INSTITUTE OF ADVANCED STUDIES IN EDUCATION
(DEEMED TO BE UNIVERSITY)

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MANUAL: SYLLABUS
FOR
MASTER OF SCIENCE IN PHYSICS

FACULTY OF SCIENCES
CHOICE BASED CREDIT SYSTEM (CBCS)
Session 2022-2024

INDEX

DEPARTMENT OF PHYSICS

About the Department:

To create an academically sound environment that nurtures, motivates and inspires excellence in research and teaching in Physics for the growth of science and technology along with concern for society**.** Research in the Department is being pursued in many of the major contemporary areas of experimental and theoretical physics such as Nuclear Physics, High Energy Physics, Atomic and Molecular Physics, Condensed Matter Physics, Astrophysics, Photonics and Non Linear Dynamics.

About the Programme:

The Department offers M.Sc. Physics programme which caters to the needs of application oriented world. The programme comprises of Condensed Matter Physics, Materials Science and Laser Physics that forms a major tool for studying ceramics, polymers, ferrites, glass, biomolecules, non-linear optical materials etc. The course on computational physics enables the students for computer simulations in research. The physics Laboratory is equipped with the modern experimental set up. One semester project work is an essential component of curriculum for M.Sc. Physics students.

Programme Code: PH (Masters of Science in Physics).

Programme Outcomes: POs describe what students are expected to know or be able to do by the time of graduation. On the completion of the M.Sc. (Physics) Programme, the students will be able to:

Programme Outcomes (POs)	
PO1	Apply knowledge of Physics, in all the fields of learning including higher research and its extensions.
PO2	Scientific knowledge: Apply the knowledge of mathematics, science to solve the complex physics problems.
PO3	Problem analysis: Identify, formulate, and analyze advanced scientific problems reaching substantiated conclusions using first principles of mathematics, physical, and natural sciences.
PO4	Conduct investigations of complex problems: Use research-based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern scientific tools to complex physics problems with an understanding of the limitations.
PO6	To provide qualitative education through effective teaching learning processes by introducing projects, participative learning and latest software tools.
PO7	To inculcate innovative skills, team work, ethical practices among students so as to meet societal expectations.
PO8	To encourage collaborative learning and application of physics to real life

	situations.
PO9	To inculcate the curiosity for physics in students and to prepare them for future research.
PO10	Communicate: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Getting Abilities Demonstrate the ability to conduct research independently and pursue higher studies towards Ph.D. degree in physics.
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of scientific and technological change.

Program Specific Outcomes (PSOs):

Programme Specific Outcomes	
PSO1	Understand the basic, fundamental and advance concepts of different branches of physics.
PSO2	Perform and design experiments in the areas of electronics, atomic, nuclear, solid state physics, nanotechnology and computational physics.
PSO3	Apply the concepts of physics in specialized areas of condensed, nuclear, renewable energies, particle physics, etc., in industry, academia, research and day today life.
PSO4	Acquire the ability to pursue research careers, careers in academics, in industries in physical science and in allied fields, and also use the knowledge obtained to be trained for competing national level tests like UGC-CSIR NET, JEST, GATE, UPSC Civil Services Examination etc.
PSO5	Develop an ability to plan and execute their own innovative ideas in physical science by acquiring knowledge in the form of projects, product design & development, summer internship and field visit/industrial visit conducted, also develop specific skills in new and advanced techniques of computational Physics based on software’s.
PSO6	To improve your own learning and performance.
PSO7	Communicate physics related ideas effectively, in writing as well as orally.
PSO8	Recognize the need to engage in lifelong learning through continuous education, and research leading to higher degrees like PhD, D.Sc. etc.

Admission Procedure(s):

The details of the eligibility conditions and admission procedures are given in the admission forms and on the university website. The admission will be granted on the basis of merit as per University Bye-Laws. Reservation for SC, ST, PH, OBC, EWS etc. will be granted as per IASE (Deemed to be University) Bye-Laws adhering to Government rules.

Attendance Clauses:

1. For regular candidates in the Faculties of Sciences, the minimum attendance requirement shall be such that a candidate must have attended at least 75% of the lecturers delivered and tutorials held taken together as well as 75% of practical and CCA from the date of his/her admission.
2. Condonation for the shortage of attendance:
   The shortage of attendance up to the limits specified below may be condoned on valid reason(s):

   i) Up to 6%, each subject plus 5 attendances in all the aggregate subjects/papers may be condoned by the Vice-Chancellor on the recommendation of the Head of the Department for the Post-graduate classes.

   ii) The Scout, NSS, and NCC cadets sent out to parades and camps and such students who are deputed by the University to take part in games, athletics or cultural activities may, for purpose of attendance, be treated, as present for the days of their absence in connection with the aforesaid activities and that period shall be added to their subject wise attendance.

Guidelines for Choice Based Credit System:

Definition clauses:

1. **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.
2. **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed elective and skill courses. A student needs to select **elective course** offered by the Departments and SWAYAM/MOOCs course of the same credit in which he/she is doing core courses. This shall be part of the core Programme during the third and fourth semesters. Each student has to complete **two skill courses** offered by the departments/faculties/any other institution(s). The students can choose the elective courses inter-department and skill courses from any other institution(s), inter-department, inter-faculty as well.

3. **Course**: Usually referred to, as 'papers' is a component of a Programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ project work/ self-study etc. or a combination of some of these.
4. **CCC stands for 'Core Course Code' and ECC for Elective Course Code.**
5. **Credit Based Semester System (CBSS)**: Under the CBSS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.
6. **Credit Point**: It is the product of grade point and number of credits for a course.
7. **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one period of teaching (lecture or tutorial) or two periods of practical work/field work per week. Here one period normally equals to 50 minutes.
8. **Cumulative Grade Point Average (CGPA)**: It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
9. **ESE** stands for '**End Semester Examination'** i.e. Even Semester & **SEE for 'Semester End Examination' i**.e. odd semester.
10. **Grade Point**: It is a numerical weight allotted to each letter grade on a 10-point scale.
11. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
12. **Programme**: An educational programme leading to award of the Postgraduate Degree in the Core subject he/she is pursuing.
13. **Semester Grade Point Average (SGPA)**: It is a measure of performance of work done in a semester. It is a ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
14. **Semester**: Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to November/ December and even semester from December/January to May.

15. **Skill Development Course(s) Resources**: The University may develop a provision for skill development course(s) by appointment, engagement, contract services of the resources; (human, institutional) at inter-department, intra-department, intra-faculty, inter-faculty, in this University or with any other University, institution of Research, institution of Technical Expertise, Professional and institution engaged in industrial activities for academic or/and technical development of skill.
16. **Transcript or Grade Card or Certificate:** Based on the grades earned, a statement of grades obtained shall be issued to all the registered students after every semester. This statement will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester along with statement of marks.

Grades and Grade Points: Methods to Ascertain

S. No.	**Letter Grade**	**Meaning**	**Grade Point**
1	‘O’	Outstanding	10
2	‘A+’	Excellent	9
3	‘A’	Very Good	8
4	‘B+’	Good	7
5	‘B’	Above Average	6
6	‘C’	Average	5
7	‘P’	Pass	4
8	‘F’	Fail	0
9	‘Ab’	Absent	0

i) A student obtaining Grade F in a course shall be considered failed and will be required to reappear in the University End Semester Examination.
ii) For non-credit courses (Skill Courses) ‘Satisfactory’ or ‘Unsatisfactory’ shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA

Grade Point assignment:

= and > 95 % marks Grade Point 10.0
90 to less than 95 % marks Grade Point 9.5
85 to less than 90 % marks Grade Point 9.0
80 to less than 85 % marks Grade Point 8.5
75 to less than 80 % marks Grade Point 8.0

70 to less than 75 % marks Grade Point 7.5
65 to less than 70 % marks Grade Point 7.0
60 to less than 65 % marks Grade Point 6.5
55 to less than 60 % marks Grade Point 6.0
50 to less than 55 % marks Grade Point 5.5
45to less than 50 % marks Grade Point 5.0
40 to less than 45 % marks Grade Point 4.5
36 to less than 40 % marks Grade Point 4.0

Computation of SGPA and CGPA:

(i) The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e.

$$\textbf{SGPA}\ (S_i) = \Sigma\ (C_i \times G_i)\ /\ \Sigma C_i$$

where C_i is the number of credits of the ith course and G_i is the grade point scored by thestudent in the ith course.

(ii) The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a Programme, i.e.

$$\textbf{CGPA} = \Sigma\ (C_i \times S_i)\ /\ \Sigma C_i$$

where S_i is the SGPA of the ith semester and C_i is the total number of credits in that semester.

(iii) The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration of Computation of SGPA and CGPA and Format for Transcripts:

(i) Computation of SGPA and CGPA (Illustration for SGPA)

Course	Credit	Grade Letter	Grade Point	Credit Point
Course 1	4	A	8	4x8=32
Course 2	4	B+	7	4x7=28
Course 3	4	O	10	4x10=40
Course 4	4	C	5	4x5=20
Course 5	4	A+	9	4x9=36
Course 6	4	P	4	4x4=16
	24			172

Thus, SGPA =172/24 =7.16

Illustration for CGPA

	Semester- I	Semester- II	Semester- III	Semester- IV
Credit	24	24	24	24
SGPA	7.25	7.25	7	6.25

Thus, CGPA=(24x7.25+24x7.25+24x7+24x6.25)/96
=666/96
=6.93

Skill Courses/ Programmes (Non credit Based):

The Department of Physics shall offer skill development courses. The skill development programmes are offered by the department and sustainable development courses offered by the department/faculty/any other institution(s) or University.

Instructions for Distribution of Periods:

In view of the course content, the Department of Physics distributed the Periods between Theory/Tutorial/Practical as mentioned in course structure:

- 4 - 0-0(Four lectures/week) (no tutorial and practical)
- 3-1-0 (Three lectures and one tutorial per week)
- 0 - 0 - 12(12 Practical classes)-For Lab work

The Duration of the Period shall be fifty minutes. In each of the combinations, the first value stands for the same number of lecture instructions per week.

Medium of Instructions:

The medium of instructions for courses will be bilingual (Hindi and English).

Medium of Examinations:

Candidates are allowed to use only English medium for answering the questions in the examination.

Marking Scheme of Examination (SEE and ESE):

Type of Exam/Assessment	Semester	Maximum Marks Allotted	Duration	Type of Questions/Evaluation Methods
End Semester Examination (ESE)	**Even Semester (II and IV)**	**70**	**3 hours**	**Subject Specific 100 MCQ. MCQ stands for Multiple Choice Question which has 4 options with only 1 correct answer.**
Semester End Examination (SEE)	**Odd Semester (I and III)**	**70**	**3 hours**	**Subject Specific 100 MCQ. MCQ stands for Multiple Choice Question which has 4 options with only 1 correct answer.**
Continuous Comprehensive Assessment (CCA)	**Throughout Every Semester**	**30**	**-**	**Refer to Table A**
Skill Development Courses	**Once in every semester**	**70**	**-**	**Project Work and Presentation**

Table A:

SR. NO.	CCA: COMPONENT	MAXIMUM MARKS
1	Monthly test	**20X3 Test = 60**
2	Quizzes and Assignments	**10**
3	Viva-voce	**10**
4	Seminar/Symposia	**10**
5	Report writing	**10**
6	Workshop	**10**
7	Review of literature	**10**
8	Creativity/Innovation	**10**
9	Experimental Skill	**10**
10	Co-curricular activity	**10**
11	Attendance	**10**

EXPLANATION (METHOD TO ASCERTAIN MARKS FOR CCA): CCA will be reduced to 30 marks. Formula: Marks obtained/Total marks × 30. For example: 60 divided by160 × 30 = 11.25

PROVISO-I: Provided that a candidate shall be granted a relaxation in the form of exemption from CCA component. However, the said exemption must not be provided in more than 3 components in a respective course.

PROVISO-II: Provided further that this will be mandatory for a candidate to appear in the monthly test conducted in the respective course.

Attendance in Lectures, Tutorials and Practical

Percentage	Marks Allotted
75% to 80%	02
81% to 85%	04
86% to 90%	06
91% to 95%	08
Above 96%	10

Evaluation of Practical/Lab/Projects/Dissertation:

Practical			
1.	Daily Evaluation of Practical Records/Viva-Voce	10	Internal Evaluation (30 Marks)
2.	Seminar/Presentation	10	
3.	Attendance	10	
4.	Final Practical Performance and Viva-Voce	70	External Evaluation (70 Marks)
Total		100	Marks may be rounded off to nearest integer.
Project Works/Dissertation			
1.	Project Report Evaluation	70	Evaluation by two Examiners (one internal and one external)
2.	Project Presentation and Viva-Voce	30	

Skill Development Course Evaluation: Based on the performance of students and hands-on practice, the respective department/faculty where the students have completed the skill course, will declare the result as “satisfactory” or “unsatisfactory”. The students have to secure two satisfactory declarations for the course completion from the respective department/faculty.

