DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

CIRCULAR NO.SU/Sci./M.Sc.Physics/52/2021

It is hereby inform to all concerned that, the syllabus prepared by the Board of Studies in Physics and recommended by the Dean, Faculty of Science & Technology the Hon'ble Vice-Chancellor has accepted the **Syllabus of M.Sc. Physics Ist to IVth semester with Bridge Course for affiliated Colleges and University Department** in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

This shall be effective from the Academic Year 2021-22 and onwards.

All concerned are requested to note the contents of this circular and bring notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO. SU/SCI/2021/3937-46
Date:- 25-10-2021.

Deputy Registrar,
Academic Section.

Copy forwarded with compliments to :-

1] **The Principal of all concerned Colleges,**
Dr. Babasaheb Ambedkar Marathwada University,
2] **Head of the Department, Department of Physics,**
Dr.Babasaheb Ambedkar Marathwada University, Aurangabad.
3] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] The Director, Board of Examinations & Evaluation,Dr.BAMU,A'bad.
2] The Section Officer,[M.Sc.Unit] Examination Branch,Dr.BAMU,A'bad.
3] The Programmer [Computer Unit-1] Examinations, Dr.BAMU,A'bad.
4] The Programmer [Computer Unit-2] Examinations, Dr.BAMU,A'bad.
5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.BAMU,A'bad.
6] The Public Relation Officer, Dr.BAMU,A'bad.
7] The Record Keeper, Dr.BAMU,A'bad.

Dr. Babasaheb Ambedkar Marathwada University, Aurangabad - 431001 (MS)

Structure and Curriculum

For

M. Sc. (Physics) Program

(Choice Based Credit System)

(Effective from June 2021 onwards)

22/9/2021
Dean
Faculty of Science & Technology
Dr. Babasaheb Ambedkar Marathwada
University, Aurangabad

from any other Department in the university campus and 02 credits from the course 'Constitution of India'.

Credit-to- contact hour Mapping:

One contact hour per week is assigned 1 credit for theory and 0.5 credits for laboratory courses/ research project. Thus a 4 - credit theory course corresponds to 4 contact hours per week and same analogy will be applicable for laboratory courses / research project.

Course Structure:

Semester I (Core and Foundation Courses)				
Course	**Course Title**	**Teaching time/week**	**Marks**	Credits
PHYC-111	Mathematical Methods in Physics	4 hours	100	4
PHYC-112	Classical Mechanics	4 hours	100	4
PHYC-113	Quantum Mechanics	4 hours	100	4
PHYC-114	Statistical Mechanics	4 hours	100	4
PHYF-115	Research Methodology	2 hours	50	2
IC-01	***Constitution of India***	***2 hours***	***50***	***2***
PHYL- 121	Lab course 1 (General Physics)	4 hours	50	2
PHYL- 122	Lab course 2 (Computational Physics based on PHYC -111, 112, 113 and 114)	4 hours	50	2
Total Credits for Semester I : 24 (Theory : 20 ; Laboratory : 04)				
Semester II (Foundation Courses)				
PHYF-211	Foundation Course in Electronics (Linear and Digital Electronics)	4 hours	100	4
PHYF-212	Foundation Course in Spectroscopy (Atomic and Molecular Physics)	4 hours	100	4
PHYF-213	Foundation Course in Nuclear Physics (General Nuclear Physics)	4 hours	100	4
PHYF-214	Foundation Course in Condensed Matter Physics (General Condensed Matter Physics)	4 hours	100	4
PHYL-221	Lab course 3 (Condensed Matter Physics + Nuclear Physics+ Spectroscopy)	4 hours	50	2
PHYL-222	Lab course 4 (Electronics + Computational Physics)	4 hours	50	2
PHYR-231	Research Project Part -I (Review of literature for Research Project and Formulation of Topic of Research Project)	4 hours	50	2
Total Credits for Semester II : 22 (Theory : 16 ; Laboratory : 04; Research project: 02)				

Semester III (Foundation and Generic Elective Courses)				
PHYF-311	Electrodynamics	4 hours	100	4
PHYE-312	Generic Electives 1 (A1/ B1/ C1/ D1)	4 hours	100	4
PHYE-313	Generic Electives 2 (A2/ B2/ C2/ D2)	4 hours	100	4
PHYE-314	Generic Electives 3 (A3/ B3/ C3/ D3/ E3 / F3 / G3 / H3 / I3/J3) **(Any one)**	4 hours	100	4
PHYL-321	Lab course 5 (Based on Electives A1/ B1/ C1/ D1)	6 hours	50	3
PHYL-322	Lab course 6 (Based on Electives A2/ B2/ C2/ D2)	6 hours	50	3
PHYR-331	Research Project Part II (Experimental Work)	6 hours	50	3
Total Credits for Semester III : 25 (Theory : 16 ; Laboratory : 06 ; Research Project : 03)				
Semester IV (Generic and Open Elective Courses)				
PHYE-411	Generic Electives 4 (A4/ B4/ C4/ D4)	4 hours	100	4
PHYE-412	Generic Electives 5 (A5/ B5/ C5/ D5)	4 hours	100	4
PHYE-413	Generic Electives 6 (A6/ B6/ C6/ D6/E6/F6/G6/H6) **(Any one)**	4 hours	100	4
OELE-101	Open Elective (from other Departments) / SWAYAM course	4 hours	100	4
PHYL-421	Lab course 7 (Based on Electives A4/ B4/ C4/D4)	6 hours	50	3
PHYL-422	Lab course 8 (Based on Electives A5/ B5/ C5/ D5)	6 hours	50	3
PHYR-431	Research Project Part III (Dissertation and Presentation)	6 hours	50	3
Total Credits for Semester IV : 25 (Theory : 16 ; Laboratory : 06 ; Research Project : 03)				
Total Credits : 96 (Sem I : 24 + Sem II : 22 : Sem III : 25 + Sem IV : 25)				

22/09/2021

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List of Generic Elective Courses for Semester III

Sr. No.	Code	Name of Course	Semester
		A: Electronics ; B : Spectroscopy C : Nuclear Physics D : Condensed Matter Physics	
1	A1	8086 Microprocessor and Interfacing	III
2	B1	Atomic Spectroscopy	III
3	C1	Radioactivity and Nuclear Decay	III
4	D1	Crystallography	III
5	A2	Microwaves	III
6	B2	Molecular Spectroscopy	III
7	C2	Reactor Physics	III
8	D2	Electrical Properties of Solids and Superconductivity	III
		PHYE - 314; Elective 3 (Any one)	
9	A3	Industrial Electronics	III
10	B3	Modern Trends in Spectroscopy	III
11	C3	Nuclear Reactions and Nuclear Energy	III
12	D3	Physics of Nano materials	III
13	E3	X-Ray Diffraction	III
14	F3	Thin Film and Vacuum Technology	III
15	G3	Methods of Theoretical Physics	III
16	H3	Communication Electronics	III
17	I3	Nuclear Spectroscopy	
18	J3	Micro Electro Mechanical System (MEMS)	
		List of Generic Elective Courses for Semester IV	
1	A4	Advanced Sensor Technology	IV
2	B4	Applied Spectroscopy	IV
3	C4	Particle Physics, Nuclear forces and Cosmic rays	IV
4	D4	Magnetic Materials and Super fluidity	IV
5	A5	8051- Microcontroller	IV
6	B5	Lasers Nonlinear Optical mixing and Spectroscopic Phenomena	IV
7	C5	Radiation Measurements And Nuclear Dosimetry	IV
8	D5	Material Synthesis and Characterization	IV
		PHYE-413; Elective 6 (Any one)	
9	A6	Fundamentals of Sensors	IV
10	B6	The Physics of Dielectrics	IV
11	C6	Nuclear Fission, Fusion and Neutron Physics	IV
12	D6	Renewable Energy	IV
13	E6	Soil Physics	Iv
14	F6	Advance communication Electronics	IV
15	G6	Accelerator Physics	IV
16	H6	X-ray Spectroscopy	IV

