FYUGP

PHYSICS HONOURS/ RESEARCH
and
MINOR PAPERS FROM DISCIPLINE-1
&
VOCATIONAL STUDIES/ DISCIPLINE-2
&
MDC (MULTIDISCIPLINARY COURSE)

FOR UNDER GRADUATE COURSES UNDER

BINOD BIHARI MAHTO KOYALANCHAL UNIVERSITY, DHANBAD

Implemented from
Academic Session 2024-2028

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Members of Board of Studies of FYUGP Syllabus as per Guidelines of the Binod Bihari Mahto Koyalanchal University, Dhanbad

1. Dr. Rajendra Pratap -Chairman
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2. Dr. Dilip Kumar Giri, -Member
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Two experts for UG

5. Dr. Umamageswari, -Member
   Associate Professor Department of Physics,
   B.S. City College, Bokaro

6. Dr. Sayantan Sil, -Member
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Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits =160]

Level of Courses	**Semester**	**MJ:** Discipline specific courses-Core or Major (80)	**MN:** Minor from discipline (16)	**MN:** Minor from vocational (16)	**MDC:** Multidisciplinary Courses [Life Sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.] (9)	**AEC:** Ability Enhancement Courses (Modern Indian Language and English (8)	**SEC:** Ability Enhancement Courses (9)	**VAC:** Value added Courses (6)	**IAP:** Internship / Dissertation (4)	**RC:** Research Courses (12)	**AMJ:** Advanced Courses in lie of Research (12)	**Credits**	**Double Major (DMJ)**
1	2	3	4	5	6	7	8	9	10	11	12	13	14
100-199: Foundation or Introductory courses	**I**	4	4		3	2	3					**20**	4+4
	II	4+4		4	3	2	3					**20**	4+4
	Exit Point: Undergraduate Certificate provided with Summer Internship/Project (4 credits)												
200-299: Intermediate-level courses	**III**	4+4	4		3	2	3					**20**	
	IV	4+4+4		4		2		2				**20**	4+4
	Exit Point: Undergraduate Diploma Certificate provided with Summer Internship in 1st or 2nd year /Project (4 credits)												
300-399: Higher-level courses	**V**	4+4+4	4						4			**20**	4+4
	VI	4+4+4+4		4								**20**	4+4
	Exit Point: Bachelor's Degree												
400-499: Advanced courses	**VII**	4+4+4+4	4									**20**	4+4
	VIII	4		4						12	4+4+4	**20**	4+4
	Exit Point: Bachelor's Degree with Hons. /Research											**160**	**224**

Note: Honours students not undertaking research will do 3 courses for 12 credits in lieu of a Research project / Dissertation

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SEMESTER WISE COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME **2024 onwards**

Table 2: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		
	Code	Papers	Credits
I	AEC-1	Language and Communication Skills (Modern Indian language including TRL)	2
	VAC-1	Value Added Course-1	4
	SEC-1	Skill Enhancement Course-1	3
	MDC-1	Multi-disciplinary Course-1	3
	MN-1A	Minor from Discipline-1	4
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	4
II	AEC-2	Language and Communication Skills (English)	2
	SEC-2	Skill Enhancement Course-2	3
	MDC-2	Multi-disciplinary Course-2	3
	MN-2A	Minor from Vocational Studies/Discipline-2	4
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	4
III	AEC-3	Language and Communication Skills (Modern Indian language including TRL)	2
	SEC-3	Skill Enhancement Course-3	3
	MDC-3	Multi-disciplinary Course-3	3
	MN-1B	Minor from Discipline-1	4
	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	4
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	4
IV	AEC-3	Language and Communication Skills (MIL-2/English-2)	2
	VAC-2	Value Added Course-2	2
	MN-2B	Minor from Vocational Studies/Discipline-2	4
	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	4
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	4
	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	4
V	MN-1C	Minor from Discipline-1	4
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	4
	MJ-10	Major paper 10 (Disciplinary/Interdisciplinary Major)	4
	MJ-11	Major Paper 11 (Disciplinary/Interdisciplinary Major)	4
	IAP	Internship/Apprenticeship/ Field work / Dissertation/ Project	4
VI	MN-2C	Minor from Vocational Studies/Discipline-2	4
	MJ-12	Major paper 12 (Disciplinary/Interdisciplinary Major)	4
	MJ-13	Major paper 13 (Disciplinary/Interdisciplinary Major)	4
	MJ-14	Major Paper 14 (Disciplinary/Interdisciplinary Major)	4
	MJ-15	Major Paper 15 (Disciplinary/Interdisciplinary Major)	4
VII	MN-1D	Minor from Discipline-1	4
	MJ-16	Major paper 16 (Disciplinary/Interdisciplinary Major)	4
	MJ-17	Major paper 17 (Disciplinary/Interdisciplinary Major)	4
	MJ-18	Major Paper 18 (Disciplinary/Interdisciplinary Major)	4
	MJ-19	Major Paper 19 (Disciplinary/Interdisciplinary Major)	4
VIII	MN-2D	Minor from Vocational Studies/Discipline-2	4
	MJ-20	Major paper 20 (Disciplinary/Interdisciplinary Major)	4
	RC/ AMJ-1 AMJ-2 AMJ-3	Research Internship/ Field work/ Dissertation Advanced Major Paper-1 (Disciplinary/Interdisciplinary Major) Advanced Major Paper-2 (Disciplinary/Interdisciplinary Major) Advanced Major Paper-3 (Disciplinary/Interdisciplinary Major)	12/ 4 4 4
		Total Credits	**160**

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Abbreviations:

AEC	Ability Enhancement Courses
SEC	Skill Enhancement Courses
IAP	Internship/Apprenticeship/ Project
MDC	Multidisciplinary Courses
MJ	Major Disciplinary/Interdisciplinary Courses
DMJ	Double Major Disciplinary/Interdisciplinary Courses
AMJ	Advance Major Disciplinary/Interdisciplinary Courses
MN	Minor Disciplinary/Interdisciplinary Courses
RC	Research Courses

AEC (Ability enhancements courses)- 2 Credits

- *Full marks – 50, Pass Marks – 20*
- *In AEC the students of all faculties will have to select either Hindi or English in Semester -1 and those students who have opted Hindi will have to select English as AEC in Semester -2 and vice versa. For 3rd and 4th semester student can opt Sanskrit, Urdu, Bengali, English, Hindi or TRL.*
- *In 4th semester there will be AEC-3 will include Language and Communication Skill in Hindi and English.*
- *No internal examination will be conducted.*

VAC (Value added Courses)- 2 Credits

- *Full marks – 50, Pass Marks – 20*
- *For 1st semester – "Understanding India"*
- *For 4th Semester – "Environmental Studies"*
- *No internal examination will be conducted.*

SEC (Skill Enhancement Courses) – 3 Credits

- *Full Marks – 75, Pass Marks – 30*
- *Digital Education or Mathematical & Computational Thinking Analysis is selected as SEC. Student will have to select or opt either of the two subjects for semester – I, II and III in no case both subjects will be allowed to opt.*
- *No internal examination will be conducted.*

MDC (Multidisciplinary Courses) – 3 credits

- *Full Marks – 75, Pass Marks – 30*
- *A student will study three different subjects in the multidisciplinary courses during first three semesters.*
- *No internal examination will be conducted.*

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Table3: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers from Discipline-1:

S.N.	Semester	Paper	Credits	Full Marks		Pass Marks	
				Theory (Internal+ End Sem)	Practical End Sem.	Theory (Internal+ End Sem	Practical
1.	I	MN-1A	3+1	15+60	25	30	10
2.	III	MN-1B	3+1	15+60	25	30	10
3.	V	MN-1C	3+1	15+60	25	30	10
4.	VII	MN-1D	3+1	15+60	25	30	10

- *No internal or mid semester examination will be conducted for practical papers.*

Table 4: Semester wise Course Code and Credit Points and Marks distribution of Minor Papers from Vocational Studies/Discipline-2:

S.N.	Semester	Paper	Credits	Full Marks		Pass Marks	
				Theory (Written test)	Practical/ Demonstration/ Skill test & Viva voce	Theory	Practical/ Demonstration/ Skill test & Viva voce
1.	II	MN-2A	4	75	25	30	10
2.	IV	MN-2B	4	75	25	30	10
3.	VI	MN-2C	4	75	25	30	10
4.	VIII	MN-2D	4	75	25	30	10

- *No internal or mid semester examination will be conducted.*

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SEMESTER WISE COURSES IN PHYSICS FOR FYUGP **2024 onwards**

Table 5: Semester wise Papers and Examination Structure for Physics Major:

Semester	Physics Major		Examination Structure				Pass Marks		
	Code	Papers	Credits	Internal (Mid Semester) Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical (F.M.)	Internal Theory (Mid Sem.)	End Sem. Theory	End sem. Practical
I	MJ-1: Theory	Mathematical Physics-I	4	25	75		10	30	-
II	MJ-2: Theory	Mechanics & Waves	4	25	75		10	30	-
	MJ-3: Practical-I	Practical	4			100	-	-	40
III	MJ-4: Theory	Electricity & Magnetism	4	25	75		10	30	-
	MJ-5: Practical-II	Practical	4			100	-	-	40
IV	MJ-6: Theory	Optics and Electromagnetic Theory	4	25	75		10	30	-
	MJ-7: Theory	Mathematical Physics-II	4	25	75		10	30	-
	MJ-8: Practical-III	Practical	4			100	-	-	40
V	MJ-9: Theory	Thermal Physics and Statistical Mechanics	4	25	75		10	30	-
	MJ-10: Theory	Analog and Digital Electronics	4	25	75		10	30	-
	MJ-11: Practical-IV	Practical	4			100	-	-	40
VI	MJ-12: Theory	Advanced Mathematical Physics	4	25	75		10	30	-
	MJ-13: Theory	Elements of Modern Physics	4	25	75		10	30	-
	MJ-14: Theory	Quantum Mechanics and Applications	4	25	75		10	30	-
	MJ-15: Practical-V	Practical	4			100	-	-	40
VII	MJ-16: Theory	Classical Dynamics	4	25	75		10	30	-
	MJ-17: Theory	Solid State Physics	4	25	75		10	30	-
	MJ-18: Theory	Nuclear and Particle Physics	4	25	75		10	30	-
	MJ-19: Practical-VI	Practical	4			100	-	-	40
VIII	MJ-20: Theory	Atomic and Molecular Physics (Quantum Approach) and Laser Physics	4	25	75		10	30	-
	AMJ-1: Theory	Advanced Quantum Mechanics	4	25	75		10	30	-
	AMJ-2: Theory	Advanced Theoretical Physics (Electrodynamics, Statistical Mechanics, Condensed Matter Physics & Nuclear and Particle Physics)	4	25	75		10	30	-
	AMJ-3: Practical	Practical	4			100	-	-	40

- *No internal or mid semester examination will be conducted for practical papers.*

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Table 6: Semester wise Papers and Examination Structure for Physics Minor from Discipline-1:

Semester	Code	Minor Papers	Credits	Full Marks		Pass Marks	
				Theory (Internal+ End Sem)	Practical End Sem.	Theory (Internal+ End Sem	Practical End Sem
I	MN-1A	Mechanics	3+1	15+60	25	30	10
III	MN-1B	Electricity & Magnetism	3+1	15+60	25	30	10
V	MN-1C	Thermal Physics and Statistical Mechanics	3+1	15+60	25	30	10
VII	MN-1D	Waves & Optics	3+1	15+60	25	30	10

Table 7: Semester wise Papers and Examination Structure for Physics Minor from Vocational Studies/Discipline-2:

Semester	Code	Minor Papers	Credits	Full Marks		Pass Marks	
				Theory (Written test)	Practical/ Demonstration / Skill test & Viva voce	Theory	Practical/ Demonstration / Skill test & Viva voce
II	MN-2A	Energy Sources	4	75	25	30	10
IV	MN-2B	Basic Instrumentation Skills	4	75	25	30	10
VI	MN-2C	Optical Instruments	4	75	25	30	10
VIII	MN-2D	Digital Systems	4	75	25	30	10

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MAJOR PAPERS

SEMESTER I

PHYSICS MJ 1 THEORY: MATHEMATICAL PHYSICS-I

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, Pass Marks = 30
Semester Internal Examination=20, Class Performance & Attendance =05), Pass Marks=10

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):
There will be ***two*** *groups of questions.* ***Group A is compulsory*** *which will contain two questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):
There will be ***two*** *group of questions.* ***Group A is compulsory*** *which will contain three questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 & 3 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *six questions of fifteen marks each, out of which any four are to answer.*
Note: *There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- The emphasis of course is to equip students with the mathematical tools required in solving problem of interest to physicists.
- To expose students to fundamental computational physics skills and hence enable them to solve a wide range of physics problems.
- To help students develop critical skills and knowledge that will prepare them not only for doing fundamental and applied research but also prepare them for a wide variety of careers.

COURSE LEARNING OUTCOMES

- Revise the knowledge of calculus, vectors and vector calculus. These basic mathematical structures are essential in solving problems in various branches of Physics as well as in engineering.
- Draw and interpret graphs of various functions.
- Solve first order differential equations and apply it to physics problems solve linear second order homogeneous and non-homogeneous differential equations with constant coefficients.
- Calculate partial derivatives of function of several variables Understand the concept of gradient of scalar field and divergence and curl of vector fields.
- Perform line, surface and volume integration and apply Green's, Stokes' and Gauss's Theorems to compute these integrals.
- Apply curvilinear coordinates to problems with spherical and cylindrical symmetries.
- Understand Dirac-delta function and its properties.
- Revise the knowledge of calculus, vectors, vector calculus, probability and probability distributions. These basic mathematical structures are essential in solving problems in various branches of Physics as well as in engineering.

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SKILLS TO BE LEARNED

- Training in calculus will prepare the student to solve various mathematical problems.
- He / she shall develop an understanding of how to formulate a physics problem and solve given mathematical equation risen out of it.

COURSE CONTENT

Differential Equations: First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. **(9 Lectures)**

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. **(8 Lectures)**

Vector Calculus: Scalar and Vector fields. Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(13 Lectures)**

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications. **(12 Lectures)**

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(8 Lectures)**

Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. **(6 Lectures)**

Introduction to probability: Independent random variables: Probability distribution functions; binomial, Gaussian, andPoisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing. **(4 Lectures)**

Reference Books:

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn. Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book.
6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
7. Mathematical Physics, Goswami, 1st edition, Cengage Learning.
8. Engineering Mathematics, S. Pal and S.C. Bhunia, 2015, Oxford University Press.
9. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
10. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press.
11. Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.
12. Mathematical Physics, B.S. Rajput, Pragati Prakashan, 21st Edition, 2009.
13. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
14. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

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SEMESTER II

PHYSICS-MJ 2 THEORY: MECHANICS & WAVES

Credits: 04 Lectures: 60

**Marks: 100 (End Semester Examination=75, Pass Marks = 30
Semester Internal Examination=20, Class Performance & Attendance =05), Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- The emphasis of this course is to enhance the understanding of the basics of mechanics.
- This course also includes the ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves and also acoustics of buildings, growth and decay of sound.
- By the end this course, students should be able to solve the seen or unseen problems/numericals in mechanics and waves and also have an in depth understanding of mechanics, wave phenomena and acoustics.

COURSE LEARNING OUTCOME

After going through the course, the student should be able to

- Understand the phenomena of collisions and idea about centre of mass and laboratory frames and their correlation.
- Understand the principles of elasticity through the study of Young Modulus and modulus of rigidity.
- Understand simple principles of fluid flow and the equations governing fluid dynamics.
- Apply Kepler's law to describe the motion of planets and satellite in circular orbit, through the study of law of Gravitation.
- Explain the phenomena of simple harmonic motion and the properties of systemsexecuting such motions.
- Describe how fictitious forces arise in a non-inertial frame, e.g., why a person sitting ina merry-go-round experiences an outward pull.
- Recognize and use a mathematical oscillator equation and wave equation, and derive these equations for certain systems.

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- Understand the principle of superposition of waves, so thus describe the formation ofstanding waves.
- Explain several phenomena we can observe in everyday life that can be explained aswave phenomena.
- Use the principles of wave motion and superposition of waves.
- Recapitulate and learn the special theory of relativity- postulates of the special theory ofrelativity, Lorentz transformations on space-time and other four vectors, four-vector notations, space-time invariant length, length contraction, time dilation, mass-energy relation, Doppler effect, light cone and its significance, problems involving energy- momentum conservations.