SWAYAM/MOOCs Course Evaluation (for Elective Course): The students have to opt for only those SWAYAM/MOOCs courses which are relevant to the subject and have the same credit points as offered in the course. The students have to pass the exam and earn the certificate.

Declaration of Result:

i. A student acquiring minimum of 40% in the total CCA is eligible for the next semester.

ii. The student of I and II semester will be promoted to III semester only when s/he has cleared more than 50% or more courses including non-credit skill courses.

iii. Both grading and marks system will be adopted reflecting the same in the grade cum mark card (i.e. statement of marks)

iv. A student who does not pass the examination (ESE+SEE) in any course(s) or remains absent will be considered as 'FAIL' and permitted to appear in such course(s) in subsequent ESE and/or SEE or when the course is offered next time.

v. A student who fails in one or more courses in a semester shall get three more chances to complete the same, after that the student is not eligible for the post-graduate programme. The students have to pay additional examination fees for the same.

vi. Students have an opportunity to improve the credit with two additional chances. The credit obtained in the improvement examination will be final. The students have to pay additional examination fees for the same.

vii. The university shall try to ensure to declare the result within a period of 20 days from the date of the completion of the examination and upload the same on the website of the university.

Grievance Redressal Mechanism:

a) The students will have the right to make an appeal against any component of evaluation. Such appeal has to be made to the Head of the Department concerned as the case may be, clearly stating in writing the reason(s) for the complaint / appeal.

b) The appeal will be assessed by the Chairman and he/she shall place it before the **Grievance Redressal Committee (GRC),** chaired by the Dean concerned, comprising of the HOD of the concerned Department and if needed Course Teacher(s) be called for suitable explanation; GRC shall meet at least once in a semester and prior to CCA finalization.

c) The Committee will consider the case and may give a personal hearing to the appellant before deciding the case. The decision of the Committee will be final and binding.

d) The online and offline grievance reporting form is available.

e) The grievance is to be redressed within 14 working days.

COURSE STRUCTURE

Courses	No. of Courses	Semester	Lecture (L)	Tutorial (T)	Practical (P)	Total Teaching Hours	Total Marks	Total Credits
Core Course (CC)	10	I and II	32	0	24	572	1000	44
	6	III and IV	20	0	12	338	600	26
Elective Course (EC)	3	III and IV	09	3	00	156	300	12
Project /Dissertation	1	IV	00	00	12	78	100	8
Skill/Sustainable Development Course (SC)	4	I, II, III and IV	12	00	00	156	400*	Non-Credit
Total	24	I,II,III,IV	73	03	48	1300	2000	90

SEMESTER WISE COURSE STRUCTURE

Semester-I										
Courses	**Course Code(s)**	**Course Title**	**Teaching Hours**	**Load Allocation**			**Marks Allocation**			**Credits**
				L	**T**	**P**	**ESE**	**CCA**	**Total**	
Core Courses	**PH-CT101**	**Classical Mechanics**	**52**	**4**	**0**	**0**	**70**	**30**	**100**	**4**
	PH-CT102	**Quantum Mechanics – I**	**52**	**4**	**0**	**0**	**70**	**30**	**100**	**4**
	PH-CT103	**Electronics**	**52**	**4**	**0**	**0**	**70**	**30**	**100**	**4**
	PH-CT104	**Mathematical Physics**	**52**	**4**	**0**	**0**	**70**	**30**	**100**	**4**
	PH-CL105	**Physics Laboratory-I**	**78**	**0**	**0**	**12**	**70**	**30**	**100**	**6**
Skill Course	**PH-106SC**		**39**	**3**	**0**	**0**	**70***	**30***	**100***	*****
Total				**19**	**0**	**12**			**500**	**22**
Total Credits for Semester-I										**22**
***Excluded in total**										

Semester-II										
Courses	Course Code(s)	Course Title	Teaching Hours	Load Allocation			Marks Allocation			Credits
				L	T	P	ESE	CCA	Total	
Core Courses	PH-CT201	Solid State Physics-I	52	4	0	0	70	30	100	4
	PH-CT202	Quantum Mechanics – II	52	4	0	0	70	30	100	4
	PH-CT203	Atomic and Molecular Physics	52	4	0	0	70	30	100	4
	PH-CT204	Numerical Methods and programming	52	4	0	0	70	30	100	4
	PH-CL205	Physics Laboratory-II	78	0	0	12	70	30	100	6
Skill Course	PH-206SC		39	3	0	0	70*	30*	100*	*
Total				19	0	12			500	22
Total Credits for Semester-II										22
*Excluded in total										

Semester-III										
Courses	Course Code(s)	Course Title	Teaching Hours	Load Allocation			Marks Allocation			Credits
				L	T	P	ESE	CCA	Total	
Core Courses	PH-CT301	Solid State Physics-II	52	4	0	0	70	30	100	4
	PH-CT302	Classical Electrodynamics-I	52	4	0	0	70	30	100	4
	PH-CT303	Statistical Physics	52	4	0	0	70	30	100	4
	PH-CL305	Physics Laboratory-III	78	0	0	12	70	30	100	6
Elective Courses	PH-ET 304***	Elective-I	52	3	1	0	70	30	100	4
Skill Course	PH-306SC		39	3	0	0	70*	30*	100*	*
Total				18	1	0			500	22
Total Credits for Semester-III										22
*Excluded in total										

Semester-IV										
Courses	Course Code(s)	Course Title	Teaching Hours	Load Allocation			Marks Allocation			Credits
				L	T	P	ESE	CCA	Total	
Core Courses	PH-CT401	Nuclear and Particle Physics	52	4	0	0	70	30	100	4
	PH-CT402	Classical Electrodynamics-II	52	4	0	0	70	30	100	4
Elective Courses	PH-ET403	Elective-II	52	3	1	0	70	30	100	4
	PH-ET404	Elective-III	52	3	1	0	70	30	100	4
Skill Course	PH-406***		39	3	0	0	70*	30*	100*	*
Project Works/Dissertation (PH-CL405)			78	0	0	12	70	30	100	8
Total (*Excluded in total)				17	2	12			500	24
Total Credits for Semester-IV										24
Programme Grand Total of Credits										90

Elective Courses:

Elective-1

Course Code	Title of the Paper	Teaching hours/week	Credit	Marks Allotment		
		L-T-P		CCA	ESE	Total
PH-ET304(A)	Digital Electronics	3-1-0	4	30	70	100
PH-ET304(B)	Laser Physics and Applications	3-1-0	4	30	70	100
PH-ET304(C)	Advanced Semiconductor Devices	3-1-0	4	30	70	100

Elective-II

Course Code	Title of the Paper	Teaching hours/week	Credit	Marks Allotment		
		L-T-P		CCA	ESE	Total
PH-ET403(A)	Physics of Nanomaterials	3-1-0	4	30	70	100
PH-ET403(B)	Experimental-Techniques in Physics	3-1-0	4	30	70	100
PH-ET403(C)	Mathematical Physics-II	3-1-0	4	30	70	100

Elective-III

Course Code	Title of the Paper	Teaching hours/week L-T-P	Credit	Marks Allotment		
				CCA	ESE	Total
PH-ET404(A)	General Theory of Relativity & Cosmology	3-1-0	4	30	70	100
PH-ET404(B)	Nuclear Accelerator and Radiation Physics	3-1-0	4	30	70	100
PH-ET404(C)	Science of Renewable source of Energy	3-1-0	4	30	70	100
PH-ET404(D)	SWAYAM Course	4-0-0	4			

L= Lecture**; T=** Tutorial**; P=** Practical (Fieldwork/Dissertation/Project etc.)

M.Sc. (Physics) SEMESTER-I			
Course Code:	PH-CT101	**Course Type** :	Core Course-01
Course Title :	Classical Mechanics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 % IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The primary objective is to teach the students Classical Mechanics at a level more advanced than what they have learnt in B.Sc. This is a course which forms the basis of Physics of many areas of Physics.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to:

1. Know the concept of classical mechanics.
2. Have deep knowledge on Lagrangian & Hamiltonian dynamics.
3. Interpret the dynamics of a rigid body.
4. Understand basic Lagrange's Poisson's brackets and Canonical transformation.
5. Know the Special Theory of Relativity.

UNIT-1 TEACHING HOURS(13)	**Lagrangian Mechanics:** Newton's laws of motion, mechanics of a system of particles, constraints, Generalized coordinates, D'Alembert's principle and Lagrange equations of motion. Velocity dependent potentials and dissipation function. Some applications of Lagrangian formulation, Hamilton's principle, derivation of Lagrange equations from the Hamilton's principle. Conservation theorems and symmetry properties. **Hamiltonian dynamics:** Hamiltonian function H and conservation of energy: Jacobi's integral and its significance, Hamilton's equation, Simple applications of Hamiltonian formulation, Routhian, Derivation of Hamilton's equation from variation principle, Principle of least actions in various forms.
UNIT-2 TEACHING HOURS(13)	**Central Force Problem:** Two body central force problem, reduction to equivalent one body problem, the equation of motion and first integrals, the equivalent one dimensional problem and classification of orbits. The differential equation for the orbit and integrable power-law potential, Virial theorem. The Kepler problem. Scattering in a central force. **Mechanics of rigid bodies:** Kinematics of a rigid body, Euler angles, inertia tensor, eigenvalues of inertia tensor, orthogonal transformations, finite & infinitesimal rotation, moving frame of reference, Euler equation, spinning top, gyroscope.

UNIT-3 TEACHING HOURS(13)	**Canonical transformation and Hamilton Jacobi theory:** Canonical transformation, Legendre transformation, Generating functions, Conditions for canonical transformation, Bilinear invariant condition. Poisson's brackets, Langrange brackets, Invariance of Poission bracket under canonical transformation, Angular momentum Poission bracket relation. Hamilton Jacobi equation for Hamilton's principal function, Harmonic oscillator problem by Hamilton Jacobi method, Hamilton's characteristic function.
UNIT-4 TEACHING HOURS(13)	**Special theory of relativity:** Lorentz transformations, Length contraction, Time dilation, Four Vector Formulation, Lagrangian and Hamiltonian of a charged particle in presence of EM Fields, Field transformations, relativistic kinematics and mass–energy equivalence, metric tensor, energy momentum tensor, relative motion of charged particle in EM fields.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
End Semester Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	**1. Classical mechanics, H Goldstein, C Poole, J Safco, III Edition, Pearson Education Inc.2018.** **2. Classical mechanics, KN Srinivasa Rao, University Press, 2003.** **3. Classical mechanics, NC Rana and PS Joag, Tata McGraw-Hill, 1991.** **4. Classical dynamics of particles and systems, JB Marian, Academic Press, 1970.** **5. Introduction to classical mechanics, Takwale and Puranik, Tata McGraw-Hill, 2006.** **6. Classical mechanics, LD Landau and EM Lifshitz, 4th edition, Pergamon press, 1985.** **7. Classical Mechanics, BA Kagali and T Shivalingaswamy, Himalaya publications, 2018.** **8. Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House, 2019.**

M.Sc. (Physics) SEMESTER-I			
Course Code:	PH-CT102	**Course Type :**	Core course-02
Course Title :	Quantum Mechanics-I		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 % IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course aims at providing an elementary introduction to the basic principles of (non-relativistic) Quantum Mechanics, its wave-mechanical and matrix mechanics formulations, and its applications to simple problems.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Gain the aspects of historical developments of quantum mechanics and interpretation of wave particle duality
2. Gain the idea of development of central concept and principles of quantum mechanics such as Schrödinger equation, wave functions, and its statistical interpretation
3. Have the solution of Schrödinger equation for simple systems in one and three dimensions
4. learn about new Dirac specific notation such as bra and ket formalism and apply this notation to formulate the various problems
5. Gain the knowledge of angular momentum, spin and their rules for quantization.

UNIT-1 TEACHING HOURS(13)	**Introductory concepts:** Wave-particle duality, interpretation of the wave function, wave function for particles having a definite momentum, Schrodinger equation, Gaussian wave Packets and their time evolution, Fourier transform and momentum space wave function, Heisenberg uncertainty principle for position and momentum, conservation of probability, operators and expectation values, Ehrenfest theorem, time-independent Schrodinger equation, stationary states and their properties, energy quantization, properties of energy Eigen functions, general solution of the time dependent Schrodinger equation for a time independent potential.
UNIT-2 TEACHING HOURS(13)	**One-dimensional problems:** Free-particle, box normalization, Eigen values and Eigen functions of particle in a) infinitely deep potential b) finite square well potential, and c) simple harmonic oscillator potential, potential barrier - transmission and reflection coefficients. Extension to three dimensional problems: Separation of the Schrodinger equation in Cartesian coordinates, particle in a three dimensional box.