Notes:

- Tutorial / assignments are integral components of all theory courses. Tutorials consist of conceptual as well as numerical problems / questions based the respective theory courses in the semester covering all four (04) units.
- Each course / paper should be taught for 60 contact hours (48 lectures and 12 tutorials).
- Teaching duration for LAB COURSES in first and second semesters should be of 04 hours and for those in third and fourth semesters should be 06 hours per week per batch.
- For LAB COURSES in First and Second semesters one batch of the students will be consisting 08 students and that of Third and Fourth semester 05 students (Specialization) for laboratory courses as well as project.
- Each of the theory courses is divided into four units.
- The content of theory course / paper as well laboratory (practical) course may be modified time to time (with the approval DC) to keep pace with the recent developments and trends in the subject.

Course Contents:

Learning objectives and learning outcomes will be integral part of course contents. Learning objectives will describe why the course is necessary? Why it should be taught as Core / Foundation / Elective? Why it should be taught at Semester I / Semester II / Semester III / Semester IV and learning outcomes will describe how the course will be beneficial? What are the job / research opportunities for the takers of the course? is the said course a pre-requisite for certain other courses? can one start an entrepreneurship after the said course or will the course help for such activity.

Each course will have 04 units and will have 60 contact hours (48 lectures and 12 tutorials). Reference section consists of latest references of reputed authors and publishers by having all details of the books such as title, author(s), edition, publisher, year, ISBN or ISSN, etc. In case of e-reference, a web link is also included.

Attendance:

Students must have 75 % of attendance in each core, foundation, elective, laboratory and research project course for appearing examination/ scholarship otherwise he / she will be strictly not allowed for appearing the examination of each course. However, students having 65 % attendance with medical certificate may request Head of the Department for the condensation of attendance.

Departmental Committee:

The existing Departmental Committee (DC) will monitor the smooth functioning of M. Sc. programme.

Results Grievances / Redressal Committee

In Choice Base Credit System (CBCS) there is no redressal of assessed papers. In CBCS - system, the assessed papers are shown to the students and it is the duty of the student to go through the assessed papers and solve the grievances if any at the respective teacher only. It is the moral duty of the student to write SEEN and SATISFIED on the assessed answers book shown by the teacher in-charge of that respective paper. Once the assessed papers are submitted to the office, then the papers will not be shown/given to the students and any type of grievances/ complaints about the assessment will not be entertained.

Even if, there are some grievances, the student must give a written application to Head of the Department before declaration of the result about his/ her grievances. The Head of the Department will constitute a Grievances / redressal committee in the department to resolve all grievances relating to the evaluation. The committee shall consist of Head of the Department (Chairman), the concerned teacher of a particular course and senior faculty member of the Departmental Committee. The decision of Grievances / redressal committee will have to be approved by the Department committee. The decision of DC will be the final decision.

Evaluation Methods:

- The assessment will be based on 20:80 ratio of continuous internal assessment (CIA) and semester end examination (SEE).
- Combined passing in CIA and SEE. In case of failure/absence in CIA of a particular course, student will have to appear for the same CIA in the same semester, with the permission of the Head of the Department.
- In case a student fails in certain courses in a particular semester and the same courses are modified / revised / removed from the curriculum in due course of time, the student will have to appear as per the newly framed curriculum and or pattern in subsequent semester at his / her responsibility.

Continuous Internal Assessment (CIA):

- There will be 20 marks for Continuous Internal Assessment. Distribution of 20 marks will be as follows; there will be two internal tests of 20 marks each. The first internal test should be after completion of 40 to 50 % curricula and on the course completed (Unit I and II). Second internal test should be after completion of 100% curricula and on the 50 % remaining curricula (Unit III and IV). Continuous Internal Assessment will consist of 5 questions of 5 marks each and the first question will be the objective of 5 marks. There will be four questions of descriptive nature and the student has to solve three out of four. The average of the two internal tests will be considered as the CIA marks out of 20.

Semester End Examination (SEE):

- The semester end theory examination for each theory course will be of 80 marks. The total marks shall be 100 for 4 credit theory course (80 marks semester end exam + 20 marks CIA).

- Pattern of semester end question paper will be as below:

    - The semester end examination of theory course will have two parts (20+80 = 100 Marks)
    - Part A will be consisting of 10 questions having 2 marks each (multiple choice questions) as compulsory questions and it should cover entire course curriculum (20

Marks) having at least 2 questions from each unit of course curriculum.

- Part B will consists (06) questions (1.5 questions from each of 04 units and each question will be of 15 marks). The students will have to attempt any four questions out of six.
- 20 to 30% weightage can be given to problems/ numerical wherein use of non-programmable scientific calculator may be allowed.
- Number of sub questions (with allotment of marks) in a question may be decided by the examiner.

- Semester end examination (SEE) time table will be declared by the departmental committee (as per the University annual calendar). The paper setting and assessment of theory courses, laboratory courses and research project will be done by external and internal examiners. However, in case of non-availability of external examiner for either paper setting or assessment or both, department committee will be empowered to take appropriate decision.

- Assessment of laboratory courses and research project will be done by the external and internal examiners. Student must perform at least eight experiments from each laboratory course. The semester end practical examination will be conducted at the end of each semester.

- The Head of the Department shall send all results to the Controller of Examination for further processing.

Earning Credits:

At the end of every semester, a letter grade will be awarded in each course for which a student had registered. A student's performance will be measured by the number of credits that he/she earned by the weighted Grade Point Average (GPA). The SGPA (Semester Grade Point Average) will be awarded after completion of respective semester and the CGPA (Cumulative Grade Point Average) will be awarded at the end of the 4^{th} semester.

Grading System:

- The grading reflects a student-own proficiency in the course. A ten point rating scale shall be used for the evaluation of the performance of the students to provide letter grade for each course and overall grade for the Master Programme. Grade points are based on the total number of marks obtained by him / her in all heads of the examination of the course. The grade points and their equivalent range of marks are shown in Table-I

Table - I : Ten point grade and grade description

Marks Obtained (%)	Grade Point	Letter Grade	Description
90-100	9.00- 10	O	Outstanding
80-89	8.00-8.90	A++	Exceptional
70-79	7.00-7.90	A+	Excellent

60-69	6.00-6.90	A	Very Good
55-59	5.50-5.90	B+	Good
50-54	5.00-5.40	B	Fair
45-49	4.50-4.90	C++	Average (Above)
41-44	4.1-4.49	C	Average
40	4.0	P	Pass
< 40	0.0	F	Fail (Unsatisfactory
	0.0	AB	Absent

- Non appearance in any examination / assessment shall be treated as the students have secured zero marks in that subject examination / assessment.
- Minimum P grade (4.00 grade points) shall be the limit to clear / pass the course / subject. A student with F grade will be considered as 'failed" in the concerned course and he / she have to clear the course by appearing in the next successive semester examinations.
- Every student shall be awarded grade points out of maximum 10 points in each subject (based on 10 point scale). Based on the grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results will be announced at the end of each semester and CGPA will be given on the completion of M. Sc. programme.