SKILLS TO BE LEARNED

- Learn the concepts of elasticity of solids and viscosity of fluids.
- Develop skills to understand and solve the equations of Newtonian gravity and centralforce problem.
- Learn about inertial and non-inertial systems.
- Acquire basic knowledge of oscillation.
- Learn about superposition of two Collinear Harmonic Oscillations.
- Superposition of two Perpendicular Harmonic Oscillations.
- Lear about Wave Motion in general.
- Learn about Velocity of Waves.
- Learn about acoustics of buildings, growth and decay of sound.
- Acquire knowledge of Superposition of Two Harmonics Waves.
- Develop the basic concepts of special theory of relativity and its applications to dynamical systems of particles.

COURSE CONTENT

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames. **(3 Lectures)**

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire. **(3 Lectures)**

Flexure of Beam: Bending of beam, Cantilever-loaded at one end and loaded at middle **(3 Lectures)**

Surface Tension: Ripples and Gravity waves, Determination of surface tension by Jaeger's and Quincke's methods. Temperature dependance of surface tension. **(5 Lectures)**

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. **(2 Lectures)**

Motion under Central Force: Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). **(4 Lectures)**

Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(6 Lectures)**

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Coriolis force and centrifugal force. Effect of centrifugal force due to rotation of the earth. Coriolis force on a freely falling body. Geographical effects of Coriolis force (qualitative). **(4 Lectures)**

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Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

(4 Lectures)

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

(2 Lectures)

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

(4 Lectures)

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **(3 Lectures)**

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N-Harmonic Waves.

(7 Lectures)

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events, Length contraction, Time dilation. Relativistic transformation of velocity, acceleration, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Mass-less Particles. Mass-energy Equivalence. Relativistic Doppler effect, Relativistic Kinematics (inelastic collisions and Compton effect). Transformation of Energy and Momentum.

(14 Lectures)

Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
7. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
8. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
9. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
10. Relativistic Mechanics, Satya Prakash & K. P. Gupta, Pragati Prakashan, 2019.

Additional Books for Reference

1. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000.
2. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
3. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning.
4. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

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PHYSICS-MJ 3: PRACTICAL-I

Credits: 04 Lectures: 120 (60X2)

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiment	*= 60 marks*
Practical record notebook	*= 20 marks*
Viva-voce	*= 20 marks*

1. To measure the volume of a sphere/cylinder using vernier caliper.
2. To measure the diameter of a thick wire using screw gauge.
3. To determine the Height of a Building using a Sextant.
4. To study the random error in observations.
5. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
7. To determine the Young's Modulus of a Wire by suitable method.
8. To determine the Modulus of Rigidity of a Wire by suitable method.
9. To determine the elastic Constants of a wire by Searle's method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater's Pendulum.
12. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2–T law.
13. To study Lissajous Figures.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
4. Engineering Practical Physics, S. Panigrahi & B. Mallick,2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.
6. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
7. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.

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SEMESTER III

PHYSICS-MJ 4 THEORY: ELECTRICITY & MAGNETISM

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30**
Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for
Semester Internal Examination (SIE 25 marks) (20+05):
*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which **any one** to answer.*

End Semester Examination (ESE 75 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- The course covers static and dynamic electric and magnetic field,
- It also includes analysis of electrical circuits and introduction of network theorems.
- By the end of the course student should be able to have an in depth understanding of electric field and electric potential, dielectric properties of matter, growth and decay of current, magnetic properties of matter analyse electrical circuits using network theorems.
- Also, students should learn about the basics of Ballistic galvanometer.

COURSE LEARNING OUTCOME

After going through the course, the student should be able to

- Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems ofpoint charges as well as line, surface, and volume distributions of charges.
- Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electricpotential, electric potential energy) formalisms of electrostatics.
- Apply Gauss's law of electrostatics to solve a variety of problems.
- Articulate knowledge of electric current, resistance and capacitance in terms of electricfield and electric potential.
- Demonstrate a working understanding of capacitors.
- Describe the magnetic field produced by magnetic dipoles and electric currents.
- Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electricand magnetic fields.
- Understand the dielectric properties, magnetic properties of materials and thephenomena of electromagnetic induction.
- Describe how magnetism is produced and list examples where its effects are observed.
- Apply Kirchhoff's rules to analyse AC circuits consisting of parallel and/or series combinations of

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SEMESTER IV

PHYSICS-MJ 6 THEORY: OPTICS AND ELECTROMAGNETIC THEORY

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30** Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

Note: *There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- The physics and mathematics of wave motion underlie many important phenomena. Light too, often displays properties that are wave-like. There are a number of phenomena in which light behaves as waves and displays wave properties such as interference, diffraction, and polarization with emphasis of examples as seen in daily life.
- The course provides an in depth understanding of wave phenomena of light, namely, interference and diffraction with emphasis on practical applications of the same.
- The course also deals with electromagnetic theory covering Maxwell's equations, propagation of electromagnetic waves in different homogeneous-isotropic as well as anisotropic unbounded and bounded media, production and detection of different types of polarized E. M. waves.

COURSE LEARNING OUTCOME

After going through the course, the student should be able to

- Understand Interference as superposition of waves from coherent sources derived from same parent source.
- Demonstrate understanding of Interference experiments: Young's Double Slit, Fresnel's biprism, , Newton's Rings.
- Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted from apertures.
- Understand Fraunhofer Diffraction from a slit.
- Achieve an understanding of the Maxwell's equations, role of displacement current, gauge transformations, scalar and vector potentials, Coulomb and Lorentz gauge, boundary conditions at the interface between different media.

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- Apply Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
- Analyse the phenomena of wave propagation in the unbounded and bounded, media.
- Understand the laws of reflection and refraction and to calculate the reflection and transmission coefficients at plane interface in bounded media.
- Understand the linear, circular and elliptical polarisations of e m waves. Production as well as detection of waves in laboratory.
- Understand propagation of e m waves in uniaxial and biaxial crystalsphase retardation plates and their uses.
- Understand the concept of optical rotation, theories of optical rotation and their experimental rotation, calculation of angle rotation and specific rotation.
- Verify the laws of Polarisation for plane polarised light.
- Determine Polarisation of light by Reflection and determine the polarization angle off orair-glass surface.
- Study specific rotation of sugar using Polarimeter.
- Analyse experimentally the Elliptically Polarised light using Babinet's Compensator

SKILLS TO BE LEARNED

- This course in basics of optics and electromagnetic theory will enable the student to understand various optical phenomena, principles, workings and applications optical instruments, propagation of electromagnetic waves through different bound and unbound media.
- He / she shall develop an understanding of Wave Motion and its properties. Comprehend the role of Maxwell's equation in unifying electricity and magnetism.
- Derive expression for Energy density.
- Derive and understand associated with the properties, EM wave passing through the interface between two media like reflection, refraction, transmission.
- Learn the basic physics associated with the polarization of electromagnetic waves by doing various experiments for plane polarized light, circularly polarized light and elliptically polarized light.

COURSE CONTENT

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

(3 Lectures)

Interference: Division of amplitude and wavefront. Interference in Thin Films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

(5 Lectures)

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer and measurement of wavelength.

(5 Lectures)

Fraunhofer diffraction: Single slit. Double slit. Plane transmission grating. Circular aperture and airy pattern, Resolving Power of a telescope. Resolving power of grating.

(6 Lectures)

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. **(5 Lectures)**

Maxwell Equations: Derivation of Maxwell's field equations. Displacement Current. Boundary Conditions at Interface between Different Media.

(4 Lectures)

EM Wave Propagation in Unbounded Media: Propagation of EM waves through vacuum and isotropic

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dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Poynting Theorem and Poynting Vector. **(8 Lectures)**

EM Wave in Bounded Media: Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. **(8 Lectures)**

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Uniaxial and Biaxial Crystals. Double Refraction. Polarization by Double Refraction. Huygen's principle of double refraction. Ordinary & extraordinary refractive indices. Nicol Prism. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light. **(11 Lectures)**

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half shade polarimeter. **(5 Lectures)**

Reference Books:

1. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
2. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
3. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill.
4. Introduction to Geometrical and Physical Optics ,B. K. Mathur, Gopal Printing.
5. A Text Book on Light, B. Ghosh and K. G. Mazumdar, 5thEdn.,Reprint 2015, Sreedhar Publishers.
6. Geometrical and Physical Optics, P. K. Chakraborty, New Central Book Agancy (P) Ltd.
7. A Text Book of Optics, Dr. N. Subrahmanyam, Brijlal, Dr. M. N. Avadhanulu, S. Chand Publishers.
8. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.
9. Classical Electromagnetism, H.C. Verma, Bharati Bhawan (Publishers & Distributors); First Edition, 2022.
10. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
11. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
12. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
13. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill.
14. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning.
15. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer.
16. Electromagnetic Fields & Waves, P. Lorrain & D. Corson, 1970, W .H. Freeman& Co.
17. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
18. Electromagnetic Theory, Chopra and Agarwal, K. Nath& Co., Meerut.
19. Electromagnetic Theory and electrodynamics Satyaprakash, , KedarNath Ram Nath Publishers
20. Electricity and Magnetism, K .K. Tiwari, S Chand Publishers.
21. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press.

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PHYSICS-MJ 7 THEORY: MATHEMATICAL PHYSICS-II

Credits: 04 Lectures: 60

**Marks: 100 (End Semester Examination=75, Pass Marks = 30
Semester Internal Examination=20, Class Performance & Attendance =05), Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):
There will be ***two*** *groups of questions.* ***Group A is compulsory*** *which will contain two questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):
There will be ***two*** *group of questions.* ***Group A is compulsory*** *which will contain three questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 & 3 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *six questions of fifteen marks each, out of which any four are to answer.*
Note: *There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- The emphasis of course is to equip students with the mathematical tools required insolving problem of interest to physicists.
- To expose students to fundamental computational physics skills and hence enable themto solve a wide range of physics problems.
- To help students develop critical skills and knowledge that will prepare them not only for doing fundamental and applied research but also prepare them for a wide variety of careers.
- This course will aim at introducing the concepts of Fourier series, special functions, solving linear partial differential equations by separation of variable method.
- To make students determine continuity, differentiability and analyticity of a complex function and findthe derivative of a function.
- To help students understand properties of elementary complex functions (polynomials, reciprocals,exponential, trigonometric, hyperbolic, etc) of single complex variable.
- To enable students work with multi-valued functions (logarithmic, complex power, inverse trigonometricfunction) and determine branches of these functions
- To evaluate a contour integral using parametrization, fundamental theorem of calculus and Cauchy's integral formula.
- To find the Taylor series of a function and determine its radius of convergence;
- To determine the Laurent series expansion of a function in different regions and find the residues use the residue theory to evaluate a contour integral and real integral.
- To find the Fourier transform and the inverse Fourier transform of a function andunderstand their properties
- To enable students, understand the properties of Laplace transform and inverse Laplace transform and useit to solve boundary value problems.

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COURSE LEARNING OUTCOMES

On successfully completing this course, the students will be able to

- Represent a periodic function by a sum of harmonics using Fourier series and their applications in physical problems such as vibrating strings etc..
- Expand an odd or even function as half range sine and cosine Fourier series.
- Understand properties and applications of special functions like Legendre polynomials, Bessel functions and their differential equations and their applications in various physical problems such as in quantum mechanics.
- Learn about gamma and beta functions and their applications.
- Solve linear partial differential equations of second order with separation of variablemethod.
- Generate and plot Legendre polynomials and Bessel functions and verify their recurrence relations.
- Learn about the complex numbers and their properties, functions of complex numbers and their properties such as analyticity, poles and residues. The students are expected tolearn the residue theorem and its applications in evaluating definite integrals.
- Learn about the Fourier transform, the inverse Fourier transform, their properties and their applications in physical problems. They are also expected to learn the Laplace transform, the inverse Laplace transforms, their properties and their applications in solving physical problems.

SKILLS TO BE LEARNED

- Training in mathematical tools like calculus, integration, series solution approach , special function will prepare the student to solve ODE, PDE's which model physicalphenomena.
- He / she shall develop an understanding of how to model a given physical phenomena such as pendulum motion, rocket motion, stretched string, etc., into set of ODE's, PDE's and solve them.
- These skills will help in understanding the behavior of the modelled system/s.
- Ability to learn mathematic of complex variables and solve simple problems with relative functions, complex integrals and their applications to physical problems.
  Ability to use Fourier transform, the inverse Fourier transform and to apply in physical problems. Also, ability to apply the Laplace transform, the inverse Laplace transforms in solving physical problems.

COURSE CONTENT

Fourier series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Fourier series of square, saw-tooth and triangular waves. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. **(7 Lectures)**

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. **(2 Lectures)**

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations: Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x)) and Orthogonality.

(12 Lectures)

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

(2 Lectures)

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.

(5 Lectures)

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of ComplexVariables. 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.

(12 Lectures)

Integrals Transforms: 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.

(10 Lectures)

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform.

(10 Lectures)

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence,3rd ed., 2006, Cambridge University Press.
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
3. Mathematical Physics with Classical Mechanics, Satya Prakash, Sultan Chand & Sons, 2014, 6th edition.
4. Mathematical Physics, P. K. Chattopadhyay, New Age International Publishers, 2004.
5. Mathematical Physics, B.D. Gupta, Vikash Publishing House, 2010, 4th edition.
6. Fundamental of Mathematical Physics, A. B. Gupta, Books & Allied Ltd, 2012, 5th edition.
7. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
8. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
9. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
10. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
11. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
12. Engineering Mathematics, S. Pal and S.C. Bhunia, 2015, Oxford University Press.
13. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books.
14. Mathematical Physics, Goswami, 1st edition, Cengage Learning.
15. Engineering Mathematics, S. Pal and S.C. Bhunia, 2015, Oxford University Press.

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16. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
17. Mathematical Physics, B.S. Rajput, Pragati Prakashan, 21st Edition, 2009.
18. Mathematical Physics, H.K. Dass and R. Verma, S. Chand & Company.
19. Schaum's Outline of Complex Variables, Murray R. Spiegel, Seymour Lipschutz, John J. Schiller, Dennis Spellman, Second Edtion.
20. Complex Variables, A .S. Fokas & M. J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.
21. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill. 8. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
22. Linear Algebra, W. Cheney, E. W. Cheney & D .R. Kincaid, 2012, Jones & Bartlett Learning.

PHYSICS-MJ 8: Practical-III

Credits: 04 Lectures: 120 (60X2)

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines

Experiment	*= 60 marks*
Practical record notebook	*= 20 marks*
Viva-voce	*= 20 marks*

1. To find the focal length of a convex lens by plotting graphs between u and v or between 1/u and 1/v.
2. To determine refractive index (μ) of the material of given prism by plotting a graph between angle of incidence (i) and angle of deviation (δ).
3. To verify the law of Malus for plane polarized light.
4. To determine the specific rotation of sugar solution using Polarimeter.
5. To analyze elliptically polarized Light by using a Babinet's compensator.
6. Familiarization with: Schuster`s focusing; determination of angle of prism.
7. To determine refractive index of the Material of a prism using sodium source.
8. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
9. To determine wavelength of sodium light using Fresnel Biprism.
10. To determine wavelength of sodium light using Newton's Rings.
11. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
12. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
13. To determine dispersive power and resolving power of a plane diffraction grating.
14. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
15. To study the polarization of light by reflection and determine the polarizing angle for air glass interface.

Reference Books:

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

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2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
5. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
6. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.

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SEMESTER V

PHYSICS-MJ 9 THEORY: THERMAL PHYSICS AND STATISTICAL MECHANICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30** Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

There will be ***two groups of questions. Group A is compulsory*** *which will contain two questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

There will be ***two group of questions. Group A is compulsory*** *which will contain three questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 & 3 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *six questions of fifteen marks each, out of which any four are to answer.*

Note: *There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- This course will introduce Thermodynamics, Kinetic theory of gases and Statistical Mechanics to the students.
- The primary goal is to understand the fundamental laws of thermodynamics and its applications to various thermodynamical systems and processes.
- This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through statistical mechanics.

COURSE LEARNING OUTCOMES

At the end of this course, students will

- Learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- Learn the quantum statistical distributions, viz., the Bose-Einstein statistics and theFermi-Dirac statistics.
- In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature co- efficient of resistance, study variation of thermo emf across two junctions of a thermocouple with temperature etc.