UNIT-3 TEACHING HOURS(13)	**General formalism of quantum theory:** Operator methods: Hilbert space, linear operators, Hermitian operators, Unitary operators, Projection operators, observables, Dirac notation, Matrix representation of Observables and states, Eigen functions of Hermitian operators, degeneracy, commutation of operators and compatibility, generalized uncertainty principle for two non-commuting observables, Unitary transformations, time-dependence of observables: Schrodinger and Heisenberg pictures, Simple harmonic oscillator by operator method.
UNIT-4 TEACHING HOURS(13)	**Angular momentum:** Orbital angular momentum commutation relations, Eigen values and Eigen functions, Central potential, separation of variables in the Schrodinger equation, the radial equation, the Hydrogen atom. General operator algebra of angular momentum operators J_x, J_y, J_z. Ladder operators, eigen values and eigenkets of J^2 and J_z, matrix representations of angular momentum operators, Pauli matrices, addition of angular momentum, Clebsch-Gordan coefficients for the case $j_1 = j_2 = 1/2$.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	**1. Introduction to Quantum Mechanics, David J Griffiths, 2nd Edition, Pearson Prentice Hall.** **2. Quantum Mechanics, BH Bransden and CJ Joachain, 2nd Edition, Pearson Education, 2007.** **3. Quantum Mechanics, VK Thankappan, 2nd Edition, Wiley Eastern Limited, 1993.** **5. Quantum Mechanics, LI Schiff, 3rd Edition, McGraw Hill Book Company, 1955.** **6. Modern Quantum Mechanics, JJ Sakurai, Revised Edition, Addison-Wesley, 1995.** **7. Principles of Quantum Mechanics, R Shankar, 2nd Edition, Springer, 1994.** **8. Quantum Mechanics, E Merzbacher, John Wiley and Sons, 1998.** **9. Quantum Physics, S Gasiorowicz, John Wiley and Sons 2014.**

M.Sc. (Physics) SEMESTER-I			
Course Code:	PH-CT103	**Course Type :**	Core Course-03
Course Title :	Electronics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 % IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

To make students familiar with basic and advanced analog and digital electronics used in circuit and instrument designing. To provide practical knowledge, electronics based design problems are included.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Understand the basic knowledge of various semiconductor devices such as BJT, FET and MOSFET.
2. Acquire knowledge on Operational Amplifier and its applications.
3. Know the building blocks of digital systems and the logic families.
4. Familiarize with feed back in amplifiers and multi-vibrators.

UNIT-1 TEACHING HOURS(13)	**Physics of Semiconductor Devices:** Review of current flow mechanism in junction diode, static & dynamic resistance, semiconductor devices; diodes, junctions, transistors, field effect devices, homo and hetero junction devices, device structure, device characteristics, frequency dependence and application, Zener diode as voltage regulator and current application of diodes, load line, optoelectronic devices; solar cells, photo detectors, LEDs, noise in electronic circuits, Noise sources.
UNIT-2 TEACHING HOURS(13)	**Feedback circuits:** Feedback concept, positive and negative feedback, Barkhausen criterion, RC phase shift oscillator, Wein bridge oscillator, Hartley and Colpitt's oscillators, Nyquist criterion, Multivibrators: astable, monostable and bistable multivibrator, Comparators, Square and triangle wave form generators. UJT relaxation oscillator, Schmitt Trigger, 555 timer based astable multivibrator.

UNIT-3 TEACHING HOURS(13)	**Differential amplifier:** Circuit configurations, dual input, balanced output differential amplifier, DC analysis and AC analysis, inverting and non inverting inputs, Block diagram of typical OP-Amplifier, Constant current-bias level translator. Open loop configuration, inverting and non-inverting amplifiers, and Frequency- response. **OP-Amp Parameters:** Input offset voltage, bias currents, input offset current, output offset voltage, CMRR, frequency response, Slew rate. OP-Amp with negative feedback, voltage series feedback, effect of feed-back on closed loop gain, input and output resistance, band width. **OP-Amp Applications:** DC and AC amplifier, voltage follower, Adder, subtractor, multiplier, phase changer, Active filters, Active Integrator and active differentiator.
UNIT-4 TEACHING HOURS(13)	**Digital electronics:** Boolean algebra, De Morgan's theorems, standard forms of Boolean expressions, Gates, K-map, number systems and codes, Half and Full Adders. Flip-flops, Registers, Counters, D/A conversion and A/D conversion. **Microwave Devices:** Principal and working of Gunn diode, IMPATT diode, Operation of Klystrons, Reflex klystrons and Magnetron.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Semiconductor Devices Physics and Technology, SM Sze, 3rd Edition, John Wiley and Sons Inc. Asia, 2006. 2. Solid State Electronic Devices, Ben G Streetman, Sanjay Bannerjee, 7th edition, Pearson, Asia, 2014. 3. The art of electronics, Paul Horowitz and Winfield Hill, Second Edition, Foundation Books, Delhi, 2008. 4. Electronic Principles, AP Malvino and J Bates, Eighth Edition, Tata McGraw Hill, Delhi, 2016. 5. Op-Amps and Linear Integrated Circuits, RA Gayakwad, 4th Edition,

	Eastern Economy Edition, 2004. 6. Operational Amplifiers with Linear Integrated Circuits, William Stanley, 4th Edition, CBS Publishers, 2002. 7. Linear Integrated Circuits, D Roy Choudhury and Shail Jain, 4th Edition, New Age International Ltd, 2010. 8. Digital principles and applications, DP Leach and AP Malvino, 5th Edition, Tata McGraw Hill, 2002. 9. Digital systems, Principles and applications, RJ Tocci and NS Widmer, 10th Ed, Pearson Education, 2007. 10. Introduction to electronic devices, MichealShur, PHI, 1996.

M.Sc. (Physics) SEMESTER-I			
Course Code:	PH-CT104	Course Type :	Core Course-04
Course Title:	Mathematical Physics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in quantum mechanics, electrodynamics and other fields of theoretical physics.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Understand and apply the mathematical skills to solve quantitative problems in the study of physics.
2. Learn about special type of matrices that are relevant in physics.
3. Will enable students to apply integral transform to solve mathematical problems of interest in physics.
4. Learn the fundamentals and applications of Fourier series, Fourier and Laplace transforms.

UNIT-1 TEACHING HOURS(13)	**Coordinate Systems:** Orthogonal coordinate systems, Gradient, Curl, Divergence and Laplacian in orthogonal coordinate systems, Spherical, Polar and Cylindrical co-ordinates, Poisson's and Laplace Equations, Green's theorem. **Theory of Probability:** Random Variables, Binomial, Poisson and Normal Distributions. Central Limit Theorem.
UNIT-2 TEACHING HOURS(13)	**Linear Vector Spaces & Matrices:** Linear independence, Bases, Dimensionality, Inner product, Linear transformations, Matrices, Cayley-Hamiltonian Theorem, matrix representation of operators, unitary & hermatian matrices, diagonalization of matrices, Eigen values & Eigen vectors. **Complex Variables:** Analytical functions, Cauchy Riemann conditions, Cauchy's integral theorem, Cauchy's integral formula, Taylor and Laurent's Series expansions, Cauchy's residue theorem, Simple examples of contour integration.

UNIT-3 TEACHING HOURS(13)	**Special Functions:** Series solution of linear differential equations with variable coefficients, Legendre, Bessel, Hermite, Laguerre, Associated Laguerre polynomials and their generating functions, Recurrence relations, Orthogonal properties and Rodrigue's formula.
UNIT-4 TEACHING HOURS(13)	**Integral Transform:** Review of Fourier series, expansion of function in Fourier series, Fourier integrals, sine and cosine transforms, Laplace, inverse Laplace transform & convolution, Fourier Transform, Shift theorem & convolution, solution of differential equations with the help of Laplace & Fourier transform.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	**1. Mathematical Physics, V. Balakrishnan, 1st Edition, Ane Books, 2018.** **2. Mathematical Methods for Physicists, G. Arfken, 7th Edition, Elsevier, 2012.** **3. Advanced Engineering Mathematics, E. Kreyzig, 2nd Edition, Pearson, 2002.** **4. Complex variables, MR Spiegel, Schaum Series, Metric edition, McGraw Hill, 1981.** **5. Linear Algebra – Seymour Lipschutz, Schaum Outlines Series, 4th Edition, 2009.** **6. Mathematical physics, Satya Prakash, Pragati Prakashan.** **7. Matrices and Tensors in Physics - AW Joshi, 3rd edition, Wiley Eastern Ltd, 1995.** **8. Vector Analysis, Schuam Series, Mc Graw Hill.**

PH-CL105	Physics Laboratory-I	L T P : 0-0-12	6 Credits

Course Objectives: This is a laboratory course to provide hands on knowledge of some basic experiments in optics and electronics**.** This course provides the student with the practical skills to understand the basic of semiconductor and components like diode, transistor, FET, MOSFET and operational amplifier. Students equipped with the knowledge and training provided in the course will be able to participate in design, development and operation in the different area of electronics system.

Course Outcomes: On the completion of the course, the students will be able to

CO1	To study basics of semiconductor & devices and their applications in different areas.
CO2	To study different biasing techniques to operate transistor, FET, MOSFET and operational amplifier in different modes.
CO3	Analyze output in different operating modes of different semiconductor devices.
CO4	Compare design issues, advantages, disadvantages and limitations of basic electronics
CO5	Able to design and perform scientific experiments as well as accurately record and analyze the results of experiments.

CONTENTS

The students will be required to perform 12 experiments in each semester from the following list of experiments.

Analog Electronics:

1. Device Characteristics and Application
    a) p-n junction diodes-clipping and clamping circuits.
    b) FET – characteristics, biasing and its applications as an amplifier.
    c) MOSFET – characteristics, biasing and its applications as an amplifier.
    d) UJT – characteristics and its application as a relaxation oscillator.
    e) SCR – Characteristics and its application as a switching device.
2. To design & study any one of the following using transistor/ operational amplifier on a bread board:
    a) Hartley oscillator
    b) Colpitt oscillator
    c) Wein bridge oscillator
    d) Phase shift oscillator
3. Operational-Amplifier: To study the following mathematical operations-
    a) Adder
    b) Subtractor
    c) Integrator (for ac i/p and dc i/p signal)
    d) Differentiator
4. Study of two stage transistor amplifier and effect of feedback.
    a) Frequency response of a transistorised RC coupled amplifier with no feedback.
    b) Frequency response of the amplifier with negative feedback.
    c) Frequency response of the amplifier with positive feedback.
5. Study of Operational- Amplifier as:
    a) Inverting amplifier
    b) Non-Inverting amplifier
    c) Emitter Follower

6. Design and study of dc power supply with various filters and IC regulator.
7. Study of two stage transistor amplifier and effect of feedback.
    a) Frequency response of a transistorised RC coupled amplifier with no feedback.
    b) Frequency response of the amplifier with negative feedback.
    c) Frequency response of the amplifier with positive feedback.
8. Measurement of amplitude, frequency and phase of given signals using oscilloscope.
9. To study the waveform characteristics of multivibrators (A stable, Mono-stable and Bistable) and determine its frequency by varying R.
10. To study of IC 555 Timer.
11. To study characteristics of Zener diode and use in voltage Regulation.

Optics:

12. Determine angle of specific rotation of sugar solution by using Polarimeter.
13. To verify Malus law & to determine Brewster's angle for glass.
14. To determine diameter of the even and odd rings by using Newtons rings apparatus.
15. To determine the grating element of a diffraction grating with the help of spectrometer.
16. Fresnel's Biprism.
    a) To determine the wavelength of sodium light with the help of Fresnel's Biprism.
    b) To determine the thickness of mica sheet.
17. Michelson interferometer.
    a) To determine the wavelength of monochromatic sodium light.
    b) To determine the difference in wavelength between sodium D lines.
    c) To determine the refractive index of glass.
18. Any other experiments of the equivalent standard can be set.

Suggested Readings:

1. Text Book of Electronics: S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006
2. Electronics Principles and Applications: A.B. Bhattacharya, New Central Book Agency P.Ltd., Kolkata, 2007.
3. Integrated Electronics Analog and Digital Circuits and Systems: J. Millman, C.C Halkins and C. Parikh, 2nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
4. Electronic Instrumentation and Measurement Techniques, W. D. Cooper and A. D. Helfrick, 2nd Ed., Phi Learning, 2008.
5. Electronic Devices and Circuits, J. Millman and C. C. Halkias and S. Jit., 4th Ed., McGraw-Hill, 2015.