Computation of SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average)

Grade in each subject / course will be calculated based on the summation of marks obtained in internal and semester end examination.

The computation of SGPA and CGPA will be as below

Semester Grade Point Average (SGPA) is the weighted average points obtained by the students in a semester and will be computed as follows

$$SGPA = \frac{\text{Sum (Course Credit X Number of Grade Points in concern Course Gained by the Student)}}{\text{Sum (Course Credit)}}$$

The SGPA will be mentioned on the mark sheet at the end of every semester.

- The Cumulative Grade Point Average (CGPA) will be used to describe the overall performance of a student in all semester of the course and will be computed as under.

$$CGPA = \frac{\text{Sum (All four Semester SGPA)}}{\text{Total Number of Semester}}$$

The SGPA and CGPA shall be rounded off to the second place of decimal.

Grade Card

Results will be declared by the Departmental Committee and the grade card (containing the grades obtained by the student along with SGPA) will be issued by the University after completion of every semester. The grade card will be consisting of following details.

- Title of the courses along with code opted by the student.
- Credits associated with the course.
- Grades and grade points secured by the student.
- Total credits earned by the student in a particular semester.
- Total credits earned by the students till that semester.
- SGPA of the student.
- CGPA of the student (at the end of the 4^{th} semester).

Cumulative Grade Card

The grade card sheet showing details grades secured by the student in each subject in all semester along with overall CGPA will be issued by the University at the end of 4^{th} semester.

Semester - I

M. Sc. (Physics) Curriculum

Semester - I

PHYC-111: Mathematical Methods in Physics

(Credits: 04; Contact Hours: 60)

Lectures: 48; Tutorials: 12

Learning Objectives:

1. To facilitate the students to understand -
   a) The basic elements of complex mathematical analysis, including the integral transform and Laplace transform.
   b) To expand a function in terms of a Fourier series, with knowledge of the conditions for the validity of the series expansion.
   c) To apply integral transform (Fourier and Laplace) to solve mathematical problems of interest in physics, use Fourier transforms as an aid for analyzing experimental data.
   d) To solve partial differential equations of second order by use of series expansion (Fourier series) and integral transforms.

Learning Outcomes:

1. After finishing the course the student should be able to:
   a) master the basic elements of complex mathematical analysis, including the integral theorems, obtain the residues of a complex function and to use the residue theorem to evaluate definite integrals
   b) Solve ordinary differential equations of second order that are common in the physical sciences.
   c) Expand a function in terms of a Fourier series, with knowledge of the conditions for the validity of the series expansion.
   d) Apply integral transform (Fourier and Laplace) to solve mathematical problems of interest in physics, use Fourier transforms as an aid for analyzing experimental data.
   e) Solve partial differential equations of second order by use of standard methods like separation of variables, series expansion (Fourier series) and integral transforms.
   f) Solve some simple classical variational problems.

Course Contents:
Unit I: Fourier series (09 Contact Hours)

Definition, Evaluation of coefficient, Fourier series representation of even and odd function General properties of Fourier series, simple applications, convergence, integration, differentiation, problems.

Unit II: Integrals Transforms (13 Contact Hours)

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Unit III: Laplace Transforms (13 Contact Hours)

Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Unit IV: Complex Analysis (13 Contact Hours)

Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Unit V: Tutorials, assignments and seminar presentations based on unit I, II, III and IV
(12 Contact Hours)

References:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence,3rd ed., **2006,** Cambridge University Press /ISBN978052167918/2006
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications/ ISBN-13: 978- 0486691930/1996
3. Complex Variables, A.S. Fokas & M.J. Ablowitz, Cambridge University Press, **ISBN**-13: 978- 0521534291/2003.
4. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 8th Ed./ (**ISBN**: 978-0-07-333730-2/ 2004, Tata McGraw-Hill
5. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, Jones & Bartlett/ **ISBN**-13: 978-0763757724/2nd edition /1940.
6. Mathematical Physics- B.S. Rajput, Pragati Prakashan (Meerut). **ISBN** 10: 8175568712/23 edition/2005
7. Engineering Mathematics H. K. Dass/ S. Chand co. / 9788121914697/2012
8. Mathematical Physics- Kumar and Gupta/ **ISBN** 10: 8125930965/ Vikas Publishing House, New Delhi/2008.

PHYC-112: Classical Mechanics

(Credits: 04; Contact Hours: 60)

Lectures: 48; Tutorials: 12

Course Objectives: The themes dealt with in this paper:

Classical Mechanics is a course where it all started
Newton demonstrated that the same forces and laws of mechanics that apply to apples and everyday objects (the terrestrial) also govern the behavior of the moon and the planets (the celestial).
In a wide array of physical situations, classical mechanics is all you need to be able to predict the motion of apples, baseballs, bones, bridges, cars, cats, and so on.
The universality of the laws and their wide range of applicability, classical mechanics is an essential course for students of physics.

Course Outcomes (COs): The present unit attempts to achieve the following learning outcomes: **At the end of the course the student should be able to;**

CO-1	Classical mechanics is a hot area of active research once more.

Learning Objectives:

> Classical mechanics is a course where it all started. Newton demonstrated that the same forces and laws of mechanics that apply to apples and everyday objects (the terrestrial) also govern the behavior of the moon and the planets (the celestial).

> He showed that nature had a high degree of structure and order, and that we could hope to uncover it and so physics was born.

> Newton's laws of motion, or mechanics, were not only universal, they proved to be useful. In a wide

CO-2	Chaos has lead to significant advances in mathematics and physics (for example, it offers some explanation for the phenomenon of ergodicity in statistical mechanics) and fundamentally changes the way we look a predictability and solvability of dynamical systems
CO-3	While classical mechanics, by definition, does not include the 21[st] century advances of quantum mechanics and relativity, it is nevertheless an essential prerequisite for study of these topics.
CO-4	We use concepts of forces and energy throughout physics, so a strong grounding in classical mechanics is essential.
CO-5	Students will study the phenomenon of chaos, fully solve two-body orbit problems and derive Kepler's Laws, and develop the theory of effective forces that arise in no inertial frames.

array of physical situations, classical mechanics is all you need to be able to predict the motion of apples, baseballs, bones, bridges, cars, cats, and so on. For these two reasons alone: the universality of the laws and their wide range of applicability, classical mechanics is an essential course for students of physics.

> There's more: recent developments in classical mechanics have led to the theory of Chaos.

