SIDO KANHU UNIVERSITY, DUMKA

Course curriculum based on Choice Based Credit System (CBCS)

For

Post-Graduate Programme

(M.Sc.-Physics)

Effective from the academic session 2024 - 2026

18.07.24

19/07/24

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Important Regulations of CBCS for Students made by University

Duration of the course: Minimum duration for completion of a two year Post Graduate Programme is four semesters (two years) and maximum eight semesters (four years).

1. Semester is used to mean a half yearly term or term of study including examinations, vacations and semester breaks. As academic year consists of two semesters.

   Odd Semester: (I & III): July to December

   Even Semester (II & IV): December to May

   A semester normally extends over a period of 16 class weeks. Each week has 30 hours of instruction spread over the week.

2. **Attendance:** A student shall be permitted to appear for the semester examination, only if he/she secures not less than 75 % attendance in each semester. Condonation of shortage of attendance of each week a maximum of 12 days for a maximum of two spells within a programme may be granted as per the existing University rules. A student who is not eligible for such condonation shall repeat the course along with the subsequent batch.

3. **Examination and Evaluation:** Evaluation will be done on a continuous basis, three times during each semester. For the purpose of uniformity, particularly for interdepartmental transfer of credits, there shall be a uniform procedure of examination to be adopted by all teachers. There will be two mid-term/ sessional tests and one End semester examination in each course during every semester.

   (a) Mid-term / Sessional Test-I will be held during the 6th week of the semester for the syllabi covered till then.

   (b) Mid-term / Sessional Test-II will be held during 11th week for the syllabi covered between 7th and 11th week.

   (c) Mid-term / Sessional Tests (of one to two hours duration) may employ one or more assessment tools such as objective tests, assignments, paper presentation, laboratory work, etc. suitable to the course. This requires an element of openness. The students are to be informed in advance about the nature of assessment. Students shall compulsorily attend the two sessional tests failing which they will not be allowed to appear for end semester examination. A student cannot repeat Sessional Tests. However, if for any compulsive reason a student could not attend the test, the prerogative of arranging a special test lies with the teacher provided the concerned student reports the matter to the course teacher within one week of the date on which the test was conducted. In case of students who could not attend any of the sessional tests due to medical reason or under extraordinary circumstances, a separate shall be conducted before the End Semester Examinations by the concerned faculty member.

(d) The mid-term sessional tests will carry 30% of total marks for the course. The marks of the two Sessional Tests (Best of Two) shall be taken into account for the computation of Grades.

Board of studies

Chairperson:

Dr. Rajesh Kumar Yadav
Assistant Professor & Head I/C University Department of Physics, SKMU, Dumka

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Members:

1) Dr. D. N. Garain
   Dean, Science Faculty, SKMU, Dumka

2) Dr. Abdus Sattar
   Associate Professor, Department of Physics & CCDC, SKMU, Dumka

3) Dr. Rajeev Rajan Sinha
   Assistant Professor, Department of Physics, SKMU, Dumka

   R R Sinha 19-07-2024

4) Dr. Indrajeet Kumar
   Assistant Professor, Department of Physics, S P College, Dumka

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5) Mr. Rajesh Kumar
   Assistant Professor, Department of Physics, Model College, Dumka

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3. External Member.
   1. Prof (Dr.) Jagdhar Mandal (Prof & Dean) - online
      (TMBU Bhagalpur).

(e) There shall be one End Semester Examination of 3 hours duration carrying 70% of Marks in each course covering the entire syllabus prescribed for the course. The end semester examination is normally a written / Laboratory–based examination. The mode of end semester examination and evaluation will be decided by teacher in consultation with the Departmental committee. Model Question Paper for each course has to be prepared by the teacher and same should be forwarded to the Head of the Department. The end semester examination schedule will be prepared by the Head of the Department/College and displayed on the notice board at least one week before the examination with intimation to the controller of Examinations. The course faculty must evaluate the answer scripts and submit the results to the Head of the Department before the Departmental/Class committee meeting. The Head of the Department will fix the date for Departmental committee meeting to finalize the results or the University will take care of all such proceedings of end semester examination.

(f) End semester practical examination shall normally be held before the theory examinations.