M.Sc. (Physics) SEMESTER-II			
Course Code:	PH-CT201	COURSE TYPE :	Core Course-01
Course Title:	Solid State Physics-I		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course intends to provide knowledge of conceptual solid-state physics. In addition, this course aims to provide a general introduction to theoretical and experimental topics in solid state physics.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Learn about crystalline state of solids and X-ray diffraction
2. Learn about various types of crystal bonding and lattice dynamics
3. Understand various types of defects that exist in crystals.
4. Learn about free electron theory of metals

UNIT-1 TEACHING HOURS(13)	**Crystal structure:** Crystalline state - periodic arrangement of atoms-lattice translation vectors. The basis and crystal structure, primitive and non-primitive lattice cell-fundamental types of lattice, 2d and 3d Bravais lattice and crystal systems. Elements of symmetry operations-points and space groups-nomenclature of crystal directions and crystal planes-miller indices. **X-ray diffraction:** Scattering of x-rays, Laue conditions and Bragg's law, atomic scattering factor, geometrical structure factor, Reciprocal lattice and its properties.
UNIT-2 TEACHING HOURS(13)	**Crystal Binding:** Bond classifications – types of crystal binding, covalent, molecular and ionic crystals, London theory of van der Waals, hydrogen bonding, cohesive and Madelung energy. **Defects and Diffusion in Solids:** Point defects: Frenkel defects, Schottky defects, examples of colour centres, line defects and dislocations.

UNIT-3 TEACHING HOURS(13)	**Lattice Dynamics:** Failure of the static lattice model, adiabatic and harmonic approximation, vibrations of linear monoatomic lattice, one-dimensional lattice with basis, models of three- dimensional lattices, quantization of lattice vibrations, Einstein and Debye theories of specific heat, phonon density of states, neutron scattering.
UNIT-4 TEACHING HOURS(13)	**Free electron theory of metals:** Free electron model, Electrons moving in one dimensional potential well, three dimensional potential well, quantum state and degeneracy, the density of states, Fermi - Dirac statistics, effect of temperature on Fermi distribution function, the electronic specific heat. Electrical conductivity of metals, relaxation time and mean free path, electrical conductivity and Ohm's law, thermal conductivity, Wiedemann-Franz law, thermionic emission, the energy distribution of the emitted electrons, field enhanced electron emission from metals, changes of work function due to absorbed atoms, the contact potential between two metals, Hall effect.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	**1. Introduction to Solid State Physics, C. Kittel, 8th Edition, Wiley, 2012.** **2. Solid State Physics, A. J. Dekker, 1st Edition, Macmillan India, 2000.** **3. Solid State Physics, G. Burns, 1st Edition, Academic Press, 1985.** **4. Condensed Matter Physics, M. P. Marder, Wiley, 2010.** **5. Elementary Solid state physics, MA Omar, Addison Wesley, New Delhi, 2000.** **6. Solid state Physics, SO Pillai. New Age International Publication, 2002.** **7. Solid state Physics, MA Wahab, Narosa Publishing House, New Delhi, 1999.** **8. Solid State Physics, HC Gupta, Vikas Publishing House, New Delhi, 2002.**

M.Sc. (Physics) SEMESTER-II			
Course Code:	PH-CT202	Course Type:	Core Course-02
Course Title:	Quantum Mechanics-II		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The primary objective is to teach the students various approximation methods in quantum mechanics. The important topic of quantum scattering is also dealt with. Relativistic quantum theory like Klein-Gordon equation and Dirac equation is also covered.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Learn various approximation techniques of solving the quantum mechanical problems.
2. Develop the theory of scattering processes.
3. Explain the relativistic quantum mechanical equations, namely, Klein-Gordon equation and Dirac equation.
4. Get basic information needed for advanced courses like quantum field theory.

UNIT-1 TEACHING HOURS	**Approximation Methods for stationary problems:** Time-independent Perturbation theory (non-degenerate and degenerate) and applications to fine structure splitting, Zeeman effect (Normal and anomalous), Stark effect, and other simple cases, Variational method and applications to helium atom and simple cases; WKB approximation and applications to simple cases.
UNIT-2 TEACHING HOURS	**Approximation Methods for time-dependent perturbations:** Interaction picture, Time- dependent perturbation theory. Transition to a continuum of final states – Fermi's Golden Rule, Application to constant and harmonic perturbations, Sudden and adiabatic approximations, Semi-classical theory of interaction of atoms with radiation.
UNIT-3 TEACHING HOURS	**Collision in 3-D and scattering:** Laboratory and reference frames; Scattering amplitude; differential scattering cross section and total scattering cross section; Scattering by spherically symmetric potentials; Partial wave analysis and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; complex potential and absorption. Born approximation.

UNIT-4 TEACHING HOURS	**Relativistic Quantum Mechanics:** Klein-Gordon and Dirac-equations, Properties of Dirac matrices. Plane wave solutions of Dirac equation. Spin and magnetic moment of the electron, non-relativistic reduction of the Dirac equation.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Introduction to Quantum Mechanics, David J Griffiths, 2nd Edition, Pearson Prentice Hall, 2005. 2. Quantum Mechanics, BH Bransden and CJ Joachain, 2nd Edition, Pearson Education, 2007. 3. Quantum Mechanics, VK Thankappan, 2nd Edition, Wiley Eastern Limited, 1993. 4. Quantum Mechanics, LI Schiff, 3rd Edition, McGraw Hill Book Company, 1955. 5. Modern Quantum Mechanics, JJ Sakurai, Revised Edition, Addison-Wesley, 1995. 6. Principles of Quantum Mechanics, R Shankar, 2nd Edition, Springer, 1994. 7. Quantum Mechanics, E Merzbacher, John Wiley and Sons, 1998. 8. Quantum Physics, S Gasiorowicz, John Wiley and Sons 2014.

M.Sc. (Physics) SEMESTER-II			
Course Code:	PH-CT203	**Course Type:**	Core Course-03
Course Title:	Atomic and Molecular Physics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The main objective is to teach the students the basic atomic and molecular structures with quantum mechanical approach leading to their fundamental spectroscopies.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Know about the emission and absorption spectra of the atoms.
2. Know about the different energy levels in atoms and various coupling schemes.
3. Understand the interaction of atomic and molecular energy level with electric and magnetic fields.
4. Understand about the spectra of molecules
5. The spectroscopies would serve as the fundamentals for various concerned experimental results.

UNIT-1 TEACHING HOURS	**Atomic Physics–A:** Brief review of early atomic models of Bohr and Sommerfeld: One electron atom; Atomic orbitals, spectrum of Hydrogen atom: Energy levels and selection rules, Rydberg atoms, relativistic correction to the kinetic energy, spin – orbit interaction and fine structure in alkali spectra, Lamb shift. Magnetic dipole hyperfine structure, energy shift, hyperfine transition on Hydrogen, Isotope shifts.
UNIT-2 TEACHING HOURS	**Atomic Physics–B:** Interaction with external fields: (Quantum mechanical treatment) Zeeman effect and Anomalous Zeeman effect – magnetic interaction energy, selection rules, splitting of levels in Hydrogen atom. Linear stark effect order correction to energy and Eigen states: Paschen-Back effect, Two electron atom: ortho & para states, role of Pauli exclusion principle, level schemes of two electron atoms. Many electron atoms: LS and JJ coupling scheme, Lande interval rule.

UNIT-3 TEACHING HOURS	**Molecular Physics-A:** Born-Oppenheimer approximation (qualitative).Classification of molecules: Rotational spectra of diatomic molecules as a rigid rotator, centrifugal distortion and non-rigid rotator, intensity of rotational lines, Rotational spectra of symmetric rotors, Experimental technique of microwave spectroscopy. Raman scattering and polarizability, Rotational Raman spectrum of diatomic and linear polyatomic molecules. Experimental technique. Applications of Raman spectroscopy: Determination of nuclear spin.
UNIT-4 TEACHING HOURS	**Molecular Physics-B:** Vibrational energy of diatomic molecule, diatomic molecules as simple harmonic oscillator, anharmonicity, effect of anharmonicity on vibrational terms, energy levels and spectrum, Morse potential energy curve, Vibrational Raman effect, Rovibronic spectrum of a diatomic molecule with example. Diatomic molecules in excited vibrational-states. Mutual exclusion principle, Correlation between Raman and IR spectroscopy, Experimental technique of IR spectroscopy: IR spectrometer, Applications of IR spectroscopy: Material characterization and structural elucidation.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Atomic Spectra and Atomic Structure, G. Herzberg, Dover Publications, 2003. 2. Molecular Spectra and Molecular Structure, G. Herzberg ,Van Nostrand, 1950. 3. Atoms, Molecules and Photons, W. Demtroder, Springer, 2006 4. Fundamentals of Molecular Spectroscopy, C. N. Banwell, McGraw Hill, 1983. 5. Basic atomic & Molecular Spectroscopy, J. M. Hollas, RSC, 2002. 6. Molecular Structure and Spectroscopy, G Aruldhas, PHI, New Delhi, 2001. 7. Fundamentals of Molecular Spectroscopy, Banwell, Tata McGraw Hill, 1998.

M.Sc. (Physics) SEMESTER-II			
Course Code:	PH-CT204	COURSE TYPE :	Core Course-04
Course Title :	Numerical Methods and programming		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

To familiarize the students with the numerical techniques to solve the problems related to science, engineering and research areas.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Find numerical solutions of the system of linear equations with accuracy and obtain numerical solutions of algebraic transcendental equations.
2. Get knowledge about various interpolating methods.
3. Solve initial and boundary value problems in differential equations using numerical methods and apply various numerical methods
4. Know the FORTRAN programming language.

UNIT-1 TEACHING HOURS	**Roots of Equations:** Errors in numerical calculations, definition of root or zero of a function, Numerical solution of transcendental equations, concept of iterative methods. Bisection method, False position method, Newton-Raphson method, Secant method, Successive iteration, Comparison of different root methods, Properties of roots of polynomial. **Solution of Simultaneous Linear equation:** Direct Method: Gauss elimination, Pivoting, Gauss-Jordon method, Matrix inversion. Iterative methods: Jacobi iteration method, Gauss Seidel iteration method.
UNIT-2 TEACHING HOURS	**Interpolation:** Polynomial interpolation, Newton formula for interpolation, Forward differences, Differences of polynomial, Backward differences, Lagrange's interpolation, Divided differences interpolation and inverse interpolation, Finite difference operators, Spline interpolation, Least square curve fitting, Linear regression.

UNIT-3 TEACHING HOURS	**Numerical Differentiation and Integration:** Numerical differentiation, First order derivative by a two point formula, Numerical Integration, Trapezoidal rule of integration, Simpson's 1/3 rule, Simpson's 3/8 rule of integration, Double integration, Newton-Cotes formulae of integration, Gaussian integration formula, Gaussian two point formula.
UNIT-4 TEACHING HOURS	Solution of first order ordinary differential equations, Taylor series method and Euler's method, Modified Euler's method, Runge-Kutta method, Higher order Runge-Kutta formulas, Predictor corrector methods, Finite difference methods, Optimization, Single variable optimization Algorithm. **Fortran:** Flow charts, Algorithms, Integer and floating point arithmetic, Precision, Variable types, Arithmetic statements, Input and output statements, Control statements, Executable and non-executable statements, Arrays, Repetitive and logical structures, Subroutines and functions, Operation with files, Operating systems, Creation of executable programs.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Mathematical Methods in the Physical Sciences, Mary L Boas, Wiley, New York, 1983. 2. Methods of Numerical Analysis, S.S. SastryIntroductorY, Prentice-Hall of India, 1979. 3. Numerical computational methods, P. B. Patil and U. P. Verma, Narosa Publishing House Pvt. Ltd., New Delhi. 4. Mathematical Methods for Physicists, George Arfken, Hans Weber, Frank E. Harris, 7th Ed., Elsevier, 2012. 5. An Introduction to Computational Physics, Tao Pang, Cambridge University Press, 2010.

PH-CL205	Physics Laboratory-II	L T P : 0-0-12	6 Credits

Course Objectives: This is a laboratory course to provide hands on knowledge of some basic experiments in digital-electronics, solid state physics, and computational physics. This course will enable the students to study the physical properties of different kind of materials and their behavior under external magnetic, electric fields and temperature. This course will also develop programming skills in the students in order to write and implement their own computer programs for solving problems arising in science, engineering and research.

Course Outcomes: On the completion of the course, the students will be able to

CO1	Acquire hands on experience of handling and building digital electronics circuits.
CO2	Capable of using components of digital electronics for various applications.
CO3	The band gap, magneto resistance, resistivity and charge carrier concentration in semiconductors
CO4	Apply their knowledge of computer programming to develop and implement their own computer codes of numerical methods for solving different types of complex problems viz. nonlinear equations, system of linear equations, interpolation and extrapolation, numerical differentiation and integration, numerical, etc
CO5	Able to design and perform scientific experiments as well as accurately record and analyze the results of experiments
CO6	Solve problem with critical thinking and analytical reasoning.

CONTENTS

The students will be required to perform 10 experiments in each semester from the following list of experiments.

