MPHYCC-14Lab-III (5 Credits)

Course Objectives:

1. To make the student familiarize with the basics of electronics.
2. To enable the student to explore the concepts involved in the oscillators
3. To make the student understand the basic concepts in IC and digital devices
4. To allow the student to understand the fundamentals of multivibrators

LIST OF EXPERIMENTS (minimum 12)

1. Study of Transistor Bias Stability
2. Construction a single stage RC coupled amplifier using transistor and study its frequency response.
3. Construction of a two stage RC coupled amplifier using transistor and study its frequency response.
4. Study of Silicon Controlled Rectifier
5. Study the characteristics of UJT
6. Experiment on FET and MOSFET characterization and application as an amplifier
7. Construction of an Astable multivibrator circuit using OP AMP & 555 IC's
8. Characteristics of Tunnel diode and Gunn diode
9. Construction of a bistable multivibrator circuit using IC555 and study its performance.
10. Construction of adder, subtracter, differentiator, and integrator circuits using the given OP – Amp
11. Construction of an A/D converter circuit and study its performance
12. Construction of a D/A converter circuit and study its performance
13. Construction of half – adder and full – adder circuit using NAND gates and study their performance.
14. Construction of half – subtracter and full – subtracter circuit using NAND gates.
15. Design of sehimitt's Trigger using ICs 741 and 555 timer – study of frequency divides.
16. Flip flops – RS, JK and D flip flops
17. Shift register and Photo diode characteristics
18. Study of counters: Ripple, Mode 3, Mod 5 counters
19. Photo – diode characteristics
20. Photo – transistor characteristics
21. Analog computer circuit design – solving the simultaneous equations.
22. Multiplexer and Demultiplexer
23. Decoders and Encoders

Course Outcome:

At the end of the course,

1. The student will have knowledge on the different experimental techniques involved in electronics.
2. The student should be able to independently construct the circuits
3. The student should be able to apply the concepts of electronics and do the interpretation and acquire the result.

SEMESTER-IV

MPHYEC-1 Elective Paper (5 Credits)

One to be chosen from the following options:

A	Advanced Quantum Mechanics
B	Advanced Condensed Matter Physics
C	Lasers and Photonics
D	Nano Science
E	Plasma Physics

MPHYEC-1A Advanced Quantum Mechanics (5 Credits)

Course Objectives:

1. To impart knowledge of advanced quantum mechanics for solving relevant physical problems.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Theory of Scattering:
Laboratory and centre of mass reference frames, Differential and total cross sections, scattering amplitudes using green's function, scattering by symmetric potential, Partial wave analysis, Phase shift, scattering amplitudes in terms of phase shift, optical theorem, scattering by square well potential and perfectly rigid sphere; Born approximation, its validity, application to square well potential and Yukawa potential

Units 2. Relativistic Quantum Mechanics:
Postulates of Quantum Mechanics, Space time description of Schrodinger Wave Equation, Klein Gordon equation, Dirac equation, covariant form; Plane wave solution; Dirac interpretation of negative energy states and concept of antiparticles; Spin and magnetic moment of the electron, Non relativistic reduction, Helicity and chirality; Properties of γ matrices; Charge conjugation; Normalization and completeness of spinors.

Unit 3. Quantum Field Theory:
Second quantization – Lagrangian field theory, Hamiltonian formulation, Quantization of scalar field, Quantization of complex scalar and "Schrodinger" field, Bosons and Fermions

Unit 4. Quantum Chromodynamics I:
Introduction to quantum chromodynamics, Quark model

Unit 5. Quantum Chromodynamics II:
Standard model, Grand Unified Theories,

Course Outcomes:
Students will have understanding of:

1. Importance of relativistic quantum mechanics compared to non-relativistic quantum mechanics.
2. Various tools to understand field quantization and related concepts.
3. Exposure to quantum field theory and universal interactions.

References:

1. Mathews, P.M. and Venkatesan K.A., Textbook of Quantum Mechanics, Tata McGrawHill (2004).
2. Thankappan, V.K., Quantum Mechanics, New Age International (2004).
3. Sakurai, J.J., Advanced Quantum Mechanics, Pearson Education (2007).
4. Bethe, H.A. and Jackiew, R., Intermediate Quantum Mechanics, Perseus Book Group (1997).

MPHYEC-1B Advanced Condensed Matter Physics (5 Credits)

Course Objectives:

1. The course is to understand the basic knowledge on crystal structures and systems
2. Understand the various process techniques available of X-Ray Crystallography
3. Acquire the knowledge of Lattice waves and Polaritons
4. To comprehend the concepts of superconductivity and magnetic properties of solids.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Electron States:
Hartree and Hartree-Fock approximations, correlation energy, Screening, plasma oscillations, Dielectric function of an electron gas in random phase approximation, limiting laws &Friedel oscillation

Unit 2. Electron-electron interaction:
Lindhard`s expression for wave length and frequency dependent dielectric constant. Static screening, Kohn effect

Unit 3. Superconductivity:
Energy gap, Cooper pair, BCS theory, Ginzsburg –Landau theory, Josephson junction and its application, Microscopic quantum interference, High temperature superconductivity

Unit 4. Magnetism:
The band model for ferromagnetism and its temperature dependence, Ferrimagnetism, Antiferromagnetism, magnetism effects in nanomaterials.