(g) The result of mid-semester examination shall be notified by the concerned course teacher(s) within ten days of the examination.

(h) **Evaluation of Project Report/Dissertation and Viva-Voce:**

The students will submit Dissertation/ Project before end semester examination of SEM-IV.

The distribution of marks for the dissertation/Project will be as below:

Dissertation/Project=50 Marks PPT=25 Marks

Viva-Voce=25Marks Total =100 Marks

Dissertation/Project report must be submitted by the candidates in the department one week before the commencement of the end semester examination and it will be evaluated jointly by the supervisor and one other external examiner within the department/University nominated by the departmental council. Students may be asked to make a presentation before the faculty members and students.

(i) **Pass Marks:** A candidate has to secure a minimum of 45% of marks (Sessional test marks and End – Semester examination marks separately) in the course taken, to pass in that course. Candidate securing below 45% marks shall be deemed to have failed in that course.

Improvement is allowed for the end semester examination. Candidates who have passed in theory papers are allowed to appear again for theory paper/papers only once in order to improve his/her marks, by paying the fee prescribed from time to time within a maximum period prescribed thereto, counting from his/her first semester of his/her admission. If candidates improve his/her marks, then improved marks will be taken into consideration for award of grading only. **Such improved marks will not be counted for the award of Prizes/Medals, Rank and Distinction.** If the candidate does not show improvement in marks, his/her previous marks will be taken into consideration.

No candidate will be allowed to improve marks in Practical papers, Project, Viva –Voce, Field work.

Note: *A student successfully completes a semester by attaining a minimum of 45% marks in all papers. If they achieve this benchmark in at least 50% of the total papers (e.g., a minimum of 2 out of 4 papers, including practical exams), they qualify for promotion to the next semester. Failing to meet*

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this requirement leads to failure for the semester, preventing promotion. In such cases, re-examination within the same semester, upon payment of the requisite fees, is mandatory. Promotion is only applicable up to the third semester; results for the final/fourth semester are released only after successfully completing all three preceding semesters

(j) Award of Grades, SGPA, CGPA

Grade – Letter is an index to indicate the performance of a student in a particular course (Paper). It is indicated by grade letter O, A, B, C, D, E, F. There is range of marks for each grade letter. Grade point is weightage allotted to each grade letter depending on the marks awarded in a course paper.

Award of Grades

Range of % of Marks	Grade Letter	Grade Point
85 to 100	O	**10**
70 to 84	A	**9**
60 to 69	B	8
55 to 59	C	7
50 to 54	D	6
45 to 49	E	5
Less than 45	F	0

(k) Semester Grade Point Average (SGPA):

$\textit{Credit Point for the paper} = \text{No. of credits assigned for the paper} \times \text{Grade point secured for that course/ paper}$

SGPA indicates the performance of a student in a given semester. SGPA is calculated by dividing the total credit points earned by the student in all the courses by the total number of credits assigned to the courses/papers in a semester.

Note:-SGPA is computed only if the candidate passes in all the papers (gets a minimum 'E' Grade in all the papers).

(l) Cumulative grade point average (CGPA):

'Cumulative Grade Point Average (CGPA) is the value obtained by dividing the sum of credit points in all the Courses taken by a student for the entire Program by the total number of credits. CGPA shall be rounded off to two decimal places. CGPA indicates the broad level of academic performance of a student in a program. An overall letter grade (Cumulative Grade) for the entire programme shall be awarded to a student depending on his/her CGPA. The final result at the end of all the semesters is declared in the form of CGPA.

Note: - CGPA is calculated only when the candidate passes in all the papers of all the semesters.