Solid State Physics:

1. To study Hall Effect and to determine Hall coefficient.
2. Study of B-H curve of a Ferromagnetic material (both hard and soft).
3. Calibration of electromagnet and magnetic susceptibility determination of magnetic salts ($MnSO_4$, $MnCl_2$) by Quincke's method.
4. Determination of Hysteresis loss by CRO.
5. To determine energy gap and resistivity of the semiconductor using four probe method.
6. Verification of Stefan's Law by electrical method.
7. To study the characteristics of a solar cell
8. To find magneto resistance of semiconductor.
9. Study of a Heat Capacity of Solids.

Computational Physics: Mathematica / Mat Lab / SCI-Lab

10. Determination of Roots
11. Curve fitting using MATLAB/FORTORN.
12. Numerical integration (Simpson's rule/ Trapezoidal rule) using MATLAB/FORTORN.
13. Numerical double integration using MATLAB.
14. Matrix Manipulation and Interpolation.

Digital Electronics:

15. To assemble Logic gates using discrete components and to verify truth table.
16. Study of logic circuits TTL, NAND, NOR and XOR gates.
17. To verify the Dmorgan's law using Logic Gates circuit
18. To study the operation of Analog to Digital convertor.
19. To study the operation of Digital to Analog convertor
20. To study the operation of Encoders and Decoders.
21. To assemble Logic gates using discrete components and to verify truth table.

Suggested Readings:

1. Text Book of Electronics: S. Chattopadhyay, New Central Book Agency P.Ltd., Kolkata, 2006.
2. Digital Principles and Applications: A.P. Malvino and D.P. Leach, Tata McGraw-Hill, Publishing Co., New Delhi.
3. Integrated Electronics Analog and Digital Circuits and Systems: J. Millman, C.C Halkins and C. Parikh, 2 nd Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2010.
4. Elementary Solid state physics, MA Omar, Addison Wesley, New Delhi, 2000.
5. Solid state Physics, SO Pillai. New Age International Publication, 2002.
6. Solid state Physics, MA Wahab, Narosa Publishing House, New Delhi, 1999.
7. Numerical Recipes in C: The Art of Scientific Computing, William H. Press , Brian P. Flannery, Saul A. Teukolsky, William T. Vetterling , 2nd Ed., Cambridge University Press, 2002.
8. Mathematical Methods for Physicists, George Arfken, Hans Weber, Frank E. Harris, 7th Ed., Elsevier, 2012.
9. Lab. Manual for Computer Programming & Numerical Methods, Dept. of Physics & Astrophysics, University of Delhi, 2017.

M.Sc. (Physics) SEMESTER III			
Course Code:	PH-CT301	Course Type :	Core Course-01
Course Title :	Solid State Physics-II		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course intends to provide knowledge of conceptual solid-state physics. In addition, this course aims to provide a general introduction to theoretical and experimental topics in solid state physics by covering band theory, semiconductors, superconductivity, dielectrics and magnetic properties of solids.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Learn about energy bands in solids
2. understand the basics theory of semiconductors
3. Grasp the concepts and basic ideas related to superconductivity.
4. Learn about dielectric properties of solids.
5. Learn about magnetic properties and various aspects of semiconductors.

UNIT-1 TEACHING HOURS (13)	**Band theory:** Bloch theorem, Bloch function and their eigen values. Kronig penny model, Tight bonding approximation for SC, BCC and FCC. Nearly free electron model, Wigner Seitz method, construction of the Fermi surfaces, de. Hass-Von Alfen effect, Cyclotron resonance, magneto resistance and quantum Hall effect.
UNIT-2 TEACHING HOURS(13)	**Semiconductors:** Introduction to semiconductors, band structure of semiconductors, Intrinsic and extrinsic semiconductors, expression for carrier concentration (only for intrinsic), ionization energies, charge neutrality equation, conductivity-mobility and their temperature dependence, Hall effect in semiconductors.
UNIT-3 TEACHING HOURS(13)	**Superconductivity:** Basic phenomena, Meissner effect, Critical field, Type- I and Type- II superconductors, Heat capacity, Isotope effect, London equations, Coherence length, BCS theory of superconductivity, Flux quantization, Normal tunneling, dc and ac Josephson Effect, SQUID, High temperature superconductors.

UNIT-4 TEACHING HOURS(13)	**Dielectrics:** Introduction, Review of basic formulae, Dielectric constant and displacement vector -different kinds of polarization-local electric field-Lorentz field- Clausius Mossotti equation relation- expressions for electronic, ionic and dipolar polarizability, Ferroelectricity and piezo electricity. **Magnetism:** Review of basic formulae -classification of magnetic materials-Langevin theory of diamagnetism, para-magnetism and Ferromagnetism, domains-Weiss molecular field theory (classical)-Heisenberg exchange interaction theory-Antiferro-magnetism and ferrimagnetism, ESR & NMR.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Introduction to Solid State Physics, C. Kittel, 8th Edition, Wiley, 2012. 2. Solid State Physics, A. J. Dekker, 1st Edition, Macmillan India, 2000. 3. Solid State Physics, G. Burns, 1st Edition, Academic Press, 1985. 4. Condensed Matter Physics, M. P. Marder, Wiley, 2010. 5. Elementary Solid state physics, MA Omar, Addison Wesley, New Delhi, 2000. 6. Solid state Physics, SO Pillai. New Age International Publication, 2002. 7. Solid state Physics, MA Wahab, Narosa Publishing House, New Delhi, 1999. 8. Solid State Physics, HC Gupta, Vikas Publishing House, New Delhi, 2002.

M.Sc. (Physics) SEMESTER III			
Course Code:	PH-CT302	**Course Type:**	Core Course-02
Course Title :	Classical Electrodynamics-I		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course will enable the students to evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method. The course provides concepts of relativistic electrodynamics and its applications in branches of Physical Sciences. It also makes students able to apply knowledge acquired through this paper to various types of problems of electromagnetic.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Basic knowledge of charge, electric field, potential, potential energy, uniqueness theorem and its application.
2. Understand about the boundary value problems in electrostatics as method of images.
3. Develop a knowledge and understanding of magneto statics, electromagnets, solenoid, toroid.
4. Develop a firm basis to understand multipoles, dipole moment, polarization, boundary value problems with dielectrics.
5. Develop a knowledge and understanding of electromagnetic fields, Maxwell's equations, conservations laws, scalar and vector potentials.

UNIT-1 TEACHING HOURS(13)	**Electrostatics: Electric field;** Gauss Law; Differential form of Gauss' law; Equation of electrostatics and the scalar potential; surface distribution of charges and dipoles and discontinuities in the electric field and potential; Poisson and Laplace equations; Uniqueness Theorem; Green's Reciprocity Theorem; Formal solutions of potential by Green's function; Electrostatic potential energy and energy density. **Boundary Value Problems in Electrostatics:** Methods of Images; A point charge near an infinite conducting plane; Point charge in the presence of a conducting sphere: Case (a) When the conducting sphere is grounded; Case (b) When the conducting sphere is insulated; Case (c) When the conducting sphere is charged and insulated; Conducting sphere in a uniform electric field by method of images; Green function for the grounded conducting sphere in the field of a charge q; Green function for the sphere: General solution for the potential; Conducting sphere with hemispheres at different potentials.

UNIT-2 TEACHING HOURS(13)	**Multipoles, Electrostatics of Macroscopic Media, Dielectrics:** Spherical Harmonics; Multipole expansions; Monopole moment; Dipole moment; Quadruple moment; Multipole expansions in Cartesian coordinates; multipole expansion of the energy of a charge distribution in an external field; Elementary treatment of electrostatics with permeable media; Boundary value problems with dielectrics; Molecular polarizability and electric susceptibility; A molecular model of the polarizability; Models for molecular polarizability: Displacement polarization, Orientation Polarization; Electrostatic energy in dielectric media.
UNIT-3 TEACHING HOURS(13)	**Magnetostatics:** Introduction and definition; Biot-Savart Law; the differential equation of Magnetostatics and Ampere's law; Vector potential and magnetic induction for a circular current loop; magnetic fields of a localized current distribution, magnetic moment; force and torque on and energy of a localized current distribution in an external magnetic induction; macroscopic equations, boundary conditions on B and H; methods of solving Boundary value Problems in Magnetostatics; uniformly magnetized sphere; magnetized sphere in an external field, permanent magnets; magnetic shielding, spherical shell of permeable material in a uniform field.
UNIT-4 TEACHING HOURS(13)	**Electrodynamics:** Faraday's law, Energy in magnetic fields, Maxwell's equations, Maxwell's displacement current, Maxwell's equations and magnetic charge, Maxwell's equations inside matter, boundary conditions. **Maxwell's equations, conservation laws:** Energy in a magnetic field, vector and scalar potentials, Gauge transformations, Lorentz gauge, Coulomb gauge, Green function for the wave equation, derivation of the equations of macroscopic electromagnetism, Poynting's theorem and conservation of energy and momentum for a system of charged particles and EM fields, conservation laws for macroscopic media.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**

SELECTED READING	1. Classical Electrodynamics, John David Jackson, 3rd Edition, Wiley, 1998. 2. Introduction to Electrodynamics, David Griffiths, 4th Edition, CU Press, 2020 3. Principles of Electrodynamics, Melvin Schwartz, Dover Publications, 1987. 4. Classical Electromagnetic Radiation, MA Heald and JB Marion, Saunders, 1983. 5. Electrodynamics, Gupta, Kumar, Singh, Pragathiprakashan,18th edition, 2010. 6. Modern Problems in Classical Electrodynamics, Charles A. Brau Oxford Univ. Press, 2003.

M.Sc. (Physics) SEMESTER III			
COURSE CODE:	PH-CT303	**Course Type:**	Core Course-03
COURSE TITEL:	Statistical Physics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course introduces students to statistical mechanics, which is part of the foundation of several branches of physics and has many applications beyond physics. The course demonstrates the profound consequences of an economical set of assumptions about nature known as the postulates of statistical mechanics. In particular, it shows how the postulates explain the general laws of thermodynamics as well as properties of classical and quantum gases, other condensed matter systems in equilibrium, and phase transitions.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Understand the basic concept of statistical mechanics to describe systems containing huge numbers of particles.
2. Know & understand the fundamental postulate of equilibrium statistical mechanics.
3. Understand & be able to apply Classical Thermodynamics to simple problems.
4. Understand & be able to apply the Micro-Canonical, Canonical, & Grand Canonical Ensembles to appropriate physical systems.
5. Understand the quantum statistical physics of fermions & bosons, also be able to apply
6. Fermi & Bose Statistics to various many particle systems.

UNIT-1 TEACHING HOURS(13)	**Brief review of thermal Physics:** Extensive and intensive variables, laws of thermodynamics, entropy and Gibbs paradox, thermodynamic potentials, chemical potential, Jacobian determinant, Maxwell's relations and their applications. **Statistical description of many-particle systems:** Binomial, Gaussian, and Poisson distributions, central limit theorem. **Classical statistical mechanics:** Phase space, Liouville's theorem. Microstates and macrostates, postulates of equal a priori probability, probability calculations, accessible states, constraint, equilibrium, irreversibility. Reversible and irreversible processes, Thermal interaction between macroscopic systems. classical ideal gas, entropy of mixing and Gibb's paradox.

UNIT-2 TEACHING HOURS(13)	**Classical ensemble theory:** Concept of ensembles, micro-canonical; canonical and grand canonical ensembles; system in grand canonical ensembles, partition function; principle of equipartition energy. Energy of Harmonic oscillator; partition function for canonical ensemble; energy fluctuations in the canonical ensemble; partition function and Thermodynamic function for grand canonical ensemble; density fluctuations in the grand canonical ensemble; theory of paramagnetism; negative temperature.
UNIT-3 TEACHING HOURS(13)	**Quantum statistical mechanics:** Basic concepts-quantum ideal gas, Identical particles and symmetry requirement, difficulties with Maxwell-Boltzmann statistics, quantum distribution functions, Bosons and Fermions. Bose-Einstein statistics, ideal Bose gas, photons, Bose-Einstein condensation. Specific heat of ideal Bose gas, Fermi-Dirac statistics, Fermi energy, ideal Fermi gas. properties of simple metals, Pauli paramagnetism, electronic specific heat, Quantum statistics in the classical limit.
UNIT-4 TEACHING HOURS(13)	**Phase transitions:** Cluster expansion for a classical gas, Virial equation of state, Dynamical model of phase transition, Ising model in zeroth approximation, Ising model in first approximation. Exact solution in one-dimension. Landau theory of phase transition, scaling hypothesis for thermodynamic functions. **Thermodynamics fluctuation:** Thermodynamics fluctuation, spatial correlation. Brownian motion, Langevin theory, fluctuation dissipation theorem. The Fokker-Planck equation.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	1. ANNUAL 2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.
SELECTED READING	1. Fundamentals of Statistical and Thermal Physics, F Reif, First Edition, Levant Books, 2010. 2. Statistical Physics of Particles, Mehran Kardar, Cambridge University Press, 2007. 3. Statistical Mechanics, Kerson Huang, 2nd Edition, Wiley-India, 2008. 4. Principles of statistical Mechanics, Richard Tollman Claredon Press, 1979. 5. Statistical Mechanics, R.K. Pathria, Butterworth-Heinemann, 1996. 6. Fundamentals of Statistical Mechanics, BB Laud, 5th Edition, New Age Publication, 2015. 7. Statistical Mechanics: An Advanced course with problems and solutions, Ryogo Kubo North- Holland, 1965.