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SKILLS TO BE LEARNED

- In this course the students should be skilled in doing calculations in thermodynamics and in statistical mechanics.
- They should also be proficient in doing calculations with the kinetic theory of ideal andreal gases.
- In the laboratory course, the students should acquire the skills of doing basic experiments in thermal physics with the right theoretical explanations of results therefrom.

COURSE CONTENT

THERMAL PHYSICS

Introduction to Thermodynamics: Zeroth Law and First Law of thermodynamics and its differential form. Internal energy. Reversible and Irreversible process with examples. Inter conversion of Work and Heat. Carnot's Theorem. Heat Engines. Carnot's Cycle, Carnot engine & efficiency, Refrigerator & coefficient of performance.

(4 Lectures)

Entropy: Concept of entropy, Clausius theorem, Clausius inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Entropy Changes in Reversible and Irreversible processes with examples. Principle of Increase of Entropy. Entropy of the Universe. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

(5 Lectures)

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples.

(5 Lectures)

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations (1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3)TdS Equations, (4)Joule-Kelvin coefficient for Ideal and Van der Waal Gases.

(5 Lectures)

KINETIC THEORY OF GASES

Molecular Collisions: Mean Free Path. Collision Probability. Estimation of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

(5 Lectures)

Real Gases: Behaviour of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Critical Constants. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. P-V diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

(8 Lectures)

STATISTICAL MECHANICS

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur-Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature. **(10 Lectures)**

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Inadequacy of classical radiation theory. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

(6 Lectures)

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Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. **(6 Lectures)**

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals. **(6 Lectures)**

Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. Heat and Thermodynamics, P. K. Chakraborty, New Age International Pvt.
3. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press
4. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
5. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
6. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
7. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
8. Advanced Text Book on Heat, P. K. Chakrabarti, 10th Edn., Reprint 2015, Sreedhar Prakashan.
9. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
10. Thermal Physics, B.K. Agrawal, Lok Bharti Publications.
11. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
12. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
13. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
14. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
15. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
16. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.

PHYSICS-MJ 10 THEORY: ANALOG AND DIGITAL ELECTRONICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30**
Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for
Semester Internal Examination (SIE 25 marks) (20+05):
*There will be **two groups of questions. Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):
*There will be **two group of questions. Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- In this paper students will get to learn both about Analog and Digital Electronics.
- They will learn about the physics of semiconductor p-n junction and devices such as rectifier diodes,Zener diode, photodiode etc. and bipolar junction transistors.
- Transistor biasing and stabilization circuits are explained. The concept of feedback is discussed in amplifiers and the oscillator circuits are also studied.
- This paper also introduces the concept of Boolean algebra and the basic digital electronics.
- In this course, students will be able to understand Arithmetic Circuits.

COURSE LEARNING OUTCOMES

At the end of this course, students will be able to develop following learning outcomes:

- To have knowledge about characteristics of semiconductor materials in terms of band structure, movement of charge carriers and to explain properties of n and p type semiconductors.
- To know the basic concepts of p-n junction diode, its fabrication, conduction mechanism and determine its barrier potential and width.
- To learn structure and operation of simple p-n junction devices such as LED, photo diodes, Solar cells, Zener diodes etc.
- To apply the basics of diodes to describe working of rectifier circuits and quantitatively explain effect of capacitance filter, line and load regulation
- n-p-n and p-n-p transistors and basic configurations namely common base, common emitter and common collector, and also about current and voltage gain.
- To understand the structure and operation of Bipolar Junction transistors. Also be able texplain various current components and characteristics of different configurations. And also have a general idea about FET.
- To describe the application of transistors for current and voltage applications, need for biasing and stabilization in transistor amplifiers.
- To analyse single stage CE and two stage RC coupled transistor amplifier using h- parameter model of the transistor.
- To ingest the effect of feedback in amplifiers and apply them to design different type of oscillators.
- Operational amplifiers and knowledge about different configurations namely inverting and noninverting and applications of operational amplifiers in D to A and A to D conversions.
- In the laboratory course, the students will design combinational logic system for a given equation minimizing the logic circuit, Adder, Subtractor,
- Differentiating with the Analog and Digital circuits, the concepts of number systemslike Binary, BCD, Octal and hexadecimal are developed to elaborate and focus on the digitalsystems.
- Explains the concepts of logic states and logic gates AND, OR, NOT, NAND, NOR,XOR and XNOR as fundamental, universal and derived gates with its utility.
- Covers the realisation of NOT, OR and AND gates using diodes and transistors.
- Students learn how to write logical Boolean statements using the truth table, its simplification using Boolean Algebra, De-Morgan's Theorem and Karnaugh Maps specially the Sum of Products method and realise the corresponding logic circuit.
- Understanding the Arithmetic circuits.

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SKILLS TO BE LEARNED

- In this course students should be able to learn basic concepts of semiconductor diodes and their applications to rectifiers.
- Students should also learn about junction transistor and their applications.
- They should also learn about different types of amplifiers.
- Students also learn about sinusoidal oscillators.
- Learn about different types of amplifiers including operational amplifier. (Op-Amp) and their applications.
- Learn the basics of IC and digital circuits, and difference between analog and digitalcircuits. Various logic GATES and their realization using diodes and transmitters.
- Learn fundamental of Boolean algebra and their role in constructing digital circuits.
- Understand basics Arithmetic circuits.

COURSE CONTENT

ANALOG ELECTRONICS

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. **(4 Lectures)**

Two-terminal Devices and their Applications: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, Zener Diode and Voltage Regulation. Principle and structure of LEDs, Photodiode and Solar Cell. **(4 Lectures)**

Bipolar Junction Transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β, Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical mechanism of current flow, Active, Cutoff and Saturation Regions. **(4 Lectures)**

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. **(4 Lectures)**

Coupled Amplifier: Two stage RC-coupled amplifier and its freq. response. **(2 Lectures)**

FET: JFET- Construction, working and characteristics. **(2 Lectures)**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **(2 Lecture)**

Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts's oscillators. **(4 Lectures)**

Operational Amplifiers and Applications: Characteristics of an Ideal and Practical Op- Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Inverting and non-inverting amplifiers, Adder, Subtractor, Differentiator, Integrator, Log amplifier. **(5 Lectures)**

DIGITAL ELECTRONICS

Digital Circuits: Difference between analog and digital circuit, Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates, NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. **(5 Lectures)**

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Boolean algebra: de Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(5 Lectures)**

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **(4 Lectures)**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip- Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. **(5 Lectures)**

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **(3 Lectures)**

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel- in-Parallel-out Shift Registers (only up to 4 bits). **(2 Lectures)**

Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **(3 Lectures)**

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation). **(2 Lectures)**

Reference Books:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. A first Course in Electronics, Khan &Dey, PHI, 1/e, 2006.
3. Basic Electronics, Arun Kumar, Bharati Bhawan, 1/e, 2007.
4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
5. Solid State Electronic Devices, B. G. Streetman & S. K. Banerjee, 6th Edn.,2009, PHI Learning.
6. Electronic Devices & circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill.
7. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
8. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
9. Analog Systems and Applications, Nutan Lata, Pragati Prakashan.
10. Electronic circuits: Handbook of design & applications, U. Tietze, C. Schenk,2008, Springer.
11. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.
12. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning.
13. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.
14. Digital Computer Electronics, Malvino and Brown, 3/e, McGraw Hill Education.
15. Digital Electronics G K Kharate ,2010, Oxford University Press.
16. Digital Systems: Principles & Applications, R. J. Tocci, N. S. Widmer, 2001, PHI Learning.
17. Logic circuit design, Shimon P. Vingron, 2012, Springer.
18. Digital Systems and Applications, Nutan Lata, Pragati Prakashan, 1/e, 2019.
19. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
20. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill.
21. Digital Electronics, Floyd.
22. Digital systems & Applications, Dr Umamageswari and Dr. M. Sivakumar, Vishal Publishing Co., 2022-23.

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PHYSICS-MJ 11: Practical-IV

Credits: 04 Lectures: 120 (60X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines

Experiment	*= 60 marks*
Practical record notebook	*= 20 marks*
Viva-voce	*= 20 marks*

1. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions. (Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like)
5. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.
6. To verify the Stefan`s law of radiation and to determine Stefan's constant.
7. To determine the Boltzmann constant using V-I characteristics of PN junction diode
8. Plot the following functions with energy at different temperatures
    a) Maxwell-Boltzmann distribution
    b) Fermi-Dirac distribution
    c) Bose-Einstein distribution
9. To study V-I characteristics of PN junction diode, and verification of diode equation.
10. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
11. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
12. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
13. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
14. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
15. To design a Wien bridge oscillator for given frequency using an op-amp.
16. To design a phase shift oscillator of given specifications using BJT.
17. To study the characteristics of JFET.
18. To study the Colpitts oscillator.
19. To design a digital to analog converter (DAC) of given specifications.
20. To study the analog to digital convertor (ADC) IC.
21. To design a NOT gate switch using a transistor.
22. To verify and design AND, OR, NOT and XOR gates using NAND gates.
23. Study of Half Adder and Full Adder and 4-bit binary Adder.
24. Study of Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers

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3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
5. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
6. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.
7. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
8. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987.
9. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
10. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
11. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
12. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
13. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
14. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
15. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
16. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.
17. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
18. Electronic Devices & circuit Theory, R.L. Boylestad& L.D. Nashelsky, 2009, Pearson.

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SEMESTER VI

PHYSICS-MJ 12 THEORY: ADVANCED MATHEMATICAL PHYSICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30** Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for
Semester Internal Examination (SIE 25 marks) (20+05):
*There will be **two groups of questions. Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):
*There will be **two group of questions. Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

The course is intended to impart the concept of generalized mathematical constructs in terms of Algebraic Structures (mainly Vector Spaces) and Tensors to have in-depth analysisof our physical system. Also this course enables to understand variational principle and apply it to calculate: Geodesics in two and three dimensions, Euler Lagrange Equation and apply it simple problems in one and two dimensions. Again, to acquire basic concept of Hamiltonian, Hamilton's principle and Hamiltonian equation of motion, Poisson and Lagrange brackets. Learn elementary group theory, i.e., definition and properties of groups, subgroups, Homomorphism, isomorphism, normal and conjugate groups, representation of groups, Reducible and Irreducible groups. Examples and exercises.

COURSE LEARNING OUTCOMES

The students will be able to learn the following from this course:

- Demonstration of Algebraic Structures in n-dimension. Application of Vector Spaces & Matrices in the quantum world.
- Learn the basic properties of the linear vector space such as linear dependence and independence of vectors, change of basis, isomorphism and homomorphism, linear transformations and their representation by matrices.
- Learn the basic properties of matrices, different types of matrices viz., Hermitian, skew Hermitian, orthogonal and unitary matrices and their correspondence to physical quantities, e.g. operators in quantum mechanics. They should also learn how to find the eigenvalues and eigenvectors of matrices.
- Learn some basic properties tensors, their symmetric and antisymmetric nature, the Cartesian tensors, the general tensors, contravariant, covariant and mixed tensors and their transformation properties under coordinate transformations, physical examples of tensors such

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as moment of inertia tensor, energy momentum tensor, stress tensor, strain tensor etc.
- Learn how to express the mathematical equations for the Laws of Physics in their co- variant forms.
- Learn how to express a mathematical equation concerned with an event compatiblewith the physical system.

SKILLS TO BE LEARNED

- In this course, the students should the learn the skills of doing calculations with the linear vector space, matrices, their eigenvalues and eigenvectors, tensors, real and complex fields, linear and multilinear transformations in various physical situations,e.g., the Lorentz transformations etc.
- They also become efficient in doing calculations with the 'calculus of variation'.
- Ability to learn variational principle and do simple application to calculate geodesics inone, two and three dimensions.
- Ability to derive Euler equations of motion and apply it to simple pendulum and harmonic oscillator.
- Learn basics of group theory.

COURSE CONTENT

Linear Vector Spaces: Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices.
(8 Lectures)

Matrices: Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices.Singular and Non-Singular matrices. Orthogonal and Unitary Matrix. Trace of a Matrix. Inner Product. **(6 Lectures)**

Eigen-values and Eigenvectors. Cayley- Hamiliton Theorem. Diagonalization of Matrices. Solution of Coupled Linear Ordinary Differential Equations. Functions of a Matrix
(5 Lectures)

Cartesian Tensors: Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors: Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors: Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry: Equation of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor. Isotropic Tensors. Tensorial Character of Physical Quantities. Moment ofInertia Tensor. Stress and Strain Tensors: Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.
(16 lectures)

General Tensors: Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors.

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Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor. **(7 Lectures)**

Calculus of Variations: Variable Calculus: Variational Principle, Euler's Equation and itsApplication to Simple Problems. Geodesics. Concept of Lagrangian. Generalized co-ordinates. Definition of canonical moment, Euler-Lagrange's Equations of Motion and its Applications to Simple Problems (e.g., Simple Pendulum and One-dimensional harmonic oscillator). Definition of Canonical Momenta. Canonical Pair of Variables. Definition of Generalized Force: Definition of Hamiltonian. Hamilton's Principle. Poisson Brackets and their properties. Lagrange Brackets and their properties. **(10 Lectures)**

Group Theory: Review of sets, Mapping and Binary Operations, Relation, Types of Relations. Groups: Elementary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group, Permutation/Transformation. Homomorphism and Isomorphism of group. Normal and conjugate subgroups, Completeness and Kernel. Some special groups with operators. Matrix Representations: Reducible and Irreducible. Lie groups and Lie algebra with SU (2), O(3) and SU(3) as an example. **(8 Lectures)**

Reference Books:

1. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
3. Mathematical Methods for Physicists and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press.
4. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.
5. Schaum's Outline of Complex Variables, Murray R. Spiegel, Seymour Lipschutz, John J. Schiller, Dennis Spellman, Second Edition.
6. Complex Variables, A. S. Fokas & M. J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press.
7. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill.
8. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
9. Mathematical Physics, B.S. Rajput, Pragati Prakashan, Edition: XXXI, 2019.
10. Mathematical Physics H K Dass, Rama Verma, Revised Edition 2018, S. Chand and Company Limited.
11. Linear Algebra, W. Cheney, E. W. Cheney & D. R. Kincaid, 2012, Jones & Bartlett Learning.
12. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

PHYSICS-MJ 13 THEORY: ELEMENTS OF MODERN PHYSICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30**
Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

*There will be **two groups of questions. Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

This course introduces modern development in Physics that ushered in relativity and quantum physics which not only revolutionized mankind's understanding of time, space, atomic and sub-atomic structures that make up the matter around us, but also ledto fascinating developments in technology that are being witnessed all around us. Beginning with technological marvels like electronics, spectroscopy, semiconductor-based devices, IC chips, lasers, harnessing of nuclear energy, satellite communication, atomic clocks, GPS, space travel, scanning tunnelling microscope, nano-materials, nano- technology, CCDs, etc. modern physics brought forth useful tools in our daily lives like laptop computers, mobile phones, laser pointers, LEDs, LCD screens, so on and so forth. Therefore, the objective of this course is to teach the physical and mathematical foundations necessary for learning various topics in modern physics. Starting from Planck's law, this course introduces experimental observation of photo-ejection of electrons, idea of wave- particle duality as well as Bohr model of atoms and, then it develops the formulation of Schrodinger equation and the idea of probability interpretation associated with wave-

COURSE LEARNING OUTCOMES

The students will be able to learn the following from this course:

- Quantum measurements and the theory of wave packets and uncertainty principle.
- The central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, time dependent and time independent cases, probability density and the normalization techniques, skill development on problem solving e.g. one-dimensional rigid box, tunnelling through potential barrier, step potential, rectangular barrier.
- The properties of nuclei like density, size, binding energy, nuclear forces andstructure of atomic nucleus, liquid drop model and nuclear shell model and mass formula.
- Decay rates and lifetime of radioactive decays like alpha, beta, gamma decay. Neutrino,its properties and its role in theory of beta decay.
- Fission and fusion well as nuclear processes to produce nuclear energy in nuclearreactor and stellar energy in stars.
- Various interactions of electromagnetic radiation with matter. Electron positron paircreation.
- The spontaneous and stimulated emission of radiation, optical pumping and population inversion. Three level and four level lasers. Ruby laser and He-Ne laser in details. Basic lasing.
- In the laboratory course, the students will get opportunity to measure Planck's constant by more than one method, verify photoelectric effect and determination of the work Function of a metal, determine e/m of electron.
- Ionization potential of atoms, wavelength of the emission lines in the spectrum of Hydrogen atom, absorption lines in the rotational spectrum of molecules.
- The wavelength of Laser sources by single and Double slit experiment and the wavelength and angular spread of He-Ne Laser using plane diffraction grating.