Learning Outcomes:

- > Classical mechanics is a hot area of active research once more.
- > Chaos has lead to significant advances in mathematics and physics (for example, it offers some explanation for the phenomenon of ergodicity in statistical mechanics) and fundamentally changes the way we look a predictability and solvability of dynamical systems.
- > And there's even more: while classical mechanics, by definition, does not include the 21st century advances of quantum mechanics and relativity, it is nevertheless an essential prerequisite for study of these topics. For example, the Hamiltonian in quantum mechanics originates from the classical mechanics Hamiltonian that we will encounter.
- > We use concepts of forces and energy throughout physics, so a strong grounding in classical mechanics is essential. While students studied classical mechanics already in B.Sc, in this course we will encounter more advanced techniques and solve a wider variety of problems. For example, we will encounter a reformulation of classical mechanics by Lagrange (and Hamilton) which makes it easier to deal with complicated situations such as more general coordinates or constraints on the motion. We will study the phenomenon of chaos, fully solve two-body orbit problems and derive Kepler's Laws, and develop the theory of effective forces that arise in no inertial frames.
- > We will close with the profound Liouville's theorem for Hamiltonian mechanics and its implications in chaotic and planetary systems.

Course Contents:

Unit I : Constrained Motion

Constraints, Classification of Constraints, Principal of Virtual Work, D'Alembert's principal and its applications (Problems only), (One or Two Problems should be discussed with D'Alembert's, Lagrangian, Hamiltons from same set of problems). **Lagrangian formulation:**Generalized coordinates, Langrange's equations of motion, properties of kinetic energy function, theorem on total energy, generalized momenta, cyclic-coordinates, integrals of motion, Jacobi integrals and energy conservation.

Unit II: Hamilton's formulation

Hamilton's function and Hamilton's equation of motion, configuration space, phase space and state space, Lagrangian and Hamiltonian of relativistic particles and light rays. **Variational Principle**: Variational principle, Euler's equation, applications of variational principle, shortest distance problem, brachistrochrone, Geodesics of a Sphere

Unit III: Canonical transformation and central force

Generating function, Conditions for canonical transformation and problem, theory of chaos, Two body central force problem, stability of orbits, condition for closure, integrable power laws, Kepler's problems, orbits of artificial satellites, Virial theorem. **Poisson Brackets**: Definition, Identities, Poisson theorem, Jacobi-Poisson theorem, Jacobi identity, (Statement only), invariance of PB under canonical transformation.

Unit IV: Rotational and oscillatory motion

Rotating frames of reference, inertial forces in rotating frames, Larmour precision, electromagnetic analogy of inertial forces, effects of Coriolis force, Focoult's pendulum, small oscillations, Normal co-ordinates and applications to vibrations of linear in triatomic molecules. Liouville's theorem for Hamiltonian mechanics and its implications in chaotic and planetary systems.

References:

1. Classical Mechanics, by H. Goldstein, 2nd Edition (Published by Narosa Publishing House Pvt. Ltd., New Delhi (2001) ISBN 10:8185015538 / ISBN 13:9788185015538
2. Classical Mechanics, by H. Goldstein, Charles Poole, John Safco, 3 rd Edition (Published by Pearson Education Asia (2014)) ISBN 10:8131758915 / ISBN 13:9788131758915
3. Classical Mechanics, by N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991) ISBN 10: 0074603159 ISBN 13: 9780074603154
4. Mechanics, by A. Sommerfeld (Academic Press, 1952) ISBN 10: 0126546703 ISBN 13: 9780126546705
5. Introduction to Dynamics, by I. Perceival and D Richards (Cambridge Univ. Press. 1982). ISBN-10: 0521281490 / ISBN-13: 978-0521174060
6. Classical Mechanics, P. V. Panat (Narosa Pub. House Pvt. Ltd.) 2008 ISBN: 9788173196317 / 8173196311
7. Classical Mechanics, by Gupta, Kumar and Sharma, Pragati Prakashan, Meerut (2012). ISBN number 9350063808 / 9789350063804
8. Classical Dynamics of Particles and Systems by Marion and Thomtron, Third Edition, Horoloma Book Jovanovich College Publisher (2003) ISBN-10: 0534408966 ISBN-13: 978-0534408961
9. Introduction to Classical Mechanics by R. G. Takawale and P. S. Puranik, Tata Mc-Graw Hill Publishing Company Limited, New Delhi. ISBN 10:0070966176 / ISBN 13: 978007096617

PHYC-113: Quantum Mechanics
(Credits: 04; Contact Hours: 60)
Lectures: 48 Tutorials: 12

Learning Objectives:
- To answer fundamental questions in physics
- To further the ability to design and exploit physical phenomena for applications.

Learning Outcomes of the Course:
- Ability to learn important quantum mechanical concepts such as electronic levels in the hydrogen atoms or the rate at which electrons scatter from a defect
- Applications to typical problems encountered in technology-related applications
- Solving problems concerning real applications, number / concept oriented problems in nuclear physics, spectroscopy, condensed matter physics, semiconductor physics, etc.

Course Contents:

Unit I - Quantum Mechanics in 1-D: Exact Solution of Schrodinger Equation in 1-D - The **Free Particle**: Continuous States; **The Potential Step**: Cases E > Vo and E < Vo [tunneling]; Tunneling effect; **The Potential Barrier** and Well Cases E > Vo and E < Vo [tunneling]; The **Harmonic Oscillator** :

Solution with ladder operator method [Zettili pp 239-248]

Unit II - Quantum Mechanics in 3-D : Angular Momentum : Physical Symmetries and Conservation Laws: Introduction Rotation Symmetry and Angular Momentum (Qualitative description) Orbital Angular Momentum L Commutator algebra of $\boldsymbol{L}$ and $\boldsymbol{p}$, $\boldsymbol{L}$ and $\boldsymbol{r}$, L^2 and r^2; Eigen values and Eigenfunctions; Spin Angular Momentum: Stern Gerlach experiment General angular momentum: definition of $\boldsymbol{J}$, commutator of $\boldsymbol{J}$ and components of $\boldsymbol{J}$, ladder operators J_+ and J_-, commutators of ladder operators, ladder operator with J and J_z, eigen values of J_+, J_-, J^2, components of $\boldsymbol{J}$;

Unit III- Approximation methods: (a) The WKB approximation. Application to bound states connecting formulae Bohr Sommerfield Quantization rules, WKB application to transmission problem, (b) Variational method: Particle in a box, harmonic oscillator, H2+ ion; (c) Time independent Perturbation theory, non-degenerate and degenerate cases; (d) Time dependent perturbation theory, Fermi's rule, Harmonic perturbation

Unit IV- Scattering Theory: Introduction , Scattering Amplitude and Differential and Total Cross Sections, Method for determination of differential scattering cross section: (a) Partial Wave Analysis (no detailed derivation expected; only problems based on end formula are to be taught); (b) The Born Approximation: The First Born Approximation (derivation from Liboff p 623 and problems), Validity of the First Born Approximation

References:

(1) Quantum Mechanics : Concepts and Applications, Nouredine Zettili (ISBN 978-0-47002678-6 ISBN 978-0-470-02679-3 John Wiley & Sons 2009)
(2) Introductory Quantum Mechanics, Richard L Liboff, (Addison-Wesley Pub Co., 1980 ISBN 0-201-12221-9 ABCDEFGHIJ-HA-8987).