M.Sc. (Physics) SEMESTER III: (Elective-I)			
Course Code:	PH-ET304(A)	Course Type:	Elective Course-01
Course Title:	Digital Electronics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The objective of this course is to provide the fundamental concepts associated with the digital logic and circuit design. To introduce the basic concepts and laws involved in the Boolean algebra and logic families and digital circuits. To familiarize with the different number systems, logic gates, and combinational and sequential circuits utilized in the different digital circuits and systems. The course will help in design and analysis of the digital circuit and system.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Became familiar with the digital signal, positive and negative logic, Boolean algebra, logic gates, logical variables, the truth table, number systems, codes, and their conversion from to others.
2. Understand the concept of minimization techniques for Boolean algebra.
3. Analyze Combination logic circuit such as multiplexers, adders, decoders.
4. Understand about synchronous and asynchronous sequential logic circuits.

UNIT-1 TEACHING HOURS(13)	**Number System and Codes:** Radix and Radix conversions, sign, magnitude & complement notation. Weighted and nonweighted codes, BCD codes, self-complementing codes, cyclic codes, error detecting and correcting codes, ASCII & EBCDIC codes. Alphanumeric codes. Fixed point and floating point arithmetic. BCD arithmetic.

UNIT-2 TEACHING HOURS(15)	**Boolean Algebra and Digital Logic Gates:** Features of Boolean algebra, postulates of Boolean algebra, theorems of Boolean algebra. Fundamental logic gates, derived logic gates, logic diagrams and Boolean expressions. Converting logic diagrams to universal logic. Positive, negative and mixed logic. **Minimization Technique:** Minterm, Maxterm, Karnaugh's maps, simplification of logic functions with K-map, conversions of truth tables in SOP & POS forms, incompletely specified functions, variable mapping, Quinn- Mcklusky method.
UNIT-3 TEACHING HOURS(10)	**Switching Circuit and Logic Families:** Diode, BJT, FET as switch. Different types of logic families: RTL, TTL, open collector TTL, three state output logic, TTL subfamilies, MOS, CMOS, ECL IIL.
UNIT-4 TEACHING HOURS(14)	**Combination System:** Combinational logic circuit design, Half and full adder & subtractors. Binary serial and parallel adders, BCD adder. Binary multiplier, comparator, decoders, encoders, multiplexer, de-multiplexer, Code converters. **Sequential Systems:** Latches, Flip-Flop: R-S, D, J-K, T, Master slave. Flip-flop conversions. Counters: asynchronous & synchronous counter. Counter design, counter applications. Registers: buffer & shift register.
TEACHING AND LEARNING METHODS	**7. Lecture method** **8. Demonstration and Experimental method** **9. Problem-solving method** **10. Seminar/Symposia method** **11. Extension activity method** **12. Project and report writing**
CONTINUES ASSESSMENT METHODS	**5. Seminar/Symposia** **6. Project and report writing** **7. Viva-voce** **8. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**3. ANNUAL** **4. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Digital principles and Applications, Malvino and Leach, Tata Mc Graw Hill Co. 2. Digital Logic and computer Design, M.Morris Mano, Tata Mc Graw Hill Co. 3. Digital circuits and design, S.Salivahnan, S.Anvazhagar. 4. Modern Digital Electronics, R. P. Jain, 3rd Edition, Tata McGraw-Hill, 2007.

M.Sc. (Physics) SEMESTER III: (Elective-I)			
Course Code:	PH-ET304(B)	Course Type:	Elective Course-01
Course Title :	Laser Physics and Application		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	45L+15T = 60 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

Laser, the light extraordinary, has so many applications in various field even having further potential and hence it has urgent need to familiarize lasers & their technical advances to the students so that students be ready to apply coherent light to solve various problems in areas such as scientific, industrial, healthcare etc.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. To apply the knowledge acquired of laser fundamentals to technological uses.
2. To apply the gained skills of optics and quantum optics into development of laser systems
3. To develop laser physics concepts into ultra short laser pulse generation technology
4. To apply the concepts of laser physics to develop and working of various laser systems

UNIT-1 TEACHING HOURS(10)	**Properties of laser beams:** Monochromaticity, Coherence: spatial and temporal coherence; directionality, brightness. Homogeneous and inhomogeneous broadening. Einstein coefficient A & B and Laser rate equations.
UNIT-2 TEACHING HOURS(10)	Population inversions, gain and gain saturation; Laser oscillations above threshold; Requirements for obtaining population inversions; Laser pumping requirements and techniques. Stability conditions, Three level and four level lasers; Issues in designing a laser.
UNIT-3 TEACHING HOURS(10)	Laser cavity modes; Longitudinal and Transverse laser modes, properties of laser modes; Stable laser resonators and Gaussian beams; Special Laser Cavities and Cavity Effects: Unstable Resonators, Q-Switching, Gain Switching, Mode Locking; Pulse-Shortening Techniques, Cavities for Producing Spectral Narrowing of Laser Output.

UNIT-4 TEACHING HOURS(15)	**Types of Lasers:** Solis State lasers, Gas Lasers, Dye Lasers, Semiconductor Lasers, Excimer Lasers, Carbon Dioxide Lasers, Nd:YAG and Nd:Glass Lasers, Titanium Sapphire Laser, Quantum Well Diode Laser, Free Electron Laser (FEL); high intensity laser matter interaction. **Industry applications:** laser cutting, welding, drilling & micromachining; laser in medicine: light-tissue interaction, Optical Coherence Tomography (OCT); satellite Laser ranging and Lasers in astronomy.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Laser Fundamentals, William T. Silfvast, 2nd edition, Cambridge University Press, 2004. 2. Optoelectronics: An Introduction, John Hawkes and John Wilson, 3rd edition, Prentice Hall Europe, 1998. 3. Atomic and Laser Spectroscopy, A.Corney, 1st edition, Oxford: Clarendon Press, 1977. 4. Principles of Lasers, Orazio Svelto, 5th edition, Springer, 2010. 5. Solid State Laser Engineering, W. Koechner, 5th edition, Springer, 1999. 6. Optical Electronics, Ajoy Ghatak and K. Thyagarajan, Cambridge University Press, 2004.

M.Sc. (Physics) SEMESTER III: (Elective-I)			
Course Code:	PH-ET304(C)	Course Type :	Elective Course-01
Course Title :	Advanced Semiconductor Devices		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	45L+15T = 60 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This core course is for M.Sc. (Physics) students to make them familiar with basic and advanced semiconductor devices and their practical application

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Understand of basic design principles and constructional details of specialized semiconductor devices used for high frequency applications in modern communication networks and systems.
2. To understand the use of semiconducting devices for diverse applications acting as signal/light sources, detection of signals and transduction of analog signals used in day to day electronics.
3. Enhanced awareness of the constant evolution in the physics of semiconductor devices and materials, the basic device design along-with the standard technological procedures adapted in the semiconductor industry for IC manufacturing and mass production of semiconductor devices.
4. Get knowledge of Basics of semiconductor devices such as Microwave Devices, Photonic Devices, Memory devices and their working.
5. To understand the various steps involves in the fabrication of semiconductor devices.

UNIT-1 TEACHING HOURS(14)	**Microwave Devices:** Klystrons amplifiers, velocity modulation, Basic principles of two cavity klystrons, Multicavity klystron amplifier and Reflex klystron oscillator, Magnetrons, principles of operation of magnetrons and Travelling wave tube (TWT). Transferred electron devices, Gun effect, Principles of operations, modes of operation, Read diode, IMPATT diode, and TRAPATT diode.
UNIT-2 TEACHING HOURS(13)	**Photonic Devices:** Radiative transition and optical absorption, LED, Semiconductor lasers, heterostructures and quantum well devices, photodetector, Schottky barrier and p-I-n photodiode, avalanche photodiode, photomultiplier tubes, electro-optic and magneto-optic devices.

UNIT-3 TEACHING HOURS(13)	**Memory Devices:** Volatile-static and D-RAM, CMOS and NMOS, non-volatile-NMOS, ferroelectric semiconductors, optical memories, magnetic memories, charge coupled devices (CCD). Other Devices: Piezoelectric, pyroelectric and magnetic devices. SAW and integrated devices
UNIT-4 TEACHING HOURS(5)	**Fabrication of Semiconductor Devices:** Vacuum techniques, thin film deposition techniques, diffusion of impurities, , Czochralski Process, MBE Technique, MOCVD
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programs	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Physics of Semiconductor Devices, S. M. Sze and K. K. Ng (3rd Ed., Wiley, 2008) 2. Semiconductor devices Physics and Technology, S. M. Sze (2nd Ed., Wiley, 2008) 3. Microwave Devices and Circuits, S. Y. Liao (3rd Ed., Pearson, 2003) 4. Electronic Instrumentation and Measurement Techniques, W. D. Cooper and A. D. Helfrick (2nd Ed., Phi Learning, 2008)

PH-CL305	**Physics Laboratory-III**	**L T P : 0-0-12**	**6 Credits**

Course Objectives: This is a laboratory course to provide hands on knowledge of some basic experiments in nuclear physics, laser physics & spectroscopy and nanoscience. The major objective of this course is to understand concepts of nuclear physics/laser physics & spectroscopy and nanoscience through standard set of experiments. In addition, the continuous evaluation process allows each and every student to not only understand and perform the experiment but also suitably correlate them with the corresponding theory.

Course Outcomes: On the completion of the course, the students will be able to

CO1	Learn and perform nuclear physics, Laser physics experiment.
CO2	Acquire hands on experience of using particle detectors such as GM counter
CO3	Understand the basic of nuclear safely management.
CO4	Working of LASERs and determination of LASER wavelength, applications of LASERs in different domains of engineering and technology.
CO5	Able to design and perform scientific experiments as well as accurately record and analyze the results of experiments
CO6	Able to analysis of structural and Surface morphology characterization of nanomaterials.

CONTENTS

The students will be required to perform 12 experiments in each semester from the following list of experiments.

Nuclear Physics, Laser physics & spectroscopy and nanoscience:

1. To study characteristics of a GM counter and to verify inverse law.
2. To study the absorption spectrum of Iodine vapour.
3. To study the variation of refractive index of the material of the prism with wavelength and to verify Cauchy's dispersion formula.
4. To determine the wavelength of He-Ne laser source by diffraction method.
5. Study of diffraction of laser beam by a slit.
6. To measure the wavelength of a given laser by using Michelson's Interferometer.
7. Measurement of thickness of thin wire with laser.
8. Determination of characteristic parameters of an optical fiber.
9. Determination of the Plank's Constant by Photo cell.
10. Determination of Plank's constant using LED's.
11. Determination of the 'e/m' ratio of electron by magnetron valve method.
12. Characteristics of Photovoltaic Cell.
13. Measure the numerical aperture and propagation loss in an optical fiber using He-Ne laser source.
14. Photoconductivity Experiment
    (i) To plot the current-voltage characteristics of a CdS photo-resistor at constant irradiance
    (ii) To measure the photocurrent as a function of irradiance at a constant voltage.
15. Estimation of band energy gap of a semiconductor.
16. Determination of wavelength of sodium light and laser light using Fabry-Perot interferometer.
17. Wavelength of laser by diffraction method (Reflection or Transmission grating).

18. Structural characterization of nanomaterials by XRD- determination of average grain/particle size, lattice parameters, strains etc.
19. Surface morphological characterization of nanomaterials by SEM.
20. Surface morphological characterization of nanomaterials by TEM.
21. Measurement and analyses of UV/vis Absorption spectrum of nanomaterials.
22. Measurement and analysis of Photoluminescence spectrum of nanomaterials.
23. Measurement and analysis of Raman spectrum of nanomaterials.
24. Any other experiments of the equivalent standard can be set.