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SKILLS TO BE LEARNED

- Comprehend the failure of classical physics and need for quantum physics.
- Grasp the basic foundation of various experiments establishing the quantum physics bydoing the experiments in laboratory and interpreting them.
- Formulate the basic theoretical problems in one-, two- and three-dimensional physics andsolve them.
- Learning to apply the basic skills developed in quantum physics to various problems in
  - Nuclear Physics
  - Atomic Physics
  - Laser Physics
- Learn to apply basic quantum physics to Ruby Laser, He-Ne Laser
- This course shall develop an understanding of how to model a given problem such asparticle in a box, hydrogen atom, hydrogen atom in electric fields.
- These skills will help in understanding the different Quantum Systems in atomic and nuclear physics.

COURSE CONTENT

Quantum theory of Light: Planck's concept of light as a collection of photons; Photo-electric effect and Compton scattering. Wave particle duality, de Broglie wavelength and matter waves; Two-Slit experiment with electrons. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Probability. Wave amplitude and wave functions. Davisson-Germer experiment. Discreteness of energy. Frank-Hertz Experiment. **(14 Lectures)**

Quantum Uncertainty: Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables), gamma ray microscope thought experiment; Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to various physical problems. **(5 Lectures)**

Matter waves and wave amplitude: Postulates of Quantum mechanics, Schrodinger equation for non-relativistic particles; Physical observables as operators, Position, Momentum and Energy operators; stationary states; Physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. **(10 Lectures)**

One dimensional infinitely rigid box: energy eigenvalues and eigenfunctions, normalization; Quantum mechanical scattering and tunnelling in one dimension- across a step potential & rectangular potential barrier. **(10 Lectures)**

Atomic nucleus: General properties of nuclei. Nature of nuclear force, Nuclear radius and its relation with atomic weight. Nucleus as a Liquid drop, Semi-empirical mass formula and its significance. Shell model and magic numbers. **(6 Lectures)**

Radioactivity: Stability of the nucleus; Law of radioactive decay; Mean life and half-life; Successive disintegration; Elementary idea: Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. **(8 Lectures)**

Fission and fusion: Mass deficit and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions). **(3 Lectures)**

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Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Laser system (basic concept). Ruby Laser and He-Ne Laser.

(4 Lectures)

Reference Books:

1. A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill.
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer.
7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press.
8. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
9. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
10. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.
11. Quantum Physics, H. C. Verma, 2018, Surya Publications.
12. Quantum Mechanics, S. N. Biswas, Books & Allied (P) Ltd.
13. Advanced Quantum Mechanics, Satya Prakash, KedarNath Ram Nath Publisher.
14. Schaum's Outline of Modern Physics, McGraw-Hill, 1999.
15. Schaum's Outline of College Physics, by E. Hecht, 11th edition, McGraw Hill, 2009.
16. Modern Physics by K Sivaprasath and R Murugeshan, S Chand Publication, 2010.
17. Quantum Mechanics: 500 problems and solutions by G. Aruldhas. PHI Learning Pvt.Ltd., 2016.
18. Introduction to Quantum Mechanics, Nikhil Ranjan Roy, 2015, Vikas Publishing.
19. Elements of Nuclear Physics, Nikhil Ranjan Roy and Rakesh Kumar Pandey, Atlantic publishers & Distributors (P) Ltd., 2024.
20. An introduction to Lasers Theory and Applications, M N Avadhanulu, P S Hemne, S. Chand Publishing; First edition, 2012.
21. Lasers And Non-Linear Optics, B. B. Laud, New Age International Private Limited,2011.
22. Lasers and Non-linear optics, G. D. Baruah, Pragati Prakashan, 2021.

PHYSICS-MJ 14 THEORY: QUANTUM MECHANICS AND APPLICATIONS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, Pass Marks = 30 **Semester Internal Examination=20, Class Performance & Attendance =05), Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

*There will be **two groups of questions. Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

*There will be **two group of questions. Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

Note: *There may be subdivisions in each question asked in Theory Examinations.*

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COURSE OBJECTIVE

After learning the elements of modern physics, students would be poised to learn more advanced topics like how to solve the Schrodinger equation for spherically symmetric potentials. Then, in this course, eigenvalues and eigen functions of the Hamiltonian as wellas the orbital angular momentum would be studied. Furthermore, application of Schrodinger equation to various quantum mechanical problems would be taken up. The spin angular momentum of electrons would also be introduced in the course.

COURSE LEARNING OUTCOMES

The Students will be able to learn the following from this course:

- Familiarization with quantum mechanics formulation.
- After an exposition of inadequacies of classical mechanics in explaining microscopic phenomena, quantum theory formulation is introduced through Schrodinger equation.
- The interpretation of wave function of quantum particle and probabilistic nature of its location and subtler points of quantum phenomena are exposed to the student.
- Methods to solve time-dependent and time-independent Schrodinger equation
- Through understanding the behavior of quantum particle encountering a barrier potential, the student gets exposed to solving non-relativistic hydrogen atom, for its spectrum and eigenfunctions.
- Study of influence of electric and magnetic fields on atoms will help inunderstanding Stark effect and Zeeman Effect respectively.
- Angular momentum: Orbital angular momentum and spin angular momentum.
- Bosons and fermions - symmetric and anti-symmetric wave functions.
- Application to atomic systems

SKILLS TO BE LEARNED

- This course shall develop an understanding of how to model a given problem such as hydrogen, particle in a box etc. atom etc using wave function, operators and solve them.
- These skills will help in understanding the different Quantum Systems.

COURSE CONTENT

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function. Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(6 Lectures)**

Time independent Schrodinger Equation: Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time independent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Position-momentum uncertainty principle. **(10 Lectures)**

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General discussion of bound states in an arbitrary potential: Continuity of wavefunction, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero- point energy & uncertainty principle.
(12 Lectures)

Quantum theory of hydrogen-like atoms: Angular momentum operator and commutation relation between them. time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d.... **(10 Lectures)**

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern- Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Normal and Anomalous Zeeman Effect. Paschen Back effect.
(12 Lectures)

Single and Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms-L-S and J- J couplings. Hund's Rule.

Reference Books: **(10 Lectures)**

1. A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill.
2. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
6. Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer.
7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press.
8. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
9. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
10. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.
11. Quantum Physics, H. C. Verma, 2018, Surya Publications.
12. Quantum Mechanics, S. N. Biswas, Books & Allied (P) Ltd.
13. Advanced Quantum Mechanics, Satya Prakash, KedarNath Ram Nath Publisher.
14. Introduction to Quantum Mechanics, Nikhil Ranjan Roy, 2015, Vikas Publishing.

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PHYSICS-MJ 15: Practical-V

Credits: 04 Lectures: 120 (60X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines

Experiment	*= 60 marks*
Practical record notebook	*= 20 marks*
Viva-voce	*= 20 marks*

1. To determine work function of material of filament of directly heated vacuum diode.
2. To determine the ionization potential of mercury.
3. To determine value of Planck's constant using LEDs of at least 4 different colours.
4. To determine the wavelength of H-alpha emission line of Hydrogen atom.
5. To determine the absorption lines in the rotational spectrum of Iodine vapour.
6. To study the diffraction patterns of single and double slits using laser and measure itsintensity variation using Photosensor & compare with incoherent source– Na.
7. Photo-electric effect: photo current versus intensity and wavelength of light; maximumenergy of photo-electrons versus frequency of light
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.
11. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
12. To show the tunnelling effect in tunnel diode using I-V characteristics.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 2011, KitabMahal.
4. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
5. An Advanced Course in Practical Physics, D. Chattopadhyay & P. C. Rakshit, 2013,New Book Agency (P) Ltd.
6. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press
7. B.Sc. Practical Physics, H. Singh & P. S. Hemne, 2011, S Chand and Company Ltd
8. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers.
9. B.Sc. Practical Physics,.C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.
10. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
11. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
12. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

SEMESTER VII

PHYSICS-MJ 16 THEORY: CLASSICAL DYNAMICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, Pass Marks = 30 Semester Internal Examination=20, Class Performance & Attendance =05), Pass Marks=10

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

This course on classical dynamics trains the student in problem solving ability and develops understanding of physical problems. The course begins with the review of Newton's Laws of Motion and ends with the Special Theory of Relativity by 4-vector approach and fluids. Students will also learn the Lagrangian and Hamiltonian Mechanics. The emphasis of this course is to enhance the understanding of Classical Mechanics (Lagrangian and Hamiltonian Approach). By the end of this course, students should be able to solve the seen or unseen problems/numericals in classical mechanics.

COURSE LEARNING OUTCOMES

- Understand the physical principle behind the derivation of Lagrange and Hamilton equations, and the advantages of these formulations.
- Translate physical problems into appropriate mathematical language and apply appropriate mathematical tools – particularly, calculus, differential equations, linear algebra, and the calculus of variations – to analyse and solve the resulting equations.
- Apply Lagrangian & Hamiltonian methods to complex motion problems.
- One will be able to relate symmetries to conservation laws in physical systems, and apply these concepts to practical situations.
- Understand the intricacies of motion of particle in central force field. Critical thinkingand problem-solving skills
- Review the retarded potentials, potentials due to a moving charge, Lienard Wiechert potentials, electric and magnetic fields due to a moving charge, power radiated, Larmor's formula and its relativistic generalization.
- Recapitulate and learn the special theory of relativity- postulates of the special theory of relativity, Lorentz transformations on space-time and other four vectors, four-vector notations, space-time invariant, length contraction, time dilation, mass-energy relation, Doppler effect, light

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cone and its significance, problems involving energy- momentum conservations.

- Learn the basics of fluid dynamics, streamline and turbulent flow, Reynolds's number, coefficient of viscosity and Poiseuille's equation.
- Upon taking the classical dynamics course students will be able to integrate competently the knowledge and skills acquired in post-undergraduate studies.

SKILLS TO BE LEARNED

- Learn to define generalised coordinates, generalised velocities, generalised force and write Lagrangian for mechanical system in terms of generalised coordinates.
- Learn to derive Euler-Lagrange equation of motion and solve them for simplemechanical systems.
- Learn to write Hamiltonian for mechanical systems and derive and solve Hamilton'sequation of motion for simple mechanical systems.
- Formulate the problem of small amplitude oscillation and solve them to obtain normalmodes of oscillation and their frequencies in simple mechanical systems.
- Develop the basic concepts of special theory of relativity and its applications todynamical systems of particles.
- Develop the methods of relativistic kinematics of one and two particle system and its application to two particle decay and scattering.
- Develop and understand the basic concepts of fluid dynamics and its applications tosimple problems in liquid flow.

COURSE CONTENT

Classical Mechanics of Point Particles: Generalized coordinates and velocities, Hamilton's principle, Lagrangian equations, Euler-Lagrange equations- one- dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy. **(22 Lectures)**

Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs. **(10 Lectures)**

Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space- time diagrams. Time -dilation, length contraction and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four- momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. **(18 Lectures)**

Elements of computational techniques: Root of functions, interpolation, extrapolation, integration by trapezoid and Simpson's rule, Solution of first order differential equation using Runge-Kutta method. Finite difference methods. **(10 Lectures)**

Reference Books:

1. Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rdEdn., PearsonEducation, 2002. Mechanics, L. D. Landau and E. M. Lifshitz, Pergamon, 1976.
2. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
3. Classical Mechanics, R. Douglas Gregory, Cambridge University Press, 2015.
4. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, Oxford Press, 2010.
5. Classical Mechanics, Tai L. Chow, CRC Press.
6. Introduction to Classical Mechanics, Nikhil Ranjan Roy, Vikash Publishing.
7. Classical Mechanics, J. C. Upadhyaya, Himalaya Publishing House, 1 January, 2019.
8. Classical Mechanics, Gupta, Kumar, Sharma, Pragati Prakashan, 2012.
9. Classical Mechanics, B. D. Gupta, Satya Prakash, Kedar Nath Ram Nath Publication, 2020.

PHYSICS-MJ 17 THEORY: SOLID STATE PHYSICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, Pass Marks = 30 Semester Internal Examination=20, Class Performance & Attendance =05), Pass Marks=10

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

The introduction to this course caters to the basic concepts and principles to understand the various properties exhibited by condensed matter, especially solids. These properties depend on the chemical constituents making the particular solid and their arrangement in the crystal. A semi-classical approach is used to introduce various models, from toy model to a higher level, suitable to explain the particular property exhibited by the solid. Towards the end of this course some basic nuclear physics and radioactivity have been introduced.

COURSE LEARNING OUTCOMES

On completion of the course students will be able to:

- Learn the concept of lattice, crystals and symmetry operations.
- Explain the concepts such as the reciprocal lattice and the Brillouin zone and thedynamics of atoms and electrons in solids.
- Explain diffraction of X-rays by solids to determine the crystal structure.
- Understand the elementary lattice dynamics and its influence on the properties of materials.

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- Understand lattice vibrations, phonons and in depth Einstein and Debye theory of specific heat of solids.
- Describe the main features of the physics of electrons in solids.
- Understand the origin of energy bands, and how they influence electronic behavior.
- Explain the origin of dia-, para-, and ferro-magnetic properties of solids.
- Explain the origin of the dielectric properties exhibited by solids and the concept of polarizability.
- Understand the basics of phase transitions and the preliminary concept and experiments related to superconductivity in so lid.
- Apply the gained knowledge to solve problems in solid state physics using relevant mathematical tools.
- To appreciate how matter exhibits such interesting and wonderful properties and communicate the importance of solid-state physics in the modern society.
- The understand properties of nuclei like density, size, binding energy, nuclear forces and structure of atomic nucleus, liquid drop model and mass formula.
- To calculate the decay rates and lifetime of radioactive decays like alpha and beta
- Fission and fusion well as nuclear processes to produce nuclear energy in nuclear reactor and stellar energy in stars.
- To carry out experiments based on the theory that they have learned to measure the magnetic susceptibility, dielectric constant, trace hysteresis loop. They will also employ to four probe methods to measure electrical conductivity and the hall set up to determine the hall coefficient of a semiconductor.

SKILLS TO BE LEARNED

- Learn basics of crystal structure and physics of lattice dynamics
- Learn the physics of different types of material like magnetic materials, dielectricmaterials, metals and their properties.
- Understand the physics of insulators, semiconductor and conductors with specialemphasis on the elementary band theory of semiconductors.
- Comprehend the basic theory of superconductors. Type I and II superconductors, their properties and physical concept of BCS theory.

COURSE CONTENT

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Bravais lattice, Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law, Laue theory of X-ray diffraction, Atomic and Geometrical Factor. **(12 Lectures)**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law **(10 Lectures)**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss. **(8 Lectures)**

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Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. DepolarizationField. Electric Susceptibility. Polarizability. Clausius Mossotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons.

(8 Lectures)

Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

(6 lectures)

Elementary band theory: Bloch Theorem, Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (four-probe method) & Hall coefficient.

(10 Lectures)

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. BCS theory (elementary idea).

(6 Lectures)

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer.
6. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India.
7. Solid State Physics, M.A. Wahab, 2011, Narosa Publications.
8. Solid State Physics, Puri and Babbar, S. Chand Publications, 1st Edition 1997, Reprint 2016.
9. Solid State Physics, M.K. Mahan and P. Mahto, 2008, Bharti Bhawan.
10. Introduction to Solid State Physics , Arun Kumar, PHI Learning.

PHYSICS-MJ 18 THEORY: NUCLEAR AND PARTICLE PHYSICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, Pass Marks = 30   **Semester Internal Examination=20, Class Performance & Attendance =05), Pass Marks=10**

Instruction to Question Setter for
Semester Internal Examination (SIE 25 marks) (20+05):
*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

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COURSE OBJECTIVE

The objective of the course is to impart the understanding of subatomic particles and their properties. It will emphasize to gain knowledge about the different nuclear techniques and their applications in different branches of Physics and application to society. The phenomenology and experimental foundations of nuclear and particle physics are exploredin this course. Emphasis is on the fundamental forces and particles, as well as composites. The students will learn how cutting-edge research is trying to answer the big questions about our universe. In addition, they will learn how new ideas find their way from fundamental research to specific applications that have practical value. They will understand the relevance of everything from development and construction of a nuclear physics experimental equipment including accelerators and detectors, and eventually their use in order to study the structure of nucleus. By the end of the course, the students wouldbe able to explain the basic properties of nuclei, classify elementary particles into hadrons and leptons, and understand how hadrons are constructed from quarks. They will also learn about flavor quantum numbers such as isospin, strangeness, etc. The course will focus on the developments of problem-based skills.