PHYC-114: Statistical Mechanics

(Credits: 04; Contact Hours: 60)

Lectures: 48; Tutorials: 12

Learning Objectives:

- To explain various properties of matter in both equilibrium with environment and in nonequilibrium
- To understand behaviour of collection of quantum particles

Learning Outcomes:

- Applications to various modern discoveries such as Ohm's law, quantum Hall effect, Bose Einstein condensates
- In depth knowledge of the fundamental idea behind various phenomena in condensed matter physics
- Solution of numerical problems to help in various exams like JEST, GATE, etc.

Course Contents:

Unit I : Ideal Fermi-Dirac Gas: Fermi-Dirac distribution, Degeneracy, Electrons in metals, Thermionic emission, Magnetic susceptibility of free electrons (Pauli paramagnetism)

Unit II : Ideal Bose systems: Photons, Phonons in solids, Bose-Einstein Condensation Liquid He, Tisza 2-fluid model, Landau theory, superfluidity, Superconductivity

Unit III: Semiconductor Statistics: Statistical equilibrium of free electrons in semiconductors, Non-degenerate case, Impurity semiconductors, Degenerate Semiconductors, Occupation of donor levels, Electrostatic property of P-N junction

Unit IV: Special Topics in Statistical Mechanics: Non-Equilibrium States: Boltzmann transport equation, Particle diffusion, Electrical conductivity, Isothermal Hall effect, Quantum Hall effect; The 1-D Ising model

References

(1) Statistical Mechanics, Kerson Huang (ISBN 0-471-8158-7, John Wiley & Sons (1987)

(2) Statistical Mechanics, B K Agarwal and Melvin Eisner (ISBN 9788122433548, New Age International (p) Ltd 2013)

(3) Statistical Mechanics, B B Laud (ISBN-10: 8122432786 ISBN-13: 978- 8122432787 ASIN: B0075MAT4S, New Age International Publishers Ltd.-New Delhi 2012)

PHYF-115: Research Methodology

(Credits: 02; Contact Hours: 30)

Learning Objectives:

1. to define research and describe the research process and research methods
2. to understand qualitative research and methods used to execute and validate qualitative research
3. to know how to apply the basic aspects of the research process in order to plan and execute a research project.
4. to provide insight into the processes that lead to the publishing of research.
5. to be able to present, review and publish scientific articles

Learning Outcomes:

1. Students will be able to -

   a) understand and explain research process
   b) do systematic literature survey, formulation of a research topic, study design, analysis and interpretation of data.
   c) to design a research approach for a specific research issue of their choice.

d) select a suitable analytical method for a specific research approach.
e) demonstrate a good understanding of how to write a research report.
f) critically assess published quantitative research with regard to the statistical methods and approaches adopted
g) create a research document for implementation research project

Course Contents:

Unit I : Research Fundamentals:

Introduction: Definition, objectives of the research, characteristics of the research, what makes people to do research, importance of research,

Unit II : Identification of Research Problem :

Defining the research problem: Identification of research problems, selection of research problem, facts one should know regarding selection of research problem, the process of research problem definition, some facts involved in defining research problem, Case Studies.

Unit III : Formulation of Research Problem :

Formulation of the problems: steps involved in defining a problem, formulation of the problems, Formulation of hypothesis: Concept of hypothesis, hypothesis testing, Developing the research plan: implementation, interpreting and reporting the findings, Importance of hypothesis in decision making, Case Studies.

Unit IV: Research Report and Proposal Writing:

Introduction, research proposal writing: costing, the research proposal, rationale for the study, research objectives, research methodology, target respondents, research Centres, sample size and sample composition, sampling procedures, research project execution, research units; An insight into research report and proposal, research project synopsis, research report writing : types of research reports, guidelines for writing reports; Steps in writing report, report presentation, typing the report, documentation and bibliography, formatting guidelines for writing a good research report / research paper, Case Studies.

References:

1. Research Methodology by Dr. S. L. Gupta, Hitesh Gupta; International Book House Pvt Ltd (**2013),** ISBN-10: 8191064278, ISBN-13: 978-8191064278
2. Basic Research Methods-Gerard Guthrie SAGE Publications, India, Pvt Ltd, New Delhi (**2010),** ISBN-10: 8132104579, ISBN-13: 978-8132104575
3. Research Methodology-methods and techniques By C. R. Kothari, New Age International Publishers **(2011)** ISBN 978-81-224-1522-3
4. Principles of Research Methodology- Phyllis G. Supino, Jeffrey S. Borer; Springer, Verlag New York **(2012),** ISBN-ebook: 1461433592, ISBN (Hardcover): 9781461433590
5. Research Design Qualitative, Quantitative. and Mixed Methods Approaches- John W. Creswell; SAGE Publications Ltd, UK **(2011),** ISBN-9780857023452

6. Research Methodology -A Step-by-Step Guide for Beginners- Ranjit Kumar; Sage Publications Ltd**(2010)**, ISBN- 1849203016.
7. Scientific Writing and Communication- Angelika Hofmann; Oxford University Press, US **(2010),** ISBN-13-: 978-0 199947560, ISBN-10: 01 99947562
8. Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded- Joshua Schimel, Oxford University Press, **(2011)**, ISBN: 9780199760237
9. Handbook of Scientific Proposal Writing- A.YavuzOruc; CRC Press, Taylor &Francis group **(2011)**, ISBN: 9781439869185.

IC-01: Constitution India ((Credits: 02; Contact Hours: 30)

This course will be taught at common level. University will arrange teaching classes for this course.

PHYL-121: Lab course 1 (General Physics) Credits 02

Learning Objectives:

- To have hands on training on measurements of fundamental constants in physics as well as computational physics.
- To gain knowledge about usage of units and dimensions, concepts in quantum mechanics, statistical mechanics and electrodynamics.
- To understand computational methods and their applications to quantum mechanic
- To understand how to solve Schrodinger equation,

Learning Outcomes:

- To help a student in designing an experiment for measurements of desirables
- To gain knowledge in understanding various concepts in physics.

(General Physics) Course content:

(1) Determination of specific charge (e/m) of an electron by Thomson method

(2) Study of black body radiation and determination of the Planck constant h

(3) Verification of Bohr's theory using Franck Hertz apparatus

(4) Study of Boltzmann statistics and determination of Boltzmann constant kB

(5) Determination of thickness of a given thin wire using LASER

(6) Determination of wavelength of a given source using Michelson's interferometer

(7) Determination of compressibility of a given liquid using Raman Nath experiment

(8) Determination of spin on an electron using Stern Gerlach experiment

(9) Study of the x-ray telexometer

(10) Determination of thermionic work function of filament material

(11) Determination of charge on an electron by Millikan's oil drop method

(12) Calibration of Platinum resistance thermometer as a function of temperature and to determine unknown temperature.

(13) Determination of temperature of flame by sodium line reversal method.

(14) h/e of electron by photocell.

A student is expected to perform at least 8 experiments in each of the courses.