Suggested Readings:

1. Lasers: Fundamental and Applications, Graduate Text in Physics, 2nd edition, K. Thyagarajan, Ajoy ghatak, Springer, 2002
2. Teaching laser physics by experiments, Am. J. Phys., (2011), http://doi.org/1-3488984
3. Nanostructured materials and nanotechnology, Hari Singh Nalwa., Academic Press, USA, 2002
4. Hand book of Nanostructured Materials and Technology. Vol.1-5, Hari Singh Nalwa, Academic Press, USA, 2000.
5. Handbook of Nanoscience, Engineering and Technology, W.Gaddand, D.Brenner, S.Lysherski and G.J.Infrate. Electrical Engineering Handbook, CRC Press, 2012.
6. Sol-Gel Science, C.J. Brinker and G.W. Scherrer, Academic Press, Boston, 1994.
7. Nanoscale Characterization of Surfaces & Interfaces,N John Dinardo, Weinheim Cambridge: Wiley-VCH, 2000
8. Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM, Ray F. Egerton, Springer, 2005
9. Scanning Probe Microscopy: Analytical Methods (NanoScience and Technology), Roland Wiesendanger, Springer, 1968.

M.Sc. (Physics) SEMESTER-IV			
Course Code:	PH-CT401	**Course Type:**	Core Course-01
Course Title :	Nuclear & Particle Physics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

To impart knowledge of basic properties of nuclei and nuclear structure, nuclear models, nuclear reactions and applications of nuclear physics. Capability of elementary problem solving in nuclear and particle physics, and relating theoretical predictions and measurement results.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Have knowledge of nuclear size, shape, binding energy etc. and also the characteristics of nuclear force in detail.
2. Have an understanding of the nuclear decay modes, radioactive decay, and the interaction of nuclear radiation with matter.
3. Gain knowledge about various nuclear models and potentials associated.
4. Have broad understanding of basic experimental radiation-detection techniques,
5. Understand the basic forces in nature and classification of particles and study in detail conservations laws and quark models in detail.

UNIT-1 TEACHING HOURS(13)	**Nuclear Interactions and Nuclear Reactions:** Nuclear sizes and shapes. Experimental methods of determining nuclear radius. Two-nucleon problem: Deuteron problem. Nucleon- nucleon interaction, exchange forces and tensor forces, meson theory of nuclear forces, nucleon, nucleon scattering, Effective range theory, spin dependence of nuclear forces, charge independence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction. Direct and compound nuclear reaction mechanisms, cross sections in terms of partial wave amplitudes, compound nucleus, scattering matrix, Reciprocity theorem, Breit- Wigner one–level formula, Resonance scattering.

UNIT-2 TEACHING HOURS(13)	**Nuclear models:** Liquid drop model, Semi empirical mass formula and isobaric stability, Bohr– wheeler theory of fission, Experimental evidence for shell effects- shell model, spin, orbit coupling, magic numbers, Angular momenta and parities of nuclear ground states, Qualitative discussion and estimates of transition rates, magnetic moment and Schmidt lines, Collective model of Bohr and Mottelson, Rotational and vibrational spectra and elementary idea of unified model .
UNIT-3 TEACHING HOURS(13)	**Nuclear Decays:** Beta decay, Fermi theory of beta decay, Comparative half, lives, Parity violation, Two component theory of neutrino decay, Detection and properties of neutrino Gamma decay, Multipole transition in nuclei Angular momentum and parity selection rules Internal conversion, Nuclear isomerism. General ideas of nuclear radiation detectors, Linear acceleration, Betatron, Proton- synchrotron, Electron synchrotron.
UNIT-4 TEACHING HOURS(13)	**Elementary Particles**: Types of interaction between elementary particles, Hadrons and leptons, Symmetry and conservation laws, Elementary ideas of : CP and CPT invariance, Classification of hadrons, lie algebra, SU(2)–SU(3) multiplets, Quark model, Gell Mann- Okubo mass formula for octet and decuplet hadrons, Charm, bottom and top quarks.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Introducing Nuclear Physics, K. S. Krane, Wiley India, 2008. 2. Nuclear Physics in A Nutshell, C. A. Bertulani, 1st Ed., Princeton University Press, 2007 3. Concept of Nuclear Physics, B. L. Cohen, McGraw – Hill, 2003. 4. Nuclear Physics- an Introduction, S. B. Patel,New Age international (P) Ltd., 1991. 5. Nuclear Physics, S. N. Ghoshal, First Edition, S. Chand Publication. 6. Nuclear & Particle Physics : An Introduction, B. Martin, Willey, 2006. 7. Introduction to Elementary Particles, D. Griffiths, Academic Press, 2nd Ed. 2008. 8. Introduction to Nuclear Physics, Wong, 2 nd edition, PHI, 2007. 9. Nuclear Physics, RR Roy and BP Nigam, Wiley-Eastern Ltd, 1983.

M.Sc. (Physics) SEMESTER IV			
Course Code:	PH-CT402	Course Type :	Core Course-02
Course Title :	Classical Electrodynamics-II		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course will enable the students to apply tools of electrodynamics and relativity to various physical problems related to moving charges, Plasma formation and its impact on behavior of particle. To make the students learn Radiation by moving charges, Radiation damping etc.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Apply Maxwell's equations to various problems and find out their solutions.
2. Solve problems involving the propagation and scattering of electromagnetic waves in different medium.
3. Grasp the idea of electromagnetic wave propagation through wave guides.
4. Obtain the characteristics of electromagnetic radiation by moving charges.
5. Understand the rather complex physical phenomena observed in plasma

UNIT-1 TEACHING HOURS(13)	**Electromagnetic waves:** Electromagnetic waves in non-conducting media: Monochromatic plane waves in vacuum, propagation through linear media, Reflection and transmission at interfaces. Fresnel's laws; Electromagnetic waves in conductors: Modified wave equation, monochromatic plane waves in conducting media. **Dispersion:** Dispersion in non-conductors, free electrons in conductors and plasmas. Guided waves, TE waves in a rectangular wave guide.
UNIT-2 TEACHING HOURS(13)	**Magneto-hydrodynamics and Plasma Physics:** Introduction and definitions, MHD equations, Magnetic diffusion, viscosity and pressure, Pinch effect, instabilities in pinched plasma column, Magneto hydrodynamics wave, Plasma oscillations, short wave length limit of plasma oscillations and Debye shielding distance.

UNIT-3 TEACHING HOURS(13)	**Radiation by moving charges:** Solution of inhomogeneous wave equation by Fourier analysis; Lienard-Wiechert Potential for a point charge, Total power radiated by an accelerated charge, Larmour's formula and its relativistic generalization, Angular distribution of radiation emitted by an accelerated charge, Radiation emitted by a charge in arbitrary extremely relativistic motion. Thomson scattering and radiation, Scattering by quasi-free charges, coherent and incoherent scattering, Cherenkov radiation.
UNIT-4 TEACHING HOURS(13)	**Radiation damping:** Introductory considerations, Radiative reaction force from conservation of energy, Abraham Lorentz evaluation of the self force, difficulties with Abraham Lorentz model, Integro-differential equation of motion including radiation damping, Line Breadth and level shift of an oscillator, Scattering and absorption of radiation by an oscillator.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Problem-solving method** **3. Demonstration and Experimental method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester and Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Classical Electrodynamics, John David Jackson, 3rd Edition, Wiley, 1998. 2. Introduction to Electrodynamics, David Griffiths, 4th Edition, CU Press, 2020 3. Principles of Electrodynamics, Melvin Schwartz, Dover Publications, 1987. 4. Classical Electromagnetic Radiation, MA Heald and JB Marion, Saunders, 1983. 5. Electrodynamics, Gupta, Kumar, Singh, Pragathiprakashan,18th edition, 2010. 6. Modern Problems in Classical Electrodynamics, Charles A. Brau Oxford Univ. Press, 2003.

SEMESTER IV(Elective-II)			
Course Code:	PH-ET403(A)	Course Type:	Elective Course-02
Course Title :	Physics of Nanomaterials		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The aim and objective of the course on **Physics of Nano-materials** is to familiarize the students of M.Sc. to the various aspects related to preparation, characterization and study of different properties of nanomaterials so that they can pursue this emerging research field as career.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Apply the knowledge on free electron theory to the band structure of metals, insulators, and semiconductors.
2. Acquire knowledge of basic approaches to synthesize the inorganic nanoparticles
3. Describe the use of unique optical properties of nanoscale metallic structures for analytical and biological applications
4. Understand the physical and chemical properties of carbon nanotubes and nanostructured mesoporous materials.
5. Determine the structure-property relationships in nanomaterials as well as the concepts, not applicable at larger length scales.

UNIT-1 TEACHING HOURS(10)	**Introductory Aspects:** Free electron theory and its features, Idea of band structure - metals, insulators and semiconductors. Density of state in one, two, and three dimensional bands and its variation with energy, Effect of crystal size on density of states and band gap. Examples of nanomaterials.
UNIT-2 TEACHING HOURS(12)	**Synthesis of Nanomaterials:** Bottom-up Synthesis -Top-down Approach: Nanolithography techniques, Arc discharge Method, Laser Ablation Method, Ball Milling, Chemical Vapour Deposition, Molecular Beam Epitaxy, The Sol-Gel Method, Co-precipitation Method, and Hydrothermal Synthesis.

UNIT-3 TEACHING HOURS(15)	**Diffraction techniques**: X-ray Diffraction (XRD) – Crystallinity, particle/crystallite size determination and structural analysis. **Microscopic techniques:** Scanning Electron Microscopy (SEM)–Morphology, grain size and EDX; Transmission Electron Microscopy (TEM) – Morphology, particle size and electron diffraction, Selected Area Electron Diffraction (SAED). **Spectroscopic techniques:** Fourier Transform Infrared Spectrometer (FTIR), Raman Spectroscopy, Photoluminescence Spectrometer, X-Ray Photoelectron Spectrometer (XPS), Auger Electron Spectroscopy.
UNIT-4 TEACHING HOURS(15)	**Quantum Dots:** Electron confinement in infinitely deep square well, confinement in one and two-dimensional wells, idea of quantum well structure, Examples of quantum dots, spectroscopy of quantum dots. **Carbon based Nanomaterials:** Synthesis, structural, and electronics properties of fullerenes, carbon nanotubes, and graphene, Functionalisation of carbon Nanomaterials, Applications of carbon based Nanomaterials.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programs	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Nanotechnology: Principle and Practices, S.K. KulKarni, Capital Publishing Company, 2015. 2. Nanoscience and Nanotechnology, B.K. Parthasarthy, Isha Books, Delhi, 2007. 3. Introduction to Nanoscience, S.M. Lindsay, Oxford University Press, New York, 2010. 4. Nanotechnology, G Timp, AIP press/Springer, 1999.

SEMESTER IV(Elective-II)			
Course Code:	PH-ET403(B)	Course Type :	Elective Course-02
Course Title :	Experimental Techniques in Physics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The aim of this course is to introduce students with the basic concepts and principles of optical and electron microscopy, X-ray diffraction, thermo gravimetric analysis, surface probe techniques and various spectroscopic techniques need to characterize the materials from bulk to nano scale associated to scientific and engineering aspects.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Students will gain the knowledge of fundamental of crystallography.
2. Introduce the various characterization techniques for materials.
3. The student will learn techniques relevant in emerging areas of industry and research.
4. Students will learn to work with their hands and learn skills required in experiments.

UNIT-1 TEACHING HOURS(15)	**Diffraction Methods:** Fundamental crystallography, Generation and detection of X-rays, Diffraction of X-rays, X-ray diffraction techniques, Electron diffraction. **Surface Analysis:** Atomic force microscopy (AFM), Magnetic force microscopy (MFM) scanning tunneling microscopy (STM), X-ray photoelectron spectroscopy (XPS), Deep Level Transient Spectroscopy (DLTS)
UNIT-2 TEACHING HOURS(10)	**Optical microscope -** Basic principles and components, Different examination modes (Bright field illumination, Oblique illumination, Dark field illumination, Phase contrast, Polarized light, Hot stage, Interference techniques), Stereomicroscopy.
UNIT-3 TEACHING HOURS(12)	**Electron Microscopy:** Interaction of electrons with solids, Scanning electron microscopy Transmission electron microscopy and specimen preparation techniques, Scanning transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy.

UNIT-4 TEACHING HOURS(15)	**Spectroscopy:** Atomic absorption spectroscopy, UV/Visible spectroscopy, Photoluminescence spectroscopy (PL), Fourier transforms infrared spectroscopy (FTIR), Raman spectroscopy and its application. **Thermal Analysis:** Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis and dilatometry.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Elements of X-Ray Diffraction by B.D. Cullity and R.S. Stock, Prentice-Hall, 2001. 2. Fundamentals of Light Microscopy and Electronic Imaging, Murphy, Douglas B, Wiley-Liss, Inc. USA, 2001. 3. Materials Characterization Techniques Sam Zhang by Li, Lin, Ashok Kumar, CRC Press, 2008. 4. Fundamentals of molecular spectroscopy, C. N. Banwell, Tata McGraw. 5. Electron Microscopy and Analysis, P.J. Googhew, Taylor & Francis, London, 2001.