COURSE LEARNING OUTCOMES

- To be able to understand the basic properties of nuclei as well as knowledge of experimental determination of the same, the concept of binding energy, its various dependent parameters, N-Z curves and their significance
- To appreciate the formulations and contrasts between different nuclear models such as Liquid drop model, Fermi gas model and Shell Model and evidences in support.
- Knowledge of radioactivity and decay laws. A detailed analysis, comparison and energy kinematics of alpha, beta and gamma decays.
- Familiarization with different types of nuclear reactions, Q- values, compound and direct reactions.
- To know about energy losses due to ionizing radiations, energy losses of electrons, gamma ray interactions through matter and neutron interaction with matter. Throughthe section on accelerators students will acquire knowledge about Accelerator facilitiesin India along with a comparative study of a range of detectors and accelerators whichare building blocks of modern-day science.
- It will acquaint students with the nature and magnitude of different forces, particleinteractions, families of sub- atomic particles with the different conservation laws, concept of quark model.
- The acquired knowledge can be applied in the areas of nuclear medicine, medical physics, archaeology, geology and other interdisciplinary fields of Physics and Chemistry. It will enhance the special skills required for these fields.

SKILLS TO BE LEARNED

- Skills to describe and explain the properties of nuclei and derive them from variousmodels of nuclear structure.
- To understand, explain and derive the various theoretical formulation of nucleardisintegration like α decay, β decay and ⍰ decays.
- Develop basic understanding of nuclear reactions and decays with help of theoretical formulate and laboratory experiments.
- Skills to develop basic understanding of the interaction of various nuclear radiation withmatter in low and high energy.
- Ability to understand, construct and operate simple detector systems for nuclearradiation and

training to work with various types of nuclear accelerators.

- Develop basic knowledge of elementary particles as fundamental constituent of matter,their properties, conservation laws during their interactions with matter.

COURSE CONTENT

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, Spin parity, magnetic moment, electric moments, nuclear excites states.

(8 Lectures)

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

(8 Lectures)

Radioactive Decay: (a) Alpha decay: basics of α-decay processes, theory of α-emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

(8 Lectures)

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value equation, reaction rate, reaction cross section, Concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering).

(8 Lectures)

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe-Bloch formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

(8 Lectures)

Nuclear Radiation Detectors: Behaviour of ion pairs in electric field, Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

(8 Lectures)

Particle Accelerators: Accelerator facility available in India: Van-de Graaff Generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. Betatron.

(4 Lectures)

Particle Physics: Particle interactions; types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, Parity, Baryon number, Lepton number, Isospin, Strangeness and Charm, Concept of quark model, Colour quantum number and gluons. Baryon octet and Meson octet.

(8 Lectures)

Reference Books:

1. Introductory nuclear Physics by Kenneth S. Krane Wiley India Pvt. Ltd., 2008.
2. Concepts of Nuclear Physics by Bernard L. Cohen. Tata Mcgraw Hill, 1998.
3. Theoretical Nuclear Physics, J.M. Blatt & V. F. Weisskopf, Dover Pub.Inc., 1991.
4. Nuclear Physics, S. N. Ghosal, S. Chand Publisher, 1994.
5. Nuclear Physics, D. C. Tayal, 2011, Himalaya Publishing House.
6. Basic ideas and concepts in Nuclear Physics, K. Heyde, 3rd Edition., Institute of Physics Pub.

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7. Concepts of Modern Physics, Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury 2017, McGraw-Hill.
8. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
9. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
10. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
11. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn., Tata McGraw-Hill Publishing Co. Ltd.
12. Elements of Nuclear Physics, Nikhil Ranjan Roy and Rakesh Kumar Pandey, Atlantic publishers & Distributors (P) Ltd., 2024.

PHYSICS-MJ 19: Practical-VI

Credits: 04 Lectures: 120 (60X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines

Experiment	*= 60 marks*
Practical record notebook	*= 20 marks*
Viva-voce	*= 20 marks*

1. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.
2. To measure the resistivity of a semiconductor (Ge) by P-N Junction diode.
3. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150°C) and to determine its band gap.
4. To determine the Hall coefficient of a semiconductor sample.
5. To measure the Dielectric Constant of a dielectric Materials with frequency
6. To study the PE Hysteresis loop of a Ferroelectric Crystal.
7. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
8. To measure the Magnetic susceptibility of Solids.
9. To determine the Coupling Coefficient of a Piezoelectric crystal.
10. To measure the Dielectric Constant of a dielectric Materials with frequency.
11. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method).

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal.
4. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
5. An Advanced Course in Practical Physics, D. Chattopadhyay & P. C. Rakshit, 2013,New Book Agency (P) Ltd.
6. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press
7. B.Sc. Practical Physics, H. Singh & P. S. Hemne, 2011, S Chand and Company Ltd

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8. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers.
9. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.
10. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
11. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
12. Elements of Solid-State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

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SEMESTER VIII

PHYSICS-MJ 20 THEORY: ATOMIC AND MOLECULAR PHYSICS (QUANTUM APPROACH) AND LASER PHYSICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30** Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):

*There will be **two** groups of questions. **Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

The main objective is to teach students the basic atomic structures with quantum mechanical approach leading to their fundamental spectroscopies. The effect of magnetic and electric field on the atomic spectra is also highlighted. To teach the students the nature of molecular spectra (rotational, vibrational, electronic and Raman), polyatomic molecules (including diatomic) are classified on the basis of their topological symmetry. The fundamentals of electronic states will also be taught. Also, the LASER part of this course will enable the students to understand the two-, three-and four- level laser systems also the non-linear interaction of light with matter.

COURSE LEARNING OUTCOMES

- Details of atomic and diatomic molecular (diatomic) structures in terms of quantum mechanical treatment elaborately beyond the basic models. It will give the descriptions of fine and hyperfine structure of atoms and molecular. Space quantization, commutator algebra, theory of orbital and spin angular momenta. Clebsch-Gordon coefficients for unitary transformation.
- The various coupling schemes and interactions of fields with spectra will enrich the student's knowledge about transitions. The details of these spectroscopies would serve as the fundamentals for various concerned experimental studies.
- Analyzing the polyatomic molecules (including diatomic) and to predict the nature of their vibrational spectra depending on their symmetry using IR Raman Spectroscopy.
- The complete picture of rotational, vibrational and electronic spectra of polyatomic molecules will be comprehended. This kind of specialization is expected to provide a larger scope for research in the various related and interdisciplinary areas.
- Understanding fundamental physical processes of the laser.
- Understanding Einstein's postulates and laser field with unique properties not found in ordinary light.

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SKILLS TO BE LEARNED

- Learn about the spectrum of 1 electron and many electron atoms; various important quantum-mechanical models to study the electronic structure of many electron systems; Spectroscopic terms which represent the states.
- Have an intuitive understanding about the outcomes of the interactions of the electromagnetic radiation with the various atoms and the molecules and the rules governing this process. They will learn about the rotational, vibrational, electronic Raman and infrared spectrums arising due to this interaction.
- Gain in-depth knowledge about the molecular structure using various concepts.
- Learn the fundamentals and the principles of lasers. Also, they will learn about various types of lasers developed with time. Also, the principle of Holography.

COURSE CONTENT

One electron system: Quantum states of an electron in an atom, Electron Probability density, Space Quantization, Electron Spin, Stern-Gerlach experiment, Spectroscopic terms and selection rules, Spin – orbit interaction energy, Relativistic corrections for energy levels of Hydrogen atom, Hydrogen fine structure, Hyperfine structure, Isotopic shift, Width of spectral lines, Pauli exclusion principle, Exchange symmetry of wave function.

(8 Lectures)

Two-electron system: Hartree-Fock theory, L-S and J-J couplings, equivalent and non-equivalent electrons, Spectrum of Helium atom and alkali atom, Ortho and para modification, Normal and Anomalous Zeeman effect, Paschen-Back effect, Characteristics X-ray Spectra: Kossel's Explanation and Moseley Law, Augur effect.

(10 Lectures)

Vibration-rotational spectra of diatomic molecules: Types of molecules, Diatomic linear symmetric-top, Asymmetric-top and Spherical-top, Pure rotational spectra-The diatomic molecule as rigid rotator,, Non-rigid rotator, Selection rules, Vibrational spectra of Harmonic oscillator, Anharmonic oscillator and vibrational-rotational spectra, Isotopic effect on vibrational-rotational spectra, Intensity of rotation-vibration spectra, Raman spectra of diatomic molecules.

(10 Lectures)

Electronic spectra: Classification of electronic states, Electronic and total energy: Born-Oppenheimer approximation, Vibrational structure of electronic transitions, Rotational fine structure, P, Q, R branches of a band, The Fortrat parabola, Intensity of electronic bands, Franck Condon principle: Absorption & emission, Isotopic effect on electronic states, Nuclear Magnetic Resonance, Electron Spin Resonance, Chemical shift.

(10 Lectures)

LASER PHYSICS

Laser rate equations and types of lasers: Three-level and Four- level laser rate equations. The Nd^{3+} YAG laser, The Neodymium Glass laser, The CO_2 Laser, Semiconductor Laser, Dye lasers, Liquid Laser.

(6 Lectures)

Laser Resonators, Coherence, and Advanced Systems: Cavity resonators and shaping of beams, condition for steady state laser oscillation, Cavity modes, qualitative description of longitudinal and transverse electromagnetic modes, Quality factor Q, Theory of Q-Switching, Methods of Q-switching, Mode locking theory, Techniques of mode locking.

(8 Lectures)

Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms, Characteristics and its applications.

(3 Lectures)

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Non-linear Interaction and Applications: Non-linear interaction of light with matter, Harmonic generation, second-order Harmonic generation, third-order harmonic generation, phase matching, optical mixing, multiphoton processes. **(5 Lectures)**

Reference Books:

1. H. E. White, Introduction to Atomic Spectra, McGraw-Hill Inc., US, 1934.
2. G. Herzberg, Atomic Spectra and Structure, Vol. I & II, 1944.
3. G. Herzberg, Molecular Spectra and Structure, 1950.
4. C. N. Banwell, Fundamentals of Molecular Spectroscopy, McGraw-Hill Higher Ed., 1994.
5. Raj Kumar, Atomic and Molecular Spectra and Laser, Kedar Nath Ram Nath, Merrut, India, 2012.
6. K. P. R. Nair, Atom, Molecules and Laser, Alpha Science International Ltd., USA, 2006.
7. B. H. Bransden and C. J. Joachain, Physics of Atoms & Molecules, Prentice Hall, 1982.
8. H. Huber and G. Herzberg, Molecular Spectra and Molecular Structure, Springer, 1950.
9. S. N. Ghoshal, Atomic Physics, S. Chand, 1991.
10. G. Aruldhas, Molecular Structure and Spectroscopy, PHI Learning Pvt. Ltd., 2014.
11. M. N. Avadhanulu and P. S. Hemne, An Introduction to Lasers: Theory and Applications, S. Chand Publishing, First Edition, 2012.
12. Leonard I. Schiff, Quantum Mechanics, 3rd Edition, McGraw-Hill, 1968.
13. R. Shankar, Principles of Quantum Mechanics, 2nd Edition, Springer, 2010.
14. David J. Griffiths, Introduction to Quantum Mechanics, 2nd Edition, Pearson, 2015.
15. Nouredine Zettili, Quantum Mechanics: Concepts and Applications, 2nd Edition, Wiley, 2009.
16. John R. Taylor, Scattering Theory: The Quantum Theory of Nonrelativistic Collisions, Revised Edition, Dover Publications, 2006.
17. B. H. Bransden and C. J. Joachain, Quantum Mechanics, 2nd Edition, Pearson, 2000.
18. V. K. Thankappan, Quantum Mechanics, 2nd Edition, New Age International Publishers, 1996.

PHYSICS-AMJ 1 THEORY: ADVANCED QUANTUM MECHANICS

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks = 30** Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for

Semester Internal Examination (SIE 25 marks) (20+05):
*There will be **two groups of questions. Group A is compulsory** which will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type** two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):
*There will be **two group of questions. Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

After completing this course on Advanced Quantum Mechanics, students will gain an essential understanding necessary for theoretical formulation of physical phenomena at the quantum level in matter and radiation fields. This foundation will support further study in various advanced topics in quantum physics.

COURSE LEARNING OUTCOMES

- Develop a foundational understanding of Quantum Mechanics needed for various quantum mechanical approaches.
- Understand the significance of quantum numbers in explaining atomic structures, including the hydrogen atom and multi-electron systems.
- Grasp the matrix formulation of quantum mechanics and the significance of the Schrödinger, Heisenberg, and interaction pictures.
- Comprehend space quantization, commutator algebra, and the theory of orbital and spin angular momenta.
- Use Clebsch-Gordon coefficients for unitary transformations.
- Apply stationary perturbation theory for approximate solutions to quantum mechanical problems.
- Understand the Klein-Gordon and Dirac equations, including their applications and limitations.
- Learn the principles of quantizing the electromagnetic field.

SKILLS TO BE LEARNED

- Grasp basic concepts and principles of quantum mechanics and their applications to systems like the simple harmonic oscillator.
- Master the matrix formulation of quantum mechanics.
- Apply the Schrödinger, Heisenberg, and interaction pictures, particularly to the linear harmonic oscillator.
- Understand and use commutation relations for angular momentum operators.
- Solve angular momentum problems using Clebsch-Gordon coefficients.
- Employ various approximation techniques to solve quantum systems.
- Distinguish between particles with half-integer and integer spin; understand the implications of symmetric and antisymmetric wavefunctions.
- Calculate energy levels and wave functions for quantum systems with conserved quantities.
- Explore the semi-classical theory of radiation, including the derivation and significance of Einstein's A and B coefficients.

COURSE CONTENT

Matrix formulation of QM: Harmonic Oscillator by Schrödinger equation and by matrix method, Matrix formulation of Quantum Mechanics, Schrödinger, Heisenberg and interaction pictures and their applications to linear harmonic oscillator. **(7 Lectures)**

Angular Momentum: Commutation relations for angular operators, Eigenvalues and Eigenvectors, Pauli spin matrices and spin eigenvectors, addition theorem, Clebsch-Gordon coefficients, angular momentum and rotation, motion in centrally symmetric field, Schrödinger's theory of Hydrogen atom. **(11 Lectures)**

Approximation method in QM: Time independent perturbation theory, non-degenerate and degenerate cases, Stark effect, Variational methods - Application to ground state of Hydrogen atom and first excited state of harmonic oscillator, WKB approximation. Time dependent perturbation theory and Fermi's golden rule, selection rules. Identical particles, Pauli exclusion principle, spin-statistics connection, Semi-classical theory of radiation-Einstein A and B coefficients. **(16 Lectures)**

Elementary theory of scattering: Laboratory and Centre of mass reference frames, scattering amplitude, differential scattering cross section and total scattering cross section. Scattering by

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spherically symmetric potentials, partial wave analysis and phase shifts, Born approximation, S-matrix scattering and T-matrix scattering theories. **(11 lectures)**

Relativistic QM: Klein – Gordon equation and its merit and demerit, Dirac equation, probabilities and current densities, Magnetic moment and spin of electron, free particle solution of Dirac equation and interpretation of negative energy states. **(9 Lectures)**

Second Quantization: Canonical Quantization of fields, Second Quantization of K G fields, Dirac fields and EM fields. **(6 Lectures)**

Reference Books:

1. Leonard I. Schiff, Quantum Mechanics, 3rd Edition, McGraw-Hill, 1968.
2. R. Shankar, Principles of Quantum Mechanics, 2nd Edition, Springer, 2010.
3. David J. Griffiths, Introduction to Quantum Mechanics, 2nd Edition, Pearson, 2015.
4. Nouredine Zettili, Quantum Mechanics: Concepts and Applications, 2nd Edition, Wiley, 2009.
5. John R. Taylor, Scattering Theory: The Quantum Theory of Nonrelativistic Collisions, Revised Edition, Dover Publications, 2006.
6. B. H. Bransden and C. J. Joachain, Quantum Mechanics, 2nd Edition, Pearson, 2000.
7. V. K. Thankappan, Quantum Mechanics, 2nd Edition, New Age International Publishers, 1996.
8. J. J. Sakurai and Jim Napolitano, Modern Quantum Mechanics, 2nd Edition, Addison-Wesley, 2010.
9. Claude Cohen-Tannoudji, Bernard Diu, and Franck Laloë, Quantum Mechanics, 2 Volumes, Wiley, 2005.
10. Franz Schwabl, Advanced Quantum Mechanics, 4th Edition, Springer, 2008.
11. Hans A. Bethe and Edwin E. Salpeter, Quantum Mechanics of One- and Two-Electron Atoms, Springer, 2008.
12. Paul Dirac, The Principles of Quantum Mechanics, 4th Edition, Oxford University Press, 1981.
13. L. D. Landau and E. M. Lifshitz, Quantum Mechanics: Non-Relativistic Theory, 3rd Edition, Pergamon Press, 1981.
14. Albert Messiah, Quantum Mechanics, 2 Volumes, Dover Publications, 2014.
15. E. Merzbacher, Quantum Mechanics, 3rd Edition, Wiley, 1998.
16. Walter Greiner, Quantum Mechanics: An Introduction, 4th Edition, Springer, 2001.
17. Julian Schwinger, Quantum Mechanics: Symbolism of Atomic Measurements, Springer, 2001.
18. P. M. Mathews and K. Venkatesan, A Textbook of Quantum Mechanics, 2nd Edition, Tata McGraw-Hill, 2010.
19. Ajoy Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 5th Edition, Macmillan India, 2004.
20. B. K. Agarwal and Hari Prakash, Quantum Mechanics, 1st Edition, PHI Learning Pvt. Ltd., 1997.
21. Aruldhas G., Quantum Mechanics, 2nd Edition, PHI Learning Pvt. Ltd., 2022.
22. Ashok Das and A. C. Melissinos, Quantum Mechanics: A Modern Introduction, Gordon and Breach Science Publishers, 1986.