Unit 5: Dielectric Properties:
Theory of Dielectrics, Piezoelectricity, Ferroelectricity, Antiferroelectricity and their applications, Nanostructured Ferroelectric materials, Synthesis and Characterization principles of Ferroelectric nanomaterials, Multiferroic and Smart materials

Course Outcome:

At the end of this course, students will be able to

1. Basic knowledge of crystal structures and systems
2. Understand the basic idea about the Electronic Properties of Solids
3. Impart the knowledge about the properties magnetic Properties of Solids
4. Understand the applications of superconductivity.

References:

1. Introduction to Solid State Physics, 3rd& 6th Editions. C. Kittel, Wiley Publishing
2. Condensed Matter in a Nutshell, WilG. D. Mahan, Princeton Univ. Press 2011.
3. Solid State Physics, W. Ashcroft, N.D. Mermin Holt-Rinehart-Winston 1976.
4. Elementary Solid State Physics, Principles and Applications, Ali Omar. M Addison Wesley Publishing, 2011

MPHYEC– 1C Lasers and Photonics(5 Credits)

Course Objectives:

On successful completion of this course, students will be able to

1. Describe and explain the principles involved in the interactions between light and matter, including the effects of anisotropy and non-linearity-comprehend the modification and control of optical properties of materials by externally imposed electric, magnetic and acoustic fields
2. Recall and recount the optical properties of semiconductor light sources and detectors- expand the theory and applications of the confinement of light in waveguides and fibers

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit 1. Basic Principles:
Laser rate equation for three level and four level systems, Dynamics of Laser Process: switching, Mode locking, mode pulling, lamb dip, hole burning, Energy levels and radiating properties of molecules, liquids and solids, Laser amplifier, Laser resonators, Techniques of laser excitation.

Unit 2. Non-linear optical effects:
Harmonic generation, Second harmonic generation, Phase matching, Third harmonic generation, Optical mixing, parametric generation, Self-focusing of light, Two photon absorption, Doppler free two photon spectroscopy, Laser spectroscopy.

Unit 3. Applications of Laser:
Fabrication of electronic components, Material processing; Laser Communication, Holography, Military applications, Medical applications, Star Wars, Laser hazards and Laser safety, Optical Amplifiers, Infrared optical devices, Laser cooling, Trapping.

Unit 4. Optical Fiber Communication:
Optical Fiber structure, Wave guiding and Fabrication of Fiber, Types of Fiber and solution of Maxwell's equation inside Fiber, Signal degradation and attenuation in Optical Fibers,

Unit 5. Optical Fiber systems:
Optical sources (ILD and PIN Diode) and Optical Detectors (APD); Analog and Digital optical fiber Transmission System (PDH, SDH and WDM Technology)

Course Outcome:

1. Knowledge of fundamental physics of photonics is developed to a high level
2. The course prepares students to be able to use sophisticated instrumentation intelligently, witha good understanding of its capabilities and limitations.

References:

1. Saleh B E A and M C Teich, "Fundamentals of Photonics", John Wiley, New York, 1991.
2. Pal B P(Ed.), "Guided Wave Optical Components and Devices", Academic Press,2006.
3. Smith F G and T A King. "Optics and Photonicss", John Wiley, Chicester, 2000.
4. Thyagarajan K and A Ghatak, "Nonlinear Optics,in Encyclopedia of Modern Optics(Editors:Bob Guenther et al)", Elsevier Ltd.,2005.

MPHYEC– 1D Nano Science (5 Credits)

Course Objectives:

1. The course is to understand the basic knowledge on Nanoscience and Nanotechnology.
2. To understanding the various process techniques available of nanostructured materials.
3. To acquire the knowledge of various nanoparticles process methods.
4. To enhance the various analytical technique to understand the nano properties and characteristics of nanomaterials.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit-1. Introduction and Basic Principles:
Definition of Nanomaterials, Properties, Applications and Scope of Nano-science, Quantum size effect, Electron confinement in infinitely deep square well, confinement in one and two dimensional well, idea of quantum well structure, Quantum wells, quantum wires and Quantum Dots: Preparation and properties; Conduction electrons and dimensionality, Properties dependent on density of states.

Carbon nanostructures: Fullerenes, structure, Superconductivity in C60, Carbon nanotubes: synthesis and structure, Electrical and Mechanical properties, Graphene.