PHYL-122

Lab Course 2 (Computational Physics based on PHYC -111, 112, 113 and 114)

Credits 02 (This course is based on computation using MS-EXCEL)

Course content:

(1) Determine the roots of given equation/expression

(2) Evaluation of given integrals using Simpson's 1/3 rule

(3) Solution of Schrodinger equation for square / harmonic oscillator potential

(4) Solution of Schrodinger equation for triangular potential

(5) Plotting the hydrogen atom ground state 1s and 2s wave functions

(6) Determination of normalization constant for 1s wave function of hydrogen atom

(7) Plotting the hydrogen atom ground state 2p wave function

(8) Study of Gaussian Type Orbitals (GTOs) and Slater Type Orbitals (STOs)

(9) Comparison of Gaussian Type Orbitals (GTOs) with Slater Type Orbitals (STOs)

(10) Stefan's constant-black body radiation

(11) Study of variation of thermo e.m.f. as a function of temperature

(12) Study of energy bad gap of a semiconductor

(13) Determination of temperature coefficient of thermistor

A student is expected to perform at least 8 experiments in each of the courses.

Semester - II

PHYF-211: Foundation Course in Electronics

(Linear and Digital Electronics)

(Credits: 04; Contact Hours: 60)

Lectures: 48; Tutorials: 12

Course Objectives:

1 ■ To establishes the general method for analyzing and predicting the performance of operational amplifiers and related circuits.

2 ■ To develop the students for designing realistic circuits to perform specified operations.

3 ■ To enable the students to select available devices for intended operations.

Course Outcomes (COs)

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

CO-1 Discuss the general properties of an operational amplifier.

CO-2 Define the terms, input impedance, output impedance , bandwidth, input offset voltage , input offset current , CMRR, open loop voltage and slew rate.

CO-3 Design an inverting and non inverting amplifier circuit or its special cases to meet the requirement.

CO-4 Analyze or design op-amp for the intended operations:
Astable Multivibrator, Monostable Multivibrator, Wien bridge Oscillator and some related circuits.

CO-5 Explain gates, its related circuits, truth table and its realization.

CO-6 Analyze or designing of combinational and sequential circuits.

Course content:

Unit I: Operational amplifier: (12 Contact Hours)
Symbol and terminals, the ideal op-amp, the practical op-amp. Operational amplifier parameters: Input offset voltage, Input offset current, Input bias current, Input impedance, Output impedance, Open loop voltage gain, Common - Mode rejection ratio, Slew rate. Inverting, non - inverting amplifier.

Unit II: Applications of Operational Amplifier and Timing Circuits: (12 Contact Hours)
Adder, Subtractor, Integrator, differentiator, Comparator & Schmitt's trigger; Wave form generators: Astable Multivibrator, Monostable Multivibrator, and Wien Bridge Oscillator. Integrated circuit timer: Block diagram of IC - 555, Monostable, Astable Multivibrator using IC555.

Unit III: Numbers systems, Codes and Combinational Logic: (12 Contact Hours)
Decimal, Binary, & Hexadecimal numbers systems, and its arithmetic's. BCD code. AND, OR, NOT operations, NAND and NOR operations, NAND and NOR as building blocks, Exclusive - OR operation. Boolean algebra, Standard Representation for Logical Functions, Half & Full adder, Parallel 4-bit adder, encoder (decimal to binary), Decoder (Decimal to BCD), BCD to seven segment decoder, Multiplexer: (4:1) and (8:1), Demultiplexer: (1:8) and (1:16) and their applications.

Unit IV: Sequential Logic: (12 Contact Hours)
Flip-Flops: S-R, D- type, T-type, J-K and J-K master-slave. Shift registers: Serial in Serial out, Serial in parallel out, Parallel in Parallel out, Parallel in Serial out. Ripple counters: Mod-16, Mod - 12 and Mod- 10. Synchronous counters: Mod-8 and Mod-16.
Unit V: Tutorials, assignments and seminar presentations based on unit I, II, III and IV **(12 Contact Hours)**

Text Books, Reference books and Websites

1. Operational amplifier with Linear integrated circuits, by William D Staney Fourth Edition, LPE PEARSON Education, 2004, ISBN 81-297-0463-3.
2. Op-Amp and Linear Integrated Circuits, R. A. Gaikwad 4th. Ed, Prentice Hall of India, 2002, ISBN 81 -203-2058-1.
3. Operational amplifier & Linear integrated circuits, 6/e Robert F. Coughlin, Frederick F. Driscoll Modern Digital Electronics , by R P Jain, 3rd Edition, Tata McGraw - Hill Publishing Company Ltd. 2003, ISBN 0-07-049492-4.
4. Digital Electronics, Second Edition, Tokheim, 1985, ISBN 0-07-064980-4.
5. Principles of Electronics, V. K. Metha , Rohit Mehta, S. Chand and Company Ltd. 2012, ISBN: 81-219-2450-2.
6. Digital Fundamentals, by Thomas L Floyd, 2nd Edition Charles E. Merrill Publishing Company.
7. Electronic Devices, by Thomas L Floyd, Charles E. Merrill Publishing company

PHYF-212: Foundation Course in Spectroscopy

(Atomic and Molecular Physics)

(Credits: 04; Contact Hours: 60)

Lectures: 48; Tutorials:12

Course Objectives: The themes dealt with in this paper:

1 > The atom, the nucleus, the electron and the photon - four necessary steps for the development of quantum physics

2 > The structure of the atom. Atoms in electric and magnetic fields. Fine and hyperfine structure. X-ray spectroscopy. Molecular structure

3 > Rotation-, vibration- and electronic spectra. Chemical bonds. Optical spectroscopy.

4 > Applying laser spectroscopic methods as well as other modern tools in atomic and molecular physics, special efforts will be made in laboratory work.

Course Outcomes (COs): The present unit attempts to achieve the following learning outcomes: **At the end of the course the student should be able to;**

CO-1 The course is a continuation of the Atomic and Molecular Physics course.

CO-2Introductory Atomic- and Molecular Physics will be discussed more in detail.

CO-3 A big part of the course will give a view of the modern experimental tools of Atomic- and Molecular Physics job prospects.

Learning objectives:

> The atom, the nucleus, the electron and the photon - four necessary steps for the development of quantum physics.

> The structure of the atom. Atoms in electric and magnetic fields. Fine and hyperfine structure. X-ray spectroscopy. Molecular structure. Rotation-, vibration- and electronic spectra.

> Chemical bonds. Optical spectroscopy. Applying laser spectroscopic methods as well as other modern tools in atomic and molecular physics, special efforts will be made in laboratory work.

Leaning Outcome:

> The course is a continuation of the Atomic and Molecular Physics course.

> Introductory Atomic- and Molecular Physics will be discussed more in detail.

> A big part of the course will give a view of the modern experimental tools of Atomic- and Molecular Physics job prospects.

Course Contents:

Unit I: Introduction

Stern Gerlach experiment, Quantum states of an electron. Quantum numbers. Spectra of Hydrogen atom. Spin angular momentum, orbital angular momentum. Coupling of spin and orbit. Fine structure, spectroscopic terms, selection rules. Spectra of the alkali elements. Interaction energy in L-S and j-j coupling, Hund's rule and term reversal. Zeeman effect in one valence electron atoms, interaction energy, selection rules, Zeeman patterns. Paschen- Back effect, Pauli principle. Hyper fine structure (Qualitative)

Unit II: Rotational spectroscopy:

Classification of molecules, Interaction of radiation with rotating molecule, IR spectra of diatomic molecules, Rigid rotator, energy levels, eigen functions and spectrum of rigid rotator, non-rigid rotator, isotopic substitution, effect of vibration on rotation, Intensities of rotational lines, information derived from rotational spectra..