<u>PHYSICS-AMJ 2 THEORY</u>: ADVANCED THEORETICAL PHYSICS

(ELECTRODYNAMICS, STATISTICAL MECHANICS, CONDENSED MATTER PHYSICS & NUCLEAR AND PARTICLE PHYSICS)

Credits: 04 Lectures: 60

Marks: 100 (End Semester Examination=75, **Pass Marks =30**
Semester Internal Examination=20, Class Performance & Attendance =05), **Pass Marks=10**

Instruction to Question Setter for
<u>Semester Internal Examination (SIE 25 marks) (20+05):</u>

There will be ***two*** *groups of questions.* ***Group A is compulsory*** *which will contain two questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *two questions of ten marks each, out of which any one to answer.*

End Semester Examination (ESE 75 marks):

There will be ***two*** *group of questions.* ***Group A is compulsory*** *which will contain three questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 & 3 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *six questions of fifteen marks each, out of which any four are to answer.*

Note: *There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

This course on Advanced Theoretical Physics aims to deepen understanding by integrating topics that have not been thoroughly covered in Electrodynamics, Statistical Mechanics, Condensed Matter Physics, and Nuclear and Particle Physics. The Electrodynamics section focuses on electromagnetic potentials, the dynamics of moving charges, radiating systems, and relativistic electrodynamics. In Statistical Mechanics, topics include Quantum Statistics, Phase Transitions, High-Density Gases, and Non-Equilibrium Statistical Mechanics. The Condensed Matter Physics section explores Transport Phenomena, Electronic Properties, Magnetism, Superconductivity, and Defects. The Nuclear and Particle Physics section addresses two-body problems, Nuclear β-Decay, Nuclear Reactions, and provides a basic understanding of Particle Physics.

COURSE LEARNING OUTCOMES

Electrodynamics:

- Review concepts of Electromagnetic Vector and Scalar Potentials, and the Wave Equation, including the Lorentz condition.
- Understand the Retarded potential, Lienard-Wiechert potentials, and the electromagnetic fields produced by moving and accelerated charges.
- Develop a solid grasp of Minkowski space, Lorentz transformations, Four Vectors, and the transformation of charge and current densities.
- Learn the transformation equations for electromagnetic potentials and the invariance of Maxwell's field equations using four-vectors and tensors.

Statistical Mechanics:

- Understand Liouville's Theorem and the Density Matrix.
- Explore the properties of degenerate Bose gases, Bose-Einstein condensation, and the thermal properties of Bose-Einstein gas and liquid helium.
- Comprehend the Ising model, Bragg-Williams Approximation, Landau theory of phase transitions, and mean field theories.
- Learn about high-density astrophysical objects such as white dwarfs and neutron stars (Chandrasekhar mass limit).
- Understand Brownian motion through Langevin's equation and solve the Fokker-Planck equation.

Condensed Matter Physics:

- Grasp the fundamentals of Boltzmann transport equation, relaxation time approximation, and Sommerfeld theory of electrical conductivity.
- Develop concepts related to electrons in a periodic lattice, free electron approximation, tight binding approximation, and Fermi surface topology.

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- Learn about magnetic phenomena, including the Heisenberg model, spin waves, magnons, and ferromagnetic domains.
- Understand superconductivity basics, including the BCS theory and Josephson effects.
- Gain knowledge about defects in crystals, liquid crystalline order, and quasi-crystals.

Nuclear & Particle Physics:

- Analyse two-body problems, including the deuteron structure and low-energy neutron-proton scattering.
- Understand Fermi's theory of beta decay and its associated phenomena, such as Kurie plots and parity violation.
- Develop a framework for nuclear reactions, including compound nucleus theory and the Breit-Wigner formula.
- Learn about fundamental symmetries and violations (CP and CPT invariance), classification of hadrons, Lie algebra, SU (2)-SU (3) multiplets, and the quark model.

SKILLS TO BE LEARNED

- Develop problem-solving skills related to electromagnetic potentials and relativistic electrodynamics.
- Understand the behaviour of Fermi and Bose gases and analyse phase transitions using theoretical models.
- Apply the Fokker-Planck equation to phenomena such as Brownian motion.
- Gain insight into advanced topics like the de Haas van Alphen Effect, superconductivity, and magnetic domains.
- Solve the deuteron problem and understand the principles behind Nuclear β-Decay and other nuclear reactions.
- Obtain foundational knowledge of particle physics, including the classification of particles and the quark model.

COURSE CONTENT

ELECTRODYNAMICS

Electromagnetic potentials: Electromagnetic Vector and Scalar Potentials, Wave equation. Lorentz condition. Non-Uniqueness of electromagnetic potentials and concept of gauge. **(3 lectures)**

Electrodynamics of a moving charge and radiating systems: Retarded potential, Lienard-Wiechert potentials and derivation of LW potential of a moving point charge. Electric and Magnetic fields due to uniformly moving point charge and accelerated charge. Angular Distribution of Radiation emitted by accelerated charge. Radiation Damping: Abraham Lorentz formula. **(6 lectures)**

Relativistic Electrodynamics: Minkowski space, Geometrical interpretation of Lorentz transformations of space and time, Four Vectors, Transformation for charge and current density, Covariance of Continuity equation and Lorentz condition. Transformation equations for the electromagnetic potentials. Invariance of Maxwell field equation in terms of four vectors. Electromagnetic field tensor, Maxwell's equation in covariance Four Tensor Form. **(6 lectures)**

STATISTICAL MECHANICS (QUANTUM APPROACH):

Quantum Ensemble Theory: Liouville's Theorem and Density Matrix. **(1 lecture)**

Quantum Statistics: Equation of state of ideal Fermi and Bose gases, Degenerate electron gas and specific heat, Degenerate Bose gas, Bose-Einstein condensation, Thermal properties of Bose-Einstein gas and liquid He, The Lambda transition, Liquid Helium I and II. **(5 lectures)**

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Phase Transitions: Ising model, Bragg-Williams Approximation, Mean field theories of the Ising model in one-dimension, Exact solutions in one dimension, Landau theory of first and second-order phase transition. **(4 lectures)**

High-Density Gases: Equation of state at very high density, Equilibrium of bodies of large mass, Chandrasekhar mass limit, White dwarf and neutron stars. **(2 lectures)**

Non-Equilibrium (fluctuation) Statistical Mechanics: Langevin's equation and Brownian motion, The Fokker-Planck Equation, Solution on Fokker-Planck Equation- application to Brownian motion. **(2 lectures)**

CONDENSED MATTER PHYSICS

Transport phenomena: Boltzmann transport equation - relaxation time approximation, Sommerfeld theory of electrical conductivity. **(2 Lectures)**

Electronic Properties: Electron in a Periodic lattice, Free electron approximation, Tight binding approximation– application to a simple cubic lattice, Cellular and Pseudopotential method, Topology of Fermi surface, de Haas van Alphen Effect. **(5 Lectures)**

Magnetism: Exchange interaction, Heisenberg model and molecular field theory, spin waves and magnons, Ferromagnetic domains and Bloch Wall energy. **(3 Lectures)**

Superconductivity: Basic properties of superconductors, a.c. and d.c. Josephson effect, BCS theory, superfluidity. **(3 Lectures)**

Defects and dislocations: Qualitative description of defects in crystals-point, line and plane defects, translational and orientational order, kinds of liquid crystalline order. Quasi crystals. **(2 Lectures)**

NUCLEAR & PARTICLE PHYSICS

Two-body problems: ground state of the deuteron, excited state of the deuteron. Two-body scattering: Kinematics, cross-sections, low energy neutron-proton scattering and proton- proton scattering, effective range theory, coherent scattering of neutrons by Ortho- and Para-hydrogen, charge independence and charge symmetry of nuclear forces, Isospin formalism, Yukawa interaction. **(6 lectures)**

Nuclear β-Decay: Fermi's theory of beta decay, Kurie plots, Comparative half-life, allowed and forbidden transitions, selection rules in beta decay, Non-conservation of parity in beta decay. **(2 lectures)**

Nuclear reactions: Statistical theory of the compound nucleus, Ghosal experiment, Breit-Wigner formula, direct reactions, optical model. **(4 lectures)**

Particle Physics: Parity, Charge conjugation and Time reversal, CP violation, CPT invariance and its consequences, classification of hadrons, Lie algebra, SU (2) -SU (3) multiplets, Quark model, Gellmann-Okubo mass formula for octet and decuplet hadrons, Gellman-Nishijima formula, Unification of forces (qualitative description of electro-weak, GUT and SUSY models). **(4 lectures)**

Reference Books:

1. S. P. Chopra and G. C. Agarwal, Electromagnetic Theory, K. Nath & Co., 1990.
2. S. L. Gupta, V. Kumar, and H. V. Singh, Electrodynamics, Pragati Prakashan, 2001.
3. Satyaprakash, Electromagnetic Theory and Electrodynamics, Kedar Nath Ram Nath, 2006.
4. John D. Jackson, Classical Electrodynamics, 3rd Edition, Wiley, 1999.
5. B. B. Laud, Electromagnetics, New Age International Publishers, 1987.
6. P. Sengupta, Classical Electrodynamics, New Age International Publishers, 2010.
7. David J. Griffiths, Introduction to Electrodynamics, 4th Edition, Pearson, 2013.

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8. Edward C. Jordan and Keith G. Balmain, Electromagnetic Waves and Radiating Systems, 2nd Edition, Prentice Hall, 1968.
9. Matthew N. O. Sadiku, Elements of Electromagnetics, 6th Edition, Oxford University Press, 2014.
10. Ashutosh Pramanik, Electromagnetism: Theory and Applications, 2nd Edition, PHI Learning Pvt. Ltd., 2014.
11. Frank S. Crawford Jr., Waves, Berkeley Physics Course, Vol. 3, McGraw-Hill, 1968.
12. S.K. Sinha, Statistical Mechanics, 1st Edition, 1984, S. Chand & Co.
18. Kerson Huang, Statistical Mechanics, 2nd Edition, 1987, Wiley
19. L.D. Landau and E.M. Lifshitz, Statistical Physics, 1st Edition, 1980, Pergamon Press
20. R.K. Patharia, Statistical Mechanics, 2nd Edition, 2011, Butterworth-Heinemann
21. B.B. Laud, Fundamentals of Statistical Mechanics, 1st Edition, 1981, New Age International
22. R.K. Srivastava and J. Ashok, Statistical Mechanics, 1st Edition, 1995, Prentice Hall of India
23. Gupta and Kumar, Statistical Mechanics, 1st Edition, 2009, Tata McGraw-Hill
24. B.K. Agrawal, Statistical Mechanics, 1st Edition, 2005, McGraw-Hill
25. Gerhard Herzberg, Atomic Spectra and Atomic Structure, 1st Edition, 1950, Dover Publications
26. G. Aruldhas, Molecular Structure and Spectroscopy, 1st Edition, 2000, Prentice Hall of India
27. Colin N. Banwell and Elaine M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition, 1994, Tata McGraw-Hill Publishing Company Limited
28. D.K. Roy and S.N. Thakur, Introduction to Atomic, Molecular and Laser Physics, 1st Edition, 2013, Prentice Hall of India
29. B. Narayan, Introduction to Atomic & Molecular Physics, 1st Edition, 2007, New Age International
30. Satyaprakash and J.P. Agrawal, Statistical Mechanics, 1st Edition, 1987, Wiley Eastern
31. B.K. Agrawal and M. Eisner, Statistical Mechanics, 1st Edition, 1996, Springer
32. F. Reif, Fundamentals of Statistical and Thermal Physics, 1st Edition, 1965, McGraw-Hill
38. John R. Christman, Fundamentals of Solid-State Physics, 1st Edition, 1988, Wiley
39. Adrian J. Dekker, Solid State Physics, 1st Edition, 1957, Macmillan
40. Charles Kittel, Introduction to Solid State Physics, 8th Edition, 2004, Wiley
41. J.P. Srivastava, Elements of Solid-State Physics, 4th Edition, 2017, Prentice Hall of India
42. James P. McKelvey, Solid State and Semiconductor Physics, 2nd Edition, 1982, Harper & Row
43. Neil W. Ashcroft and N. David Mermin, Solid State Physics Problems and Solutions, Companion to the 1st Edition, 1976
44. S.O. Pillai, Solid State Physics, 8th Edition, 2015, New Age International Publishers
45. M. Ali Omar, Elementary Solid-State Physics, Revised Edition, 1999, Pearson
46. Charles Kittel, Quantum Theory of Solids, 2nd Edition, 1987, Wiley
47. Nikhil Ranjan Roy and Rakesh Kumar Pandey, Elements of Nuclear Physics, Atlantic publishers & Distributors (P) Ltd., 2024.
52. R.R. Roy and B.P. Nigam, Nuclear Physics, Revised Edition, 2001, New Age International
53. Kenneth S. Krane, Introductory Nuclear Physics, 1st Edition, 1987, Wiley
54. S.N. Ghoshal, Atomic and Nuclear Physics (Vol. 2), 1st Edition, 1997, S. Chand Group
55. Irving Kaplan, Nuclear Physics, 2nd Edition, 1987, Narosa Publications
56. H.A. Bethe and P. Morrison, Elementary Nuclear Theory, 2nd Edition, 1956, Dover Publications
57. Enrico Fermi, Nuclear Physics, 1st Edition, 1950, University of Chicago Press
58. J.P. Srivastava, Elements of Nuclear Physics, 1st Edition, 2015, Prentice Hall of India
59. A.K. Sinha and K. Chattopadhyay, Fundamentals of Nuclear Physics, 1st Edition, 2012, Prentice Hall of India

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PHYSICS-AMJ 3: Practical

Credits: 04 Lectures: 120 (60X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines

Experiment	*= 60 marks*
Practical record notebook	*= 20 marks*
Viva-voce	*= 20 marks*

1. Determination of wavelength of He-Ne Laser light using transmission Grating.
2. Determination Of Wavelength of He-Ne Laser Light by using vernier callipers/ reflection grating.
3. Determination of thickness of thin wire using He-Ne Laser light.
4. Verification of Brewster's Law using spectrometer.
5. Determination of wavelength of Sodium light using Michelson Interferometer.
6. Determination of wavelength of Sodium light using Fabry – Perot interferometer.
7. Analysis of elliptically polarized light using l/4 plate and Babinet's compensator.
8. Verification of Rayleigh's criterion for the limit of resolution of spectral lines using (a) telescope and (b) grating spectrum.
9. To study Characteristics of MOSFET.
10. To study Characteristics of UJT.
11. To study Characteristics of SCR (Silicon Controlled Rectifier).
12. Study of waveform of Monostable Multivibrator using Oscilloscope.
13. Study of waveform of Bistable multivibrator using Oscilloscope.
14. Study of BCD to seven segments.
15. To determine refractive index of a given sample using He-Ne/diode laser.
16. Study of mode characteristics of near infrared diode laser and measurement of atmospheric oxygen absorption.
17. Study of materials by Mossbauer spectroscopy and positron annihilation technique.
18. Measurement of optical properties of a glass plate by laser Fizeau interferometry.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash& Ramakrishna, 11th Ed., 2011, Kitab Mahal.
4. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
5. An Advanced Course in Practical Physics, D. Chattopadhyay & P. C. Rakshit, 2013,New Book Agency (P) Ltd.
6. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press
7. B.Sc. Practical Physics, H. Singh & P. S. Hemne, 2011, S Chand and Company Ltd
8. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition,reprinted 1985, Heinemann Educational Publishers.
9. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.