M.Sc. (Physics) SEMESTER IV: (Elective-II)			
Course Code:	PH-ET304(C)	Course Type :	Elective Course-02
Course Title :	Mathematical Physics-II		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The aim of the course "Mathematical Physics-II" is familiarize the students with some of the most important mathematical methods not covered in the course "Mathematical Physics", PH-CT104. Students will learn about the representation theory of groups, their application to the various branches of Physics, probability and statistics

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. A very important branch of mathematics called "Group theory" will be introduced. Students will be familiar about the basics of group theory, various groups and their properties.
2. Students will learn about the representation theory of groups. They will learn how about various concepts and theorems leading up to the character table for finite groups.
3. Students will learn about the continuous groups, Lie groups, their generators and various groups important in the field of Physics.
4. After learning the basic theory behind various groups, students will learn about the applications of the theory in the various branches of Physics, such as Solid State Physics, Quantum Physics, Atomic Physics and Particle Physics
5. Students will be familiar with the Probability theory, probability distributions, their properties and transformation of random variables.
6. Statistics will be introduced to the students where they will learn about how errors propagate. They will learn about fitting curves to data, various distributions and about confidence intervals.

UNIT-1 TEACHING HOURS(10)	**Group Theory:** Definition of a group, Multiplication table, Conjugate elements and classes of groups, directs product, Isomorphism, homomorphism, permutation group.

UNIT-2 TEACHING HOURS(15)	**Representation theory of finite groups:** Representation of groups, equivalent representations, reducibility of a representation, Schur's lemmas and the orthogonality theorem, characters of a representation, Orthogonality property of characters, character table, product representations. **Continuous groups:** Continuous groups, Lie groups and their generators, SO(2), SO(3), SU(2) and SU(3) groups.
UNIT-3 TEACHING HOURS(12)	**Applications of groups theory:** Vanishing integrals, symmetry and degeneracy. Symmetry in crystals and molecules, Crystallographic point groups, translation and space groups, molecular point groups, irreducible representations of point groups, the double group and crystal field splitting
UNIT-4 TEACHING HOURS(15)	**Probability:** Review of probability theory, counting permutations and combinations. Random variables and distributions (discrete & continuous and their properties), binomial, Poisson and Gauss distributions. Limits of Poisson and Binomial distributions. Transformations of random variables (addition and multiplication/division), Gamma distribution. **Statistics:** Error propagation, fitting curves to data, the chi-square distribution, the t-distribution, confidence intervals.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Mathematical methods for physicists, Arfken, Weber and Harris, Academic press. 2. Mathematical methods for physics and engineering, Riley, Hobson and Bence, Cambridge University Press. 3. Elements of group theory for physicists, A W Joshi, New Age International Publishers. 4. Group theory with applications in chemical physics, P Jacobs, Cambridge University Press. 5. Molecular quantum mechanics, Atkins and Friedman, Oxford University Press

M.Sc. (Physics) SEMESTER IV: Elective-III			
Course Code:	PH-ET404(A)	Course Type :	Elective Course-03
Course Title :	General Theory of Relativity & Cosmology		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course is designed to introduce the theory of general relativity and cosmology, theory of gravitation, cosmological principles, Einstein's field equations and their cosmological solutions in various spaces to solve research problems in cosmology.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Understand the concept of transformation of coordinates using tensors.
2. Understand the various types tensors useful in solving cosmological problems.
3. Understand the Planetary orbits and analogues of Kepler's laws in general relativity.
4. Solving Einstein's and its modified field equations.
5. Understand the problems in dynamical cosmology.
6. Extend these ideas to solve cosmological problems in current research areas.

UNIT-1 TEACHING HOURS(13)	**General Relativity:** Transformation of coordinates. Tensors. Algebra of Tensors. Symetric and skew symmetric Tensors. Contraction of tensors and quotient law. Reimannian metric, Parallel transport, Christoffel Symbols. Covariant derivatves. Intrinsic derivatives and geodesics, Reiemann Christoffel curvature tensor and its symmetry properties. Bianchi identities and Einstein tensor.
UNIT-2 TEACHING HOURS(13)	Review of the special theory of relativity and the Newtonian Theory of gravitation. Principle of equivalence and general covariance, geodesic principle. Newotonian approximation. Schwarzchild external solution and its isotropic form. Planetary orbits and analogues of Kepler's laws in general relativity. Adavance or perihelion of a planet. Bending of light rays in gravitational field.

UNIT-3 TEACHING HOURS(13)	Gravitational redshift of spectral lines. Reader echo delay. Energy-momentum tensor of a perfect fluid. Schwarzchild internal solution. Boundary conditions. Energy momentum tensor of an electromagnetic filed. Eistein-Maxwell equations. Reissner-Nordstrom solution. Cosmology: Mach's principle. Einstein modified field equations with cosmological term. Static Cosmological models of Einstein and De-Sitter, their derivation, properties and comparison with the actual universe.
UNIT-4 TEACHING HOURS(13)	Hubble's law. Cosmological principle's Weyl's postulate. Derivation of Robertson-Walker metric. Hubble and deceleration parameters. Redshift. Redsshift versus distance relation. Angular size versus redshift relation and source counts in Robertson-Walker space-time. Friedmann models. Fundamental equations of dynamical cosmology. Critical density. Closed and open Universes. Age of the universe. Matter dominated era of the universe. Einstein-de-Sitter model. Particle and even horizons. Eddington- Lamaitre models with Λ-trem. Perfect cosmological principle. Steady state cosmology.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. General Relativity and Cosmilogy, J.V. Narlikar, The Machmillann Company of India Ltd. 1978. 2. A first course in genral relativity, B.F. Shutz, Combridge University Press, 1990. 3. Gravity, Black Holes and the Very Early universe: An Introduction to General Relativity and Cosmology, Tai L. Chow , Springer, 2008. 4. Introduction to Cosmology, J. V. Narlikar, Cambridge University Press, 2002. 5. Cosmology, Steven Weinberg , Oxford University, 2008.

M.Sc. (Physics) SEMESTER IV: Elective-III			
Course Code:	PH-ET404(B)	Course Type :	Elective Course-03
Course Title :	Nuclear Accelerator and Radiation Physics		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	52 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

This course is aimed to introduce the student to practical aspects of nuclear radiation, the role of fundamental processes involved in the interaction of photon, charged particles and neutrons with matter, the principles underlying the operation of nuclear detection instruments.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Learn about the different type of accelerators.
2. Get knowledge about principle of operation of various radiation detectors.
3. Understand various modes of interaction of electromagnetic radiations, neutron and charged particles with matter
4. Distinguish various types of radiations based on their interaction with matter.

UNIT-1 TEACHING HOURS(13)	**Sources of Radiation:** Cosmic rays, radioactive sources, accelerators (Brief study of principle of operation & characteristics of radiations of Cockroft Walton, Van de Graff, cyclotron, betatron, electron synchrotron, linear accelerator) Synchrotron radiation: Polarization, coherence and emittance. Neutron Source: Reactors, Neutrons from charged particle and photon induced reactions. **Radiation Protection:** Units and special parameters, background levels, radiation carcinogesis

UNIT-2 TEACHING HOURS(13)	**Interaction of Charged Particle with Matter:** Definition of range, types of charged particle interaction, energy transfer in elastic collisions, Bethe formula, scattering of heavy and light charged particles. **Interaction of electromagnetic radiation with matter:** Attenuation coefficients, classical scattering from single electrons, coherent scattering, Klein–Nishina cross section for Compton scattering (No derivation), Compton scattering from atomic electrons: Effect of electron binding, electron recoil energy, electron momentum distributions from Compton profiles. Photoelectric absorption, characteristic X-rays, Auger electrons, pair production.
UNIT-3 TEACHING HOURS(13)	**Interaction with Neutrons:** Neutron interactions, Neutron fields in non-multiplying media: Definition of flux, current density, collision dynamics, distribution of energy and angle of scatter, Mean scatter angle and energy loss in single collision, extension to multiple collision, slowing down in hydrogen, neutron diffusion, moderation and diffusion.
UNIT-4 TEACHING HOURS(13)	**Nuclear Detectors:** Methods for detection of free change carriers, Ionization chamber, Proportional counter, Geiger-Muller counter, Semiconductor detectors, Scintillation detector, Cherenkov detector, Wilson cloud chamber, Bubble chamber, Spark chamber, Nuclear emulsion techniques, Solid State nuclear track detector.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. A Primer in Applied Radiation Physics, F.A. Smith, World Scientific. 2. Nuclear Radiation Physics, R.E. Lapp and H.L. Andrews, Prentice-Hall, New Jersey, 1972. 3. Radiation Detection and Measurements, G. F. Knoll, Wiley & Sons, New Delhi. 4. Introductory Nuclear Physics: K. S. Krane, Wiley & Sons, New Delhi. 5. An Introduction to X-ray Spectrometry: Ron Jenkin, Wiley. 6. Techniques for Nuclear and Particle Physics Experiments: W. R. Leo, Narosa Publishing House, New Delhi. 7. Introduction to experimental Nuclear Physics: R.M. Singru, Wiley & Sons, New Delhi

M.Sc. (Physics) SEMESTER IV: (Elective-III)			
Course Code:	PH-ET404(C)	Course Type:	Elective Course-03
Course Title :	Science of Renewable source of Energy		
Credit:	4	Hours:	4 Hours/Week
		Total Teaching Hours:	45L+15T = 60 Hours
Max. Marks:	100	Minimum Pass Marks:	36
Theory Examination:	70	Minimum Pass Marks:	25
Internal Assessment:	30	Minimum Pass Marks:	11
Attendance Eligibility	75 PERCENT IN RESPECTIVE SEMESTER		
Examination	ESE	Mid. TEST	
Duration	03 Hrs	1 Hr	

COURSE OBJECTIVE:

The aim and objective of the course on Science of renewable Energy Sources is to expose the M.Sc. students to the basics of the alternative energy sources like solar energy, hydrogen energy, etc.

COURSE OUTCOMES:

Upon successful completion of the course students will be able to

1. Understand the energy demand of world & distinguish between traditional and alternative form of energy
2. Describe the concept of solar energy radiation and thermal applications.
3. Analyze making of solar cell and its types.
4. Identify hydrogen as energy source, its storage and transportation methods.
5. Summarize the fundamentals of other renewable energy resources like wind, bio, geothermal, ocean etc.

UNIT-1 TEACHING HOURS(10)	**Introduction:** Production and reserves of energy sources in the world and in India, need for alternatives, renewable energy sources.
UNIT-2 TEACHING HOURS(13)	**Solar Energy:** Thermal applications, solar radiation outside the earth's atmosphere and at the earth's surface, Principal of working of solar cell, Performance characteristics of solar cell. Types of solar cell, crystalline silicon solar cell, Thin film solar cell, multijunction solar cell, Elementary ideas of perovskite solar cell, dye synthesized solar cell and Tandem solar cell, PV solar cell, module array, and panel, Applications.

UNIT-3 TEACHING HOURS(12)	**Hydrogen Energy:** Environmental considerations, solar hydrogen through photo electrolysis and photocatalytic process, physics of material characteristics for production of solar hydrogen. Storage processes, solid state hydrogen storage materials, structural and electronic properties of storage materials, new storage modes, safety factors, use of hydrogen as fuel; use in vehicles and electric generation, fuel cells.
UNIT-4 TEACHING HOURS(10)	**Other Renewable Energy Resources:** Wind Energy, Bio Energy, Geothermal energy, ocean thermal energy, wave energy, Tidal energy, waste to energy, heat to energy, Fuel cells: types and applications.
TEACHING AND LEARNING METHODS	**1. Lecture method** **2. Demonstration and Experimental method** **3. Problem-solving method** **4. Seminar/Symposia method** **5. Extension activity method** **6. Project and report writing**
CONTINUES ASSESSMENT METHODS	**1. Seminar/Symposia** **2. Project and report writing** **3. Viva-voce** **4. Monthly test**
Semester End Examination methods for post graduate programme	**NET examination for PG or any other pattern notified by the University at the time of commencement of the respective semester.**
PERIODICAL REVISE OF SYLLABUS	**1. ANNUAL** **2. HOWEVER THE UNVIERSITY may revise the syllabus at any time during the running semester after giving a notice for a period one months.**
SELECTED READING	1. Solar Energy: S.P. Sukhatme, Tata McGraw-Hill, New Delhi, 2008 2. Solar Cell Devices: Fonash, Academic Press, New York,2010. 3. Fundamentals of Solar Cells, Photovoltaic Solar Energy: Fahren bruch and Bube Springer, Berlin, 1982. 4. Photo electrochemical Solar Cells: Chandra, New Age, New Delhi. 5. Rai G.D, "Non conventional Energy Sources" Khanna Publishers, 2006. 6. A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes-John Wiley (1980) 7. F. Kreith and J.F. Kreider, Principles of Solar Engineering, McGraw-Hill, 1978. 8. Handbook of Energy Engineering, Albert Thumann, D. Paul Mehta, Fairmont Press,2008.