Unit III: Vibrational spectroscopy:

Vibrational course structure, Deslandres table, Diatomic molecule as a harmonic oscillator, energy levels, eigen functions and spectrum of harmonic oscillator, Morse potential, anharmonic oscillator, vibrating rotator with & without Born Oppenheimer approximation.

Unit IV: Laser Fundamentals:

Masers and lasers, methods of obtaining population inversion, Ammonia maser, Spontaneous and induced emission, Einstein's A and B coefficients, Properties of lasers, Principle & working of He-Ne, Ruby, semiconductor and color center.

References

1. Introduction to Atomic Spectra H. E. White McGraw Hill, First Edition ISBN-10: 0070697205 / ISBN-13: 978-0070697201.
2. Atomic Physics by Christopher J. Foot, Oxford University Press 2005. ISBN 10: 0198506961 / ISBN 13: 9780198506966
3. Fundamentals of Molecular Spectroscopy C.N Banwell & Elaine M. McCash. Tata McGraw Hill. ISBN 10: 0077079760 ISBN 13: 9780077079765
4. Spectra of diatomic molecules G. Herzberg, Krieger Malbar Florida (2015). ISBN 10: 5458354060 ISBN 13: 9785458354066.
5. Molecular structure and spectroscopy by G Aruldhas Prentice Hall of India (2009) ISBN 10: 8120332156 ISBN 13: 9788120332157.
6. Spectroscopy volume 2, Edited by B.P. Straughan and S. Walker, London Chapman and Hall. ISBN 10: 0470150319 ISBN 13: 9780470150313.
7. Laser & Non linear Optics B. B. Laud. Wiley Eastern Limited (2011). ISBN 10: 8122430562 ISBN 13: 9788122430561
8. Laser Spectroscopy, Basic Concepts and Instrumentation by W. Demtroder, Springer. ISBN 10: 0387103430 ISBN 13: 9780387103433

   Physics of atoms and molecules B. H. Bransden and C. J. Joachain Pearson Education. ISBN 10: 0306410494 ISBN 13: 9780306410499

PHYF-213: Foundation Course in Nuclear Physics

(General Nuclear Physics)

(Credits: 04; Contact Hours: 60)

Lectures: 48; Tutorials: 12

Learning Objective: The themes dealt with in this paper:

> This course will introduce students to the fundamentals of General Nuclear Physics.

> It aims to provide a coherent and concise coverage of traditional nuclear physics.

> Important topics of current research interest will be also discussed, such as radioactivity, radiation detector and accelerators which plays an important role in the realization of this course.

> A General Nuclear Physics is a foundation course as it is a preparatory course for university-level art and design education.

Learning Outcomes: The present unit attempts to achieve the following learning outcomes:

- On successful completion of the course, students should be able to illustrate general considerations of Nuclear physics to atomic and nuclear system; make general orders of magnitude of estimation of physical effects.
- Explain how interaction of gamma radiation with matter; the working principle of accelerators and radiation detector.

Pre-requisite - This general nuclear physics is a pre-requisite for certain other courses.

- One can starts an entrepreneurship after the completion of this general nuclear physics foundation course.

Course Contents:

Unit I : General Properties of Nucleus:
Nuclear size and its determination, nuclear radii by electron scattering and mirror nuclei methods. Binding energy, mass defect, Packing fraction. Semi-empirical mass formula and its applications. Quantum numbers of nuclei, nuclear angular momentum, nuclear magnetic dipole moment, electric quadrupole moment.

Unit II : Radioactivity (Natural and Artificial):
The basis of the theory of radioactive disintegration, the disintegration constant, half life and the mean life. Successive radioactive transformation, radioactive equilibrium, the natural radioactive series, units of radioactivity. The discovery of artificial radioactivity, the artificial radio nucleids, electron and positron emission, orbital electron capture, the artificial radio nucleids: alpha emitters.

Unit III : Nuclear Radiation detectors:
Types of detectors, ionization chamber, G.M. Counters, proportional counter, semiconductor

detector, counting errors, counting efficiency, scintillation counter, energy decapitation in phosphor, photoemission from phosphor.

Unit IV : Nuclear Models and Acceleration of Charged particles:
Liquid drop model, single particle levels and magic numbers, evidence of shell effects, Bhor-wheeler theory of fission. Shell model, single particle shell model, deformed nuclei and collective model, nuclear wave function for even-even nuclei, energy spectrum and wave function for odd - A nuclei. Acceleration of Charged particles: Cascade generators, Cockroft and Walton voltage multiplier, Vande Graff machine, tandem accelerators, linear multipole accelerator, wave-guide accelerator, cyclotron.

Books:

1. Introduction to Nuclear Physics; H.A. Enge, Addison- Wesley, 1975.
2. Nuclear Physics; I. Kaplan, 2^{nd} edition, Narosa, 1989.
3. The atomic Nucleus; R.D. Evans, Mc Graw- Hill, New York 1955.
4. Nuclear Physics; R.R. Roy and B.P. Nigam, Wiley - Eastern Ltd, 1983.
5. Basic Nuclear physics; B. N. Shrivastava, Pragati prakashan, Meerut.
6. Theory of Nuclear Structure; M. K. Pal, East - weast press Ltd. 1982.
7. Nuclear Physics; D.C. Tayal, Himalaya Publishing House, Bombay.
8. Experimental Nuclear Physics; E.Serge, John Wiley and sons, New York, 1959.
9. Encyclopaedia of nuclear Physics 3 : M.Chandrabhanu first edition : 2011.
10. Atomic and Nuclear Physics: N Subrahmanyam Brijlal. first edition : 1984.
11.. Atomic and Nuclear Physics : Shatendra Sharma 2008.
12. Nuclear Physics An Introduction: S B Patel 2011.
13. Nuclear Physics : Rajkumar First Edition 2010.
14. Fundamentals of Nuclear Physics : Prof Jahan Singh, Pragati Prakashan First Edition 2012.
15. Radiation Physics For Medical Physicists E.B Podgor Second,Enlarged Edition Springer 2009.
16. Physics and Engineering of Radiation Detection Syed Naeem Ahmed Queen's University, Kingston, Ontario Academic Press Inc. Published by Elsevier First edition 2007
17. Radiation, Ionization, and Detection in Nuclear Medicine: Tapan K.Gupta ISBN978-3-642-34076- 5(eBook) Springer-Verlag Berlin Heidelberg 2013

PHYF-214: Foundation Course in Condensed Matter Physics

(General Condensed Matter Physics)

(Credits: 04; Contact Hours: 60)

Lectures: 48; Tutorials: 12

Learning Objectives: This course deals with crystalline solids and is projected to make available students with the basic physical concept and mathematical tools used to portray solids. The course deals with groups of materials, as in the periodic table, in terms of their structure, electronic, optical, and thermal properties. Specific objectives are: To show how crystal symmetry leads to substantial mathematical simplifications when dealing with solids. To describe basic experimental measurements, to show typical data sets and to compare these with theory.

Learning Outcomes: The field of General Condensed Matter Physics investigates different classes of materials -metals, ceramics, electronic materials with an emphasis on the relationships between the underlying structure and the processing, properties, and performance of the materials. Research opportunities are offered as scientists and technologists, etc in national and international institutions.