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MINOR PAPERS

MINOR PAPERS FROM DISCIPLINE-1

SEMESTER I

PHYSICS-MN-1A : MECHANICS

(Credits: Theory-03, Practicals-01)

MN-1A: Theory

Credits: 03 Lectures: 45

Marks: 75 (End Semester Examination=60, Semester Internal Examination=10, Class Performance & Attendance =05) **Pass Marks (Internal + End Semester) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE 10 marks):

*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

- This course begins with the review of Vectors and Differential equations and ends with the Special Theory of Relativity. Students will also appreciate the Gravitation, Elasticity, Surface tension, Viscosity and Oscillations.
- The emphasis of this course is to enhance the basics of mechanics. By the end of this course, students should be able to solve the seen or unseen problems/numericals in vectors, differential equations and mechanics and some properties of matter.

COURSE LEARNING OUTCOMES

Upon completion of this course, students are expected to understand the following concepts which would help them to appreciate the application of the fundamental concepts to the analysis of simple, practical situations related to the real world:

- Understand the role of vectors and coordinate systems in Physics.
- Learn to solve Ordinary Differential Equations: First order, Second order Differential Equations with constant coefficients.
- Understand laws of motion and their application to various dynamical situations.
- Apply Kepler's law to describe the motion of planets and satellite in circular orbit through the study of law of Gravitation.
- Explain the phenomenon of simple harmonic motion.

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- Understand special theory of relativity - special relativistic effects and their effects on the mass and energy of a moving object.
- In the laboratory course, after acquiring knowledge of how to handle measuring instruments (like screw gauge, vernier callipers, travelling microscope) student shall embark on verifying various principles learnt in theory. Measuring 'g' using Bar Pendulum, Kater's pendulum and measuring elastic constants of materials, viscous properties of liquids etc.

SKILLS TO BE LEARNED

- Learn the concepts of vector calculus.
- Learn the concepts of elasticity of solids and viscosity of fluids.
- Develop skills to understand and solve the equations of Newtonian gravity and central force problem.
- Acquire basic knowledge of oscillation.
- Have an understanding of basic concepts of Special Theory of Relativity.

COURSE CONTENT

Vector Analysis: Triple Scalar product, Triple Vector product, gradient, divergence, Curl and their physical significance, scalar and vector fields, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem. **(10 Lectures)**

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(4 Lectures)**

Central force field: Motion of a particle in a central force field –two body problem. Kepler's Laws and their deduction. **(4 Lectures)**

Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. **(4 Lectures)**

Elasticity: Elastic constants and their interrelations, Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion, Torsional pendulum. **(8 Lectures)**

Fluids: Surface Tension: Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature. Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula - Determination of coefficient of viscosity of a liquid - Variations of viscosity of liquid with temperature. **(8 Lectures)**

Special Theory of Relativity: Galilean transformations. Postulates of Special Theory of Relativity. Lorentz transformation, Length contraction. Time dilation. Relativistic addition of velocities. **(7 Lectures)**

Reference Books:

1. Mathematical Physics, H K Das and Dr. Rama Verma, S. Chand and Company Limited.
2. Mathematical Physics, B D Gupta, Vikash Publishing House, 4th edition.
3. Mathematical Physics, B.S. Rajput, Pragati Prakashan, 21st Edition, 2009.
4. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jonesand Bartlett Learning.

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5. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
6. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley.
7. Mechanics Berkeley Physics, v.1: Charles Kittel, et. al. 2007, Tata McGraw-Hill.
8. Physics – Resnick, Halliday& Walker 9/e, 2010, Wiley.
9. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
10. Elements of Properties of Matter, D. S. Mathur, S. Chand Publication.
11. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
12. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
13. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
14. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning
15. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
16. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
17. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
18. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
19. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
20. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Additional Books for Reference

1. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
2. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
3. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010,
a. Cengage Learning
4. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

MN-1A: Practical

Credit: 01 Lectures: 30 (15X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. To measure the diameter of a thick wire using vernier caliper.
2. To measure the diameter of a thick wire using screw gauge.
3. To measure the diameter of a thick wire using travelling microscope.
4. To study the random error in observations.
5. To study the Motion of Spring and calculate (a) Spring constant, (b) **g**.
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille'smethod).
7. To determine the Young's Modulus of a Wire by suitable method.
8. To determine the Modulus of Rigidity of a Wire by suitable method.
9. To determine the elastic Constants of a wire by Searle's method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater's Pendulum.

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Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, KitabMahal
4. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
5. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company, 19th Edition, 1995, Reprint 2014.
6. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt.Ltd.
7. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

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SEMESTER III

PHYSICS- MN-1B: THEORY ELECTRICITY & MAGNETISM

(Credits: Theory-03, Practicals-01)

MN-1B: Theory

Credits: 03 Lectures: 45

Marks: 75 (End Semester Examination=60, Semester Internal Examination=10, Class Performance & Attendance =05) **Pass Marks (Internal + End Semester)= 30**

Instruction to Question Setter for

Semester Internal Examination (SIE 10 marks):

*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

This course begins with static electric field and magnetic field. By the end of the course student should have in depth knowledge of electrostatics and magnetostatics, learn about Faraday's and Len'z laws of electromagnetic induction and also appreciate Maxwell's equations.

COURSE LEARNING OUTCOMES

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

- Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.
- Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
- Apply Gauss's law of electrostatics to solve a variety of problems.
- Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electric potential.
- Demonstrate a working understanding of capacitors
- Calculate the magnetic forces that act on moving charges and the magnetic fields due to currents (Biot- Savart and Ampere laws)
- Have brief idea of dia-, para- and ferro-magnetic materials
- Understand the concepts of induction and self-induction, to solve problems using Faraday's and Lenz's laws
- Have an introduction to Maxwell's equations
- In the laboratory course the student will get an opportunity to verify various laws in electricity and magnetism.

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- Should be able to verify of various circuit laws, network theorems elaborated above, using simple electric circuits.

SKILLS TO BE LEARNED

- This course will help in understanding basic concepts of electricity and magnetism and their applications.
- He / she shall comprehend the role of Maxwell's equation in unifying electricity and magnetism.
- Enable the student to understand propagation of electromagnetic waves through different bound and unbound media.

COURSE CONTENT

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

(20 Lectures)

Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro- magnetic materials. **(10 Lectures)**

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field. **(5 Lectures)**

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves.

(10 Lectures)

Reference Books:

1. Classical Electromagnetism, H.C. Verma, Bharati Bhawan (Publishers & Distributors); First Edition (1 February 2022).
2. Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
3. Electricity & Magnetism, J.H. Fewkes&J.Yarwood. Vol. I, 1991, Oxford Univ. Press
4. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
6. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn, 1998, Benjamin Cummings.
7. Electromagnetic Theory and electrodynamics Satyaprakash, Kedar Nath Ram Nath Publishers
8. Electricity and Magnetism, K.K. Tiwari, S Chand Publishers.
9. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
10. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
11. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill.
12. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning.
13. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer.
14. Electromagnetic Fields & Waves, P. Lorrain & D. Corson, 1970, W.H. Freeman & Co.
15. Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.

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16. Electromagnetic Theory, Chopra and Agarwal, K. Nath& Co., Meerut.
17. Electromagnetic Theory and electrodynamics, Satyaprakash, , KedarNath Ram Nath Publishers
18. Electricity and Magnetism, K.K. Tiwari, S Chand Publishers.
19. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press.

MN-1B: Practical

Credit: 01 Lectures: 30(15X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. To find the value of a resistor and its tolerance by colour coding.
2. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
3. To study the characteristics of a series RC Circuit.
4. To verify the laws of combination (series and parallel) of resistances using a metre bridge.
5. To determine an unknown Low Resistance using Potentiometer.
6. To verify Ohm's law for the given unknown resistance.
7. To verify the Thevenin theorem.
8. To verify the Norton theorem.
9. To verify the Superposition theorem.
10. To verify Maximum power transfer theorem.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
4. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
5. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
6. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company.

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SEMESTER V

PHYSICS- MN-1C: THERMAL PHYSICS AND STATISTICAL MECHANICS

(Credits: Theory-03, Practicals-01)

MN-1C: Theory

Credits: 03 Lectures: 45

Marks: 75 (End Semester Examination=60, Semester Internal Examination=10, Class Performance & Attendance =05) **Pass Marks (Internal + End Semester)= 30**

Instruction to Question Setter for
Semester Internal Examination (SIE 10 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

This course will introduce Thermodynamics, Kinetic theory of gases and Statistical Mechanics to the students. The primary goal is to understand the fundamental laws of thermodynamics and its applications to various thermodynamical systems and processes.This coursework will also enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecule through statistical mechanics.

COURSE LEARNING OUTCOMES

At the end of this course, students will

- Learn the basic concepts of thermodynamics, the first and the second law of thermodynamics, the concept of entropy and the associated theorems, the thermodynamic potentials and their physical interpretations. They are also expected to learn Maxwell's thermodynamic relations.
- Know the fundamentals of the kinetic theory of gases, Maxwell-Boltzmann distribution law, equipartition of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion and Brownian motion.
- Learn about the black body radiations, Stefan- Boltzmann's law, Rayleigh-Jean's law and Planck's law and their significances.
- Learn the quantum statistical distributions, viz., the Bose-Einstein statistics and theFermi-Dirac statistics.
- In the laboratory course, the students are expected to: Measure of Planck's constant using black body radiation, determine Stefan's Constant, coefficient of thermal conductivity of a bad conductor and a good conductor, determine the temperature co- efficient of resistance, study variation of thermo emf across two junctions of a thermocouple with temperature etc.

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SKILLS TO BE LEARNED

- In this course the students should be skilled in doing calculations in thermodynamics and in statistical mechanics.
- They should also be proficient in doing calculations with the kinetic theory of ideal and real gases.
- In the laboratory course, the students should acquire the skills of doing basic experiments in thermal physics with the right theoretical explanations of results there from.

COURSE CONTENT

Laws of Thermodynamics: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics (statement only), Unattainability of absolute zero. **(15 Lectures)**

Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for (CP – CV), CP/CV, TdS equations. **(8 Lectures)**

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path, Transport Phenomena: Viscosity, Conduction and Diffusion, Law of equipartition of energy and its applications to specific heat of gases; mono-atomic and diatomic gases. **(8 Lectures)**

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction from Planck's law-Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law. **(5 Lectures)**

Statistical Mechanics: Maxwell-Boltzmann law - distribution of velocity, Quantum statistics: Phase space - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics. **(9 Lectures)**

Reference Books:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
4. Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears and G.L. Salinger. 1988, Narosa.
5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
6. Advanced Text Book on Heat, P. K. Chakrabarti, 10th Edition, Reprint 2015, Sreedhar Publishers.
7. Heat Thermodynamics and Statistical Physics, Brijlal, Dr. N. Subrahmanyam and P. S. Hemne, S. Chand Publishers.

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MN-1C: Practical

Credit: 01 Lectures: 30(15X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
5. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
6. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
7. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers.
3. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.
4. A text book on Practical Physics, K. G. Mazumdar and B. Ghosh, Sreedhar Publishers, Reprint 2016.
5. Advanced Text Book on Heat, P. K. Chakrabarti, 10th Edition, Reprint 2015, Sreedhar Publishers.
6. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
7. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
8. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company.

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SEMESTER VII

PHYSICS- MN-1D: WAVES & OPTICS

(Credits: Theory-03, Practicals-01)

MN-1D: Theory

Credits: 03 Lectures: 45

Marks: 75 (End Semester Examination=60, Semester Internal Examination=10, Class Performance & Attendance =05)
Pass Marks (Internal + End Semester)= 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10 marks):

*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

COURSE OBJECTIVE

This is one of the core courses in Physics curriculum that begins with explaining ideas of superposition of harmonic oscillations leading to physics of travelling and standing waves. This course helps in understanding forced vibrations, resonance, acoustics of buildings, Reverberation and time of reverberation - absorption coefficient. The course also provides an in depth understanding of wave phenomena of light, namely, interference, diffraction and polarization with emphasis on practical applications of the same.

COURSE LEARNING OUTCOMES

At the end of this course, students will

- Understand Simple harmonic oscillation and superposition principle.
- Understand superposition of a range of collinear and mutually perpendicular simpleharmonic motions and their applications.
- Understand the importance of classical wave equation in transverse and longitudinalwaves and solving a range of physical systems on its basis.
- Understand different types of waves and their velocities: Plane, Spherical, Transverse, Longitudinal.
- Understand Concept of normal modes in transverse and longitudinal waves: theirfrequencies and configurations.
- Understand Forced vibrations and resonance, Fourier's Theorem. Acoustics of buildings, Reverberation and time of reverberation - Absorption coefficient - Sabine's formula.
- Understand Interference as superposition of waves from coherent sources derived from same

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parent source.

- Demonstrate understanding of Interference experiments: Young's Double Slit, Fresnel'sbiprism, Llyod's Mirror, Newton's Rings, Michelson Interferometer and Fabry-Perot Interferometer
- Demonstrate basic concepts of Diffraction: Superposition of wavelets diffracted fromapertures
- Understand Fraunhoffer Diffraction from apertures: Rectangular, Slit, Double Slit, Grating, Circular apertures.
- Demonstrate fundamental understanding of Fresnel Diffraction: Half period zones,Zone Plate, Fresnel's Integrals, Cornu's Spiral and its applications.
- Understand the phenomenon of polarization of light, production and analysis of plane, circular and elliptical polarized light.
- In the laboratory course, student will gain hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. Resolving power of optical equipment can be learnt first-hand.
- The motion of coupled oscillators, study of Lissajous figures and behaviour of transverse and longitudinal waves can be learnt in this laboratory course.

SKILLS TO BE LEARNED

- In this course the students should understand waves motion and its properties.
- The students shall develop the skills to understand about Acoustics of buildings, Reverberation and time of reverberation
- The students shall develop an understanding on various opticalphenomena, principles, workings and applications optical instruments

COURSE CONTENT

Superposition of Two Collinear Harmonic oscillations: Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).
(4 Lectures)

Waves Motion: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. **(6 Lectures)**

Sound: Forced vibrations and resonance, Fourier's Theorem - Application to saw tooth wave and square wave. Acoustics of buildings, Reverberation and time of reverberation - Absorption coefficient - Sabine's formula. **(8 Lectures)**

Interference: Interference: Division of amplitude and division of wavefront. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.
(8 Lectures)

Michelson's Interferometer: (1) Idea of form of fringes (no theory needed), (2) Determination of wavelength, (3) Wavelength difference, (4) Refractive index, and (5) Visibility of fringes. **(5 Lectures)**

Diffraction: Fraunhofer diffraction- Single slit; Double Slit. Plane Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(9 Lectures)**

Polarization: Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization. **(5 Lectures)**

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Reference Books:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
3. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
4. Oscillations & Waves, Satya Prakash, Pragati Prakashan, Meerut, Edition XI, 2019.
5. Sound, K. Bhattacharyya, Shreedhar Prakashani, Reprint-2015.
6. A text book of Sound, M. Ghosh, S. Chand & Company, 1998.
7. A text book of Oscillations, Waves and Acoustics, M Ghosh & D Bhattacharya, S. Chand, 2016.
8. A textbook of Sound, N Subrahmanyam, Brij Lal, S, Chand, Second Edition, 2018.
9. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
10. Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
11. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications.
12. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley.
13. Introduction to Geometrical and Physical Optics, B. K. Mathur, Gopal Printing,
14. Geometrical and Physical Optics, P. K. Chakraborty, New Central Book Agancy (P) Ltd.
15. Introduction to Geometrical and Physical Optics, B. K. Mathur, Gopal Printing.
16. A Text Book on Light, B. Ghosh and K. G. Mazumdar, 5th Edn.,Reprint 2015, Sreedhar Publishers.
17. A Text Book of Optics, Dr. N. Subrahmanyam, Brijlal, Dr. M. N. Avadhanulu, S. Chand Publishers.