Unit-2. Synthesis:
Techniques for synthesis: Top down approach: Ball milling; Bottom up approach: Chemical methods of synthesis; Gas-phase Synthesis; RF Plasma and Pulsed Laser techniques; Biological methods: synthesis using microorganisms and plant extracts.

Unit-3. Characterization Techniques:
Characterization tools for nanomaterials: Thermal analysis: DTA, DSC, TGA, dilatometry; Electrical measurements: LCR meter, electrometer amplifier; Optical, UV-Visible spectroscopy, IR spectroscopy, Ellipsometry, Photoluminescence and Raman spectroscopy, Atomic absorption spectroscopy, Structural characterization: X-ray Diffractometer; Magnetic characterization: Vibrating sample magnetometer and SQUID; XPS, TEM, SEM, STM, AFM.

Unit-4. Magnetic Nanomaterials:
Magnetic nanoparticles: Synthesis, properties and potential applications, Elementary idea of NEMS and nanotransistors

Unit-5. Dielectric and Multiferroic materials:

Theory of Dielectrics, Piezoelectricity, Ferroelectricity, Anti-Ferroelectricity and their applications, Nanostructured Multiferroic materials, Synthesis and Characterization techniques of Multiferroic materials,, Smart materials.

Course Outcome:

At the end of this course, students will be able to

1. Basic knowledge of Nanoscience and nanotechnology.
2. Understand the basic idea about the nanostructures.
3. Impart the knowledge about the properties and characteristics techniques of nanomaterials.
4. Understand the applications of nanomaterials.

References:

1. Nanostructure and Nanomaterials, synthesis properties and application, 2nd Edition, Author by Guozhong Cao &yingwang, Published by world scientific published, printed in 2004 Singapore.
2. Hand book of Nanotechnology, 3rd edition Author by Bhusha, Published in springer, printed 2004 German.
3. Nanostructure materials, processing, properties and potential applications, 2nd Edition, Author by Carl C Koch, Published by William andrew publications, printed in 2007 US.
4. Nanomaterials, synthesis, properties and applications 2nd Edition, Author by A.S. Edelstein, Published by Institute of physics publishing Bristol and Philadelphia, printed in 2000 UK.

MPHYEC– 1E Plasma Physics (5 Credits)

Course Objective:

1. To expose the students to theory related to motion of charge particle in inhomogeneous field, production of plasma and usage of plasma.

The End Semester Examination will be of 3 hour duration and will carry 70 marks. The Question paper will be divided into three parts A, B and C. Part A will have ten compulsory questions (multiple choice type) covering the whole syllabus (10 X 2 = 20). Part B will have five short answer questions, with one question from each unit. The student is required to answer any four out of them (4 X 5 = 20). Part C will have five long answer questions with one question from each unit. The student is required to answer any three out of them (3 X 10 = 30).

Unit-1. Basics (Single Particle Approach):
Charged particles in uniform and non-uniform electromagnetic field, Plasma - the forth state of matter, Concept of electron and ion temperature, Debye Length, Cyclotron Frequency, Larmor radius, Drift velocity of guiding center, Magnetic moment Magnetic mirror systems and their relation to the plasma confinement, Adiabatic Invariants..

Unit-2. Magneto Hydro Dynamics (Fluid Approach):
Introduction to ideal MHD systems, Fundamental equations of magneto hydrodynamic systems, Diffusion and mobility of charged particles in plasma, Plasma as fluid and MHD equations, Approximations and linearization of MHD from dimensional considerations, Single fluid MHD equation, MHD Generator.

Unit-3. Waves and instabilities in plasma:
Waves in unmagnetised plasma, Energy transport, Ion acoustic waves and MHD waves, Issue of plasma stability and the use of normal mode to analyze stability, Interaction between plasma particles, Perturbation at two fluid interface, Rayleigh Taylor instability, Kelvin Helmholtz instability and Jeans instability.

Unit-4. Kinetic Theory:
Need for kinetic theory and MHD as approximation of kinetic theory, Meaning of f(v), Phase space for many particle motion, Velocity and space distribution function, Derivation of fluid equation and Electron-ion plasma oscillation frequency, Derivation of Landau damping, Equations of Kinetic Theory and Vlasov equations for fluid dynamics.

Unit-5. Applications:
Saha's theory of thermal ionization, Application in Space Science, Controlled Thermonuclear Fusion, Magnetic reconnection, Dynamo action.

Course Outcomes:
Students will have understanding of:
1. Theoretical method to study the charge particle motion.
2. Process to generate plasma in the laboratory.
3. Mechanism plasma production is helpful to make fusion reactors.

References:

1. A.R. Choudhari, „The Physics of fluids and plasmas" (Cambridge UP 1998).
2. Chen Francis, „Plasma Physics", II Edn. (Plenum Press, 1984).
3. Bitten Court J A, „Fundamentals of Plasma Physics" (Pergamon Press, 1988).
4. Paul Bellan, „Fundamentals of Plasma Physics" (CUP 2006).