Course Contents:

Unit I : Crystal Structure: (13 Contact hours)

Lattice translation vectors and lattices, basis and crystal structure, primitive, non-primitive Wigner- Seiz cells, fundamental types of lattices, 2d & 3d Bravais lattices, characteristics of cubic lattices, miller indices, symmetry elements, point group and space groups, different crystal structures: hexagonal close packed structure, s.c., b.c.c., fc.c, sodium chloride, diamond, Expermental method on the basis of Ewald Construction, Electron and Neutron diffraction by crystals, Atomic and geometric structure factors, Reciprocal lattice and Brillouin Zone.

Unit II : Lattice Dynamic and Specific Heat: (13 Contact hours)

Vibrations of one-dimensional monoatomic lattices: Firs Brillouin zone, Group velocity, long wavelentha and force constant, Diatomic lattices, quantization of lattice vibrations, phonons, inelastic scattering of neutron by phonons, models of Einstein, Debye of lattice heat capacity, comparison with electronic heat capacity, anharmonicity, thermal expansion and thermal conductivity: thermal resistivity, Umklapp processes and problems: zero point lattice, Grunsissen constant, density of modes of square lattice.

Unit III: Free electron model of metals: (11 Contact hours)

Free electron gas in three dimensions, Fermi - Dirac distribution, heat capacity of electron gas, hall effect, Matthiessen rule, fermi surface, de Hass von Alfen effect, magnetoresistance, tight binding method, pseudopotentials.

Unit IV: Energy bands in solids: (11 Contact hours)

Origin of energy band gap, Bloch function, Kronig-Penny Model, number of states in a band, distinction between metals, insulators and semiconductors, concept of holes, equation of motion for electron and holes, effective mass of electron and holes.

References

1. Solid State Physics: An Introduction- Philip Hofmann, 2nd Edition, Willey-VCH (2015) ISBN: 978-3-527-41282-2, E-Book978-3-527-68206-5.
2. Introduction to solid state physics - C. Kittel, Willey Eastern Pvt. Ltd. (2015) ISBN 10: 8126535180 ISBN 13: 9788126535187.
3. Elementary Solid State Physics - M. A. Omar, Addition Wesley Pvt. Ltd. ISBN 10: 0201607336 ISBN 13: 9780201607338.

4. Solid State Physics - A. J. Dekker, Published by Macmillan India (2000) ISBN 10:0333918339/ISBN 13:9780333918333.
5. Solid State Physics - Aschroft and Mermen, New York, Holt, Rinehart and Winston (1976).
6. Introduction to Solids - L. V. Azaroff McGraw Hill, New York (1960)
7. Solid State Physics - S. O. Pillai, New age International Pvt. Ltd (2015). ISBN 10: 8122436978 ISBN 13: 9788122436976.
8. Solid State Physics - M. A. Wahab (2011). ISBN 10: 8184870566 ISBN 13: 9788184870565.
9. Concept in Solid State Physics - J. P. Shrivastava, Prentice Hall Ltd.
10. Fundamentals of Solid State Physics - Saxena, Gupta, Saxena, Pragati Prakashan, Publisher: Anu Books (2019) **ASIN:** B07YCMDBTT.
11. Dynamical stability and low-temperature lattice specific heat of one-dimensional fullerene polymers, Atsushi Shimizu, Shota Ono,Chemical Physics LettersVolume 694, 16 February 2018, Pages 14-17, https://doi.org/10.1016Zi.cplett.2018.01.037.
12. Photoswitching mechanism of a fluorescent protein revealed by time-resolved crystallography and transient absorption spectroscopy,Joyce Woodhouse, Gabriela NassKovacs, Martin Weik, Nature Communications**volume 11**, Article number: 741 (2020).
13. Structural, morphological, physical and dielectric properties of Mn doped ZnOnanocrystals synthesized by sol-gel method,VD Mote, Y Purushotham, **BN Dole**, Materials & Design 96 (2016) 99-105.

PHYL-221 Lab course 3 (Condensed Matter Physics + Nuclear Physics + Spectroscopy) Credits: 02

This course is based on **Foundation Courses: Condensed Matter Physics, Nuclear Physics and Spectroscopy**)

Learning Objectives: The themes dealt with in this paper:

> This course gives basic foundation to specialization in nuclear physics Condensed Matter Physics and Spectroscopy and applications.

> The course is an advanced course and requires special efforts. So, it can be taught in Semester II.

> The course will help the student to explain characteristics of Geiger Muller counter/tube: Operating voltage, Dead time and counting statistics.

> The course is most suitable in IInd semester, because this interpret the contents of the next following course PHYL-321-Lab course 5 (C1) Nuclear Physics to be covered as lab course in IIIrd semester.

Learning Outcomes: The present unit attempts to achieve the following learning outcomes:

- After completing this course the student will be prepare to explain the scope and possibilities of studies in nuclear physics for research career as well as in industry.
- The students able to explain the characteristics of Geiger Muller counter/tube: Operating voltage, Dead time and counting statistics.
- This course is prerequisite to the second lab course as mentioned above for IIIrd semester.

Course Contents:

1. Study of given XRD data for cubic and diamond type materials and determination of lattice parameters.
2. Study of given XRD data for hexagonal type materials and determination of lattice parameters.
3. Determination of characteristics of Geiger Muller counter/tube: Operating voltage and Dead time.
4. Determination of characteristics of Geiger Muller counter/tube: Counting Statistics.
5. Study of variation of resistivity of given specimen using 4-probe method and determination of its energy band gap.

6. Determination of magnetic Susceptibility of diamagnetic/paramagnetic samples using Guoy type balance method and determination of number of unpaired electron.
7. Study of variation of dielectric constant as a function of temperature and verification of the Curie law and determination of the Curie temperature.
8. Determination of magnetogyric ratio of 1H in glycerin sample
9. Continuous wave NMR experiment in rubber and glycerine
10. Continuous wave ESR experiment in TCNQ and DPPH
11. Determination of band structure of given specimen.
12. Study of Hall Effect and determination of type and number of charge carriers, Hall coefficient and drift mobility
13. Study of UV Vis Spectra of II-VI type semiconductors

A student is expected to perform at least 8 experiments.

PHYL-222; Lab course 4 (Electronics + Computational Physics) Credits: 02

This course is based on **Foundation Course: Electronics**. It also contains some experiments based on **Computational Physics**. Students will choose any four experiments from list of experiments below based on Electronics and four experiments from list of experiments below based on computational physics)

Course Contents:

1. Determination of Characteristics of Op -Amp 741: CMRR and Slew rate.
2. Determination of Characteristics of Op -Amp 741: input offset voltage and input bias current.
3. Study of Inverting and non-inverting amplifier using Op-amp 741.
4. Study of Astable multivibrator using Op-amp 741.
5. Op- amp as comparator and Schmitt Trigger using op-amp 741.
6. Study of Wien bridge oscillator using op-amp 741.
7. Study of Monostable multivibrator using IC-555.
8. Study of Decimal to BCD encoder.
9. Study of diode matrix ROM.
10. Study of Mod 16 ripple counter
11. Study of Mod 10 and Mod 12 ripple counter.

A student is expected to perform at least 8 experiments.

PHYR-231: Research Project Part I (Review of literature for Research Project and formulation of Topic of Research Project) : Credits 02

Students are expected to formulate the topic of research project