MN-1D: Practical

Credit: 01 Lectures: 30(15X2)

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination will be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

1. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $\lambda 2$ – T Law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine the Refractive Index of the Material of a Prism using Sodium Light.
6. To determine Dispersive Power of the Material of a Prism using Mercury Light
7. To determine the value of Cauchy Constants.
8. To determine the Resolving Power of a Prism.
9. To determine wavelength of sodium light using Fresnel Biprism.
10. To determine wavelength of sodium light using Newton's Rings.
11. To determine the wavelength of Laser light using Diffraction of Single Slit.
12. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
13. To determine the Resolving Power of a Plane Diffraction Grating.

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Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers.
3. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.
4. A text book on Practical Physics, K. G. Mazumdar and B. Ghosh, Sreedhar Publishers, Reprint 2016.
5. Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
6. A Text Book on Light, B. Ghosh and K. G. Mazumdar, 5th Edn., Reprint 2015, Sreedhar Publishers.
7. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
8. B.Sc. Practical Physics, N. N. Ghosh, Bharati Bhawan Publishers.
9. B.Sc. Practical Physics, C. L. Arora, S. Chand & Company

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MINOR PAPERS FROM VOCATIONAL STUDIES/ DISCIPLINE-2

SEMESTER II

PHYSICS-MN-2A: ENERGY SOURCES

Credits: 04 (Theory +Practical/ Viva voce/ Demonstration/ Skill test)

Theory + Practical/ Viva voce/ Demonstration/ Skill test *Marks*: 100	**Pass Marks= 40**

Instruction to External examiner for Written Test (Theory): 75 marks

*There will be **two group of questions. Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

Practical/Viva voce/ Demonstration/ Skill test: 25 marks

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible.

MN-2A: Theory

Lectures: 45

COURSE CONTENT

Non-Renewable energy sources: Introduction: Energy concept-sources in general, its significance & necessity, Classification of energy sources: Primary and Secondary energy, Commercial and Non-commercial energy, Renewable and Non-renewable energy, Conventional and Non-conventional energy, Based on Origin-Examples and limitations. Importance of Non-commercial energy resources. **(7 Lectures)**

Conventional energy sources: Fossil fuels & Nuclear energy- production & extraction, usage rate and limitations. Impact on environment and their issues & challenges. Overview of Indian & world energy scenario with latest statistics- consumption & necessity. Need of eco-friendly & green energy & their related technology. **(8 Lectures)**

Renewable energy sources: Introduction: Need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **(8 Lectures)**

Solar energy: Solar Energy-Key features, its importance, Merits & demerits of solar energy, Applications of solar energy. Solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar, cell -brief discussion of each. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(7 Lectures)**

Wind and Tidal Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies,

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Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy.

(8 Lectures)

Geothermal and hydro energy: Geothermal Resources, Geothermal Technologies, Hydropower resources, hydropower technologies, environmental impact of hydro power sources, Carbon captured technologies, cell, batteries, power consumption. **(7 Lectures)**

Reference Books:

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative , Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford.
5. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
6. J. Balfour, M. Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

MN-2A: Practical/ Demonstration/ Skill test & Viva voce

Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):

There will be one Practical/Demonstration Examination of 3Hrs duration. Evaluation of Practical/Demonstration Examination will be as per the following guidelines:

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

1. Performance testing of solar cooker.
2. Measurement of I-V characteristics of solar cell.
3. Study the effect of input light intensity on the performance of solar cell.
4. Study the characteristics of wind.
5. Study of charge and discharge characteristics of storage battery.
6. Study of charging and discharging behaviour of a capacitor.
7. Performance estimation of a fuel cell.
8. Study of effect of temperature on the performance of fuel cell.
9. Demonstration of Training modules on Solar energy, wind energy, etc.
10. Conversion of vibration to voltage using piezoelectric materials
11. Conversion of thermal energy into voltage using thermoelectric modules.

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SEMESTER IV

PHYSICS- MN-2B: BASIC INSTRUMENTATION SKILLS

Credits: 04 (Theory +Practical/ Viva voce/ Demonstration/ Skill test)

Theory + Practical/ Viva voce/ Demonstration/ Skill test *Marks*: 100	**Pass Marks= 40**

Instruction to External examiner for Written Test (Theory): 75 marks
*There will be **two group of questions. Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*
***Note:** There may be subdivisions in each question asked in Theory Examinations.*
Practical/Viva voce/ Demonstration/ Skill test: 25 marks

The aim of this course is to enable the students to be familiar with various aspects of instruments and also their usage through hands-on mode. This course enables students to understand the basics of measurement, measurement devices such as electronic voltmeter, Oscilloscope, signal and pulsegenerators, Impedance bridges, digital instruments etc.

MN-2B: Theory
Lectures: 45

COURSE CONTENT

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. **(5 Lectures)**

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. **AC millivoltmeter:** Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance. **(8 Lectures)**

Cathode Ray **Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence &chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. **(8 Lectures)**

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. **(5 Lectures)**

Signal Generators and Analysis Instruments: Block diagram, explanation and specificationsof low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. **(6 Lectures)**

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

(5 Lectures)

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

(5 Lectures)

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

(3 Lectures)

Reference Books:

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

MN-2B: Practical/ Demonstration/ Skill test & Viva voce

Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):

There will be one Practical/Demonstration Examination of 3Hrs duration. Evaluation of Practical/Demonstration Examination will be as per the following guidelines:

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

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

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SEMESTER VI

PHYSICS- MN-2C: OPTICAL INSTRUMENTS

Credits: 04 (Theory +Practical/ Viva voce/ Demonstration/ Skill test)

Theory + Practical/ Viva voce/ Demonstration/ Skill test *Marks*: 100	**Pass Marks= 40**

Instruction to External examiner for Written Test (Theory): 75 marks
There will be ***two*** *group of questions.* ***Group A is compulsory*** *which will contain three questions.* ***Question No.1 will be very short answer type*** *consisting of five questions of 1 mark each.* ***Question No.2 & 3 will be short answer type*** *of 5 marks.* ***Group B will contain descriptive type*** *six questions of fifteen marks each, out of which any four are to answer.*
Note: *There may be subdivisions in each question asked in Theory Examinations.*
Practical/Viva voce/ Demonstration/ Skill test: 25 marks

The course is aimed at equipping the students with the basic understanding of Optics and various optical instruments like different types of microscopes, telescopes, spectrometer, camera and also human eye and enabling them to gain hands-on experience of using these optical instruments.

MN-2C: Theory
Lectures: 45

COURSE CONTENT

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

Camera and microscopes: Human eye (constitution and working), Photographic camera (principle, construction and working), construction, working and utilities of
- (i) Simple microscopes
- (ii) Compound microscope
- (iii) Electron microscopes
- (iv) Binocular microscopes **(13 Lectures)**

Telescopes and Spectrometer: Construction, working and utilities of
- (i) Astronomical telescopes
- (ii) Terrestrial telescopes
- (iii) Reflecting telescopes,

Spectrometer-Construction, working and utilities, measurement of refractive index. **(12 Lectures)**

Reference Books:

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

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5. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
6. Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
7. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications
8. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley.
9. Introduction to Geometrical and Physical Optics, B. K. Mathur, Gopal Printing,
10. Geometrical and Physical Optics, P. K. Chakraborty, New Central Book Agency (P) Ltd.
11. Introduction to Geometrical and Physical Optics, B. K. Mathur, Gopal Printing.
12. A Text Book on Light, B. Ghosh and K. G. Mazumdar, 5th Edn., Reprint 2015, Sreedhar Publishers.
13. A Text Book of Optics, Dr. N. Subrahmanyam, Brijlal, Dr. M. N. Avadhanulu, S. Chand Publishers.

MN-2C: Practical/ Demonstration/ Skill test & Viva voce

Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):

There will be one Practical/Demonstration Examination of 3Hrs duration. Evaluation of Practical/Demonstration Examination will be as per the following guidelines:

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

1. Find position and size of the image in a magnifying glass and magnification.
2. Observe rain bows and understand optics. Create a rainbow.
3. Find out what makes a camera to be of good quality.
4. Observe the dispersion of light through prism.
5. Make a simple telescope using magnifying glass and lenses.
6. Learn principle of refraction using prisms.
7. Check bending of light in different substances and find out what matters here.
8. Learn about different telescopes used to see galaxies and their ranges.

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SEMESTER VIII

PHYSICS- MN-2D: DIGITAL SYSTEMS

Credits: 04 (Theory +Practical/ Viva voce/ Demonstration/ Skill test)

Theory + Practical/ Viva voce/ Demonstration/ Skill test *Marks*: 100	Pass Marks= 40

Instruction to External examiner for Written Test (Theory): 75 marks
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*
Note: *There may be subdivisions in each question asked in Theory Examinations.*
Practical/Viva voce/ Demonstration/ Skill test: 25 marks

The aim of this course is to enable the students to have a basic understanding of Boolean algebra, Arithmetic Circuits, flip flops etc. and also have a hands-on experience of studying and designing various digital circuits.

MN-2D: Theory
Lectures: 45

COURSE CONTENT

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. **(12 Lectures)**

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion ofa Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(10 Lectures)**

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **(5 Lectures)**

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors. **(8 Lectures)**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip- Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S J K Flip-Flop. **(10 Lectures)**

Reference Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw Hill.
2. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Digital Electronics G K Kharate ,2010, Oxford University Press.
5. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning.
6. Logic circuit design, Shimon P. Vingron, 2012, Springer.
7. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

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8. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill.
9. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
10. Digital Electronics, Floyd.
11. Digital Computer Electronics, Malvino.
12. Digital systems & Applications, Dr Umamageswari and Dr. M. Sivakumar, Vishal Publishing Co., 2022-23.

MN-2D: Practical/ Demonstration/ Skill test & Viva voce

Lectures: 30 (15X2)

Practical/ Demonstration/ Skill test & Viva Voce: 25 marks

Instruction to External examiner for End Semester Examination (ESE):

There will be one Practical/Demonstration Examination of 3Hrs duration. Evaluation of Practical/Demonstration Examination will be as per the following guidelines:

Demonstration/Experiment	= 15 marks
Practical/Demonstration record notebook	= 05 marks
Viva-voce	= 05 marks

1. To design a switch (NOT gate) using a transistor.
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To design a combinational logic system for a specified Truth Table.
4. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
5. To minimize a given logic circuit.
6. To study Half Adder and Full Adder and Truth Table verification.
7. To study Half Subtractor and Full Subtractor and Truth table verification

MDC (Multidisciplinary Course): PHYSICS

SEMESTER I/II/III

MDC-1/2/3: PHYSICS

(Credits: Theory-03 Lectures-45)

Marks: 75 (End Semester Examination=75, *No* Semester Internal Examination	**Pass Marks: = 30**

Instruction to Question Setter for

End Semester Examination (ESE 75 marks):
There will be ***two** group of questions.* ***Group A is compulsory*** *which will contain* ***three questions.*** ***Question No.1 will be very short answer type*** *consisting of* ***five questions*** *of* ***1 mark*** *each.* ***Question No. 2 & 3 will be short answer type*** *of* ***5 marks.*** ***Group B will contain descriptive type six questions*** *of* ***fifteen marks*** *each, out of which any* ***four*** *are to answer.*

Unit I Motion
Velocity, acceleration, momentum, inertia, force, laws of motion. Newton's law of gravitation, acceleration due to gravity, mass and weight, weightlessness. **(6 lectures)**

Unit II Properties of Matter
Different phases of matter, surface tension capillary rise, viscosity-Poiseuille's formula, Heat, temperature, different temperature scales: degree Celsius, Fahrenheit and Kelvin, idea of transverse and longitudinal waves. **(9 Lectures)**

Unit III Light & lenses
Reflection, refraction, total internal reflection, dispersion, diffraction, interference, scattering (elementary ideas only), blue colour of sky, twinkling of stars. Mirage, rainbow, concave and convex lenses, focal length, power of a lens, refractive index, defects of the eye– myopia, hypermetropia, presbyopia and astigmatism and their correction by lens. **(11 Lectures)**

Unit IV Electricity & Magnetism
Electricity: Voltage and current, Ohms law, idea of combination of resistance in series and parallel, Electric power (E Bill), calculation of energyrequirement of electric appliances, transformer, generator.
Magnetism: Electromagnetic induction-super conductivity-Meissner effect (qualitative idea), Maglev train. **(10 Lectures)**

Unit V Our Universe
Galaxies- Stars, Planets & satellites – solar system, lunar and solar eclipses, evolution of stars, black holes (basic concept). Artificial satellites: Geo stationary and Polar satellites. **(9 Lectures)**

Reference Books:

1. Physics text books for class 11th and 12th NCERT, New Delhi, revised editions 2022.
2. Concepts of Physics, Part-I and Part-II, H. C. Verma, 2020, Bharati Bhawan.
3. Elements of Properties of Matter, D. S Mathur,2010, S. Chand & Co.
4. Fundamentals of Physics with Applications, Arthur Beiser, 2010, Tata McGraw-Hill publishing Co. Ltd.

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5. Optics by Ajay Ghatak, New Delhi, 1998 Tata McGraw-Hill publishing Co. Ltd.
6. Electricity and Magnetism, A S Mahajan, A. A. Rangwala, 2017 McGraw Hill, New Delhi.
7. An Introduction to Astrophysics, Baidyanath Basu, Tanuka Chattopadhyay, sudhindraNath Biswas, Second Edition, 2010, PHI Learning Private Limited.

Additional Books for reference:

1. Mechanics (in SI units) - (Berkley Physics course-volume 1), Charles Kittel, Walter Dknight etc, Tata McGraw Hill publication, 2017, second edition
2. Fundamental of General Properties of Matter, H.R Gulati, R Chand and Co, Fifthedition (1977).
3. A Text book of Optics by Subrahmanyam N., BrijLal and M. N. Avadhanulu,

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FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATIONS

Question format for 10 Marks:

Subject/ Code

F.M. =10 Time=1Hr. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. Answer 1 out of 2 subjective/ descriptive questions given in Group B.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. ....
   ii. ....
   iii. ....
   iv. ....
   v. ....

Group B

2. .... [5]
3. .... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for 20 Marks:

Subject/ Code

F.M. =20 Time=1Hr. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. Answer 1 out of 2 subjective/ descriptive questions given in Group B.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. ....
   ii. ....
   iii. ....
   iv. ....
   v. ....
2. .... [5]

Group B

3. .... [10]
4. .... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

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FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATIONS

Question format for **50 Marks:**

Subject/ Code

F.M. =50 Time=2Hrs. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. Answer 3 out of 5 subjective/ descriptive questions given in **Group B.**
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. ....
   ii. ....
   iii. ....
   iv. ....
   v. ....

Group B

2. .... [15]
3. .... [15]
4. .... [15]
5. .... [15]
6. .... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **60 Marks:**

Subject/ Code

F.M. =60 Time=3Hrs. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B.**
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. ....
   ii. ....
   iii. ....
   iv. ....
   v. ....
2. .... [5]
3. .... [5]

Group B

4. .... [15]
5. .... [15]
6. .... [15]
7. .... [15]
8. .... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

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Question format for **75 Marks:**

Subject/ Code

F.M. = 75 Time=3Hrs. Exam Year

General Instructions:

i. Group A carries very short answer type compulsory questions.
ii. Answer 4 out of 6 subjective/ descriptive questions given in Group B.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. ....
   ii. ....
   iii. ....
   iv. ....
   v. ....
2. .... [5]
3. .... [5]

Group B

4. .... [15]
5. .... [15]
6. .... [15]
7. .... [15]
8. .... [15]
9. .... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Sayantan Sil
28-08-2024

28/08/24

28.08.24

28/8/24

28/8/24

28/8/24