A. **FOR ANY ONE SEMESTER (SGPA):**

$$SGPA = \frac{Sum\ of\ credit\ points\ of\ all\ papers\ (or\ Total\ credit\ points)}{Total\ course\ credit\ in\ a\ semester}$$

Example: If we have total 04 papers (X_1, X_2, X_3 and X_4) each carries 05 credits. If we obtain grade point $10, 9, 7$ and 5 respectively in these papers, then the

Total credit points $=(4 \times 10) + (4 \times 9) + (4 \times 7) + (4 \times 5) = 124$

Thus the SGPA will be

$$SGPA = \frac{124}{20} = 6.2$$

B. **WHEN THE CANDIDATE PASSES ALL SEMESTERS (CGPA):**

$$CGPA = \frac{SGPA\ (Sem\ I) \times Total\ credit\ (20) + SGPA(Sem\ II) \times Total\ credit\ (20) + SGPA(Sem\ III) \times Total\ credit\ (20) + SGPA(Sem\ IV) \times (20)}{Grand\ Total\ Course\ Credit\ (80)}$$

Conversion from CGPA to Percentage of Marks: $\%\ of\ marks = (CGPA \times 10) - 4.5$

17. Pattern of questions

17.1 Questions shall be set to assess knowledge acquired, standard application of knowledge, application of knowledge in a new situations, critical evaluation of knowledge and ability to synthesize knowledge. The question setter shall ensure that questions covering all the skills are set. He/ She shall also submit a detailed scheme of evaluation along with the question paper.

17.2. A question paper shall be judicious mix of objective type, short answer type, and long answer type questions.

Question Pattern of the End Semester Exam

A. Core, Open elective and Special papers: Theory

F.M. = 70		Subject Code: PHY/C/	Exam Year
PASS MARKS=32		Time: 3 hours.	
.		Group –A (Compulsory)	
1.		Multiple Choice Questions	[2×10=20]
	i.		
	ii.		
	iii.		

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	iv.		
	v.		
	vi.		
	vii.		
	viii.		
	ix.		
	x.		
		Group – B	
2.		Answer any four of the following:	
	i		[5]
	ii		[5]
	iii		[5]
	iv		[5]
	v		[5]
	vi		[5]
		Group – C	
		Answer any three of the following:	
3.			[10]
4..			[10]
5.			[10]
6.			[10]
7.			[10]
8.			[10]
	Note: There may be subdivisions in each question asked in Theory Examination		

PRACTICAL: Core/Special:

FULL MARKS 70 (Notebook: 25, Experiment and Results: 30, Viva-voce: 15)

PASS MARKS: 32

Time: 06 hours

Only one experiment will be asked to perform the experiment.

B. SKILL DEVELOPMENT PAPER (PHY/S/05T):

F.M. = 35	Subject Code: PHY/S/05		Exam Year
PASS MARKS =16	Time: 3 hours.		
		Group –A (Compulsory)	
1.		Multiple Choice Questions	[2×5=10]

	i.		
	ii.		
	iii.		
	iv.		
	v.		
		Group – B	
2.		Answer any four of the following: (2.5x4=10)	
i.			[2.5]
ii.			[2.5]
iii.			[2.5]
iv.			[2.5]
v.			[2.5]
vi.			[2.5]
		Group – C	
		Answer any three of the following: (5x3=15)	
3.			[05]
4.			[05]
5.			[05]
6.			[05]
7.			[05]
8.			[05]
	Note: There may be subdivisions in each question asked in Theory Examination		

PRACTICAL: SKILL DEVELOPMENT PAPER

FULL MARKS: 35: (Notebook: 10, Experiment and Results: 15, Viva-voce: 10)

PASS MARKS: 16

TIME: 03 HOURS

Only one experiment will be asked to perform.

17.3 Components of continuous internal assessment (Sessional Test I and Sessional Test II) will be:

A. **Core, Open elective and Special papers: Theory and Experiment**

Both sessional tests carry 30 Marks (Best of two will be considered) (Theory: 20, Attendence and Extra activities: 10)

Theory:

(a) Short answer type/Multiple Choice Test 1x5=05 Marks

(b) Short notes 02 out of 04 2.5x2=05 Marks

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(c) Long answer type questions (2 out of 4) 5x2=10 marks

Experiment: (a) Note book and experiment: 10 Marks

(b) Performance in Practical and Viva-Voce: 10 Marks

Total: 20 Marks

(d) Seminar / Extra activities =05 Marks

(e) Attendance (follow the % rule) = 05 Marks

GT=30 Marks

B. Skill Development paper (PHY/S/05): Theory and Practical

Two sessional tests each of 15 Marks (Best of two will be considered)

Theory:

(a) Short answer type/Multiple Choice Test 1x5=05 Marks

(b) Long answer type questions (1 out of 2) 5x1=05 Marks

Practical: (a) Notebook and Experiment: =05 Marks

(b) Viva-Voce = 05 Marks

Total= 10 Marks

(d) Seminar / Extra activities =2.5 Marks

(e) Attendance (follow the % rule) = 2.5 Marks

GT=15 Marks

Credits & Courses:

a. Each paper will carry 5 credits.

b. A candidate who successfully completes the entire core courses, the project prescribed, the optional and supportive courses, and acquires not less than 80 credits and puts in the minimum of residence time will be eligible for receiving the degree.

c. One credit means one teaching period per week for one semester (16 weeks) for theory courses and one laboratory session of two periods/ week for one semester. One teaching period is of 60 minutes duration.

SYLLABUS FOR M.Sc.(PHYSICS), W.E.F. SESSION 2024 – 2026 (CBCS)

Semester	Course			Marks Distribution			
	Code	Paper	Credit	Internal		External	
				Th.	Pract.	Th.	Pract.
I	PHY –C-01	MATHEMATICAL PHYSICS , COMPUTATIONAL METHOD AND GTR ASTROPHSICS	5	30	—	70	—
	PHY-C- 02	QUANTUM MECHANICS I AND CLASSICAL MECHANICS	5	30	—	70	—
	PHY-C- 03	ELECTRODYNAMICS AND PLASMA PHYSICS	5	30	—	70	—
	PHY-C/P-04	PRACTICAL	5	—	30	—	70
II	PHY-S- 05T	SKILL DEVELOPMENT COURSE: ELECTRONIC APPLIANCES	5	15	—	35	—
	PHY-S- 05P	SKILL DEVELOPMENT COURSE: ELECTRONIC APPLIANCES PRACTICAL	5	—	15	—	35
	PHY-C- 06	QUANTUM MECHANICS II AND NANO PHYSICS	5	30	—	70	—
	PHY-C- 07	ATOMIC AND MOLECULAR PHYSICS	5	30	—	70	—
	PHY-C/P-08	ELECTRONICS PHYSICS PRACTICAL	5	—	30	—	70
III	PHY-A-09	BASIC APPLIED PHYSICS	5	30	—	70	—
	PHY-C- 10	SOLID STATE PHYSICS AND STATISTICAL MECHANICS	5	30	—	70	—
	PHY-C- 11	NUCLEAR AND PARTICLE PHYSICS & ELECTRONICS – GENERAL	5	30	—	70	—
	PHY-C/P-12	CMP PRACTICAL	5	—	30	—	70
IV	PHY-E-13	ELECTRONICS SPECIAL I	5	30	—	70	—
	PHY-E-14	ELECTRONICS SPECIAL II	5	30	—	70	—
	PHY-E/P-15	SPECIAL ELECTRONICS PRACTICAL	5	—	30	—	70
	PHY-E-13	CONDENSED MATTER PHYSICS (CMP) SPECIAL-I	5	30	—	70	—
	PHY-E-14	CONDENSED MATTER PHYSICS (CMP) SPECIAL-II	5	30	—	70	—
	PHY-E/P-15	SPECIAL CONDENSED MATTER PHYSICS (CMP) PRACTICAL		—	30	—	70
	PHY-D-16	DISSERTATION				100	

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Semester – I

PHY-C-01(Mathematical Physics, Astrophysics and Computational Methods)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course Objectives:

This course aims to enable the students to acquire the concepts of the advance mathematical physics, basics about Astrophysics and computational physics with their applications.

Learning Outcomes:

- Learn about different types of Mathematical Special functions and their properties.
- Understand the Integral transform and their role in physical systems.
- Build a basic idea about the foundation of the course related to Astrophysics and enrich the knowledge of computational method to handle the different physical and mathematical problems.

Course Content:

Unit-1: Special Functions

Special Functions: Legendre, Bessel, Hermite and Laguerre differential equations and their physical applications, Generating function, Rodrigue's formula and Recurrence relation. **(Lectures 10)**

Unit-2: Integral Transform

Laplace transform (LT), 1st and 2nd shifting theorems, Inverse LT by partial fractions, LT of derivative and integral of function, Solving differential equation using LT , Fourier integral and transforms, Dirac-Delta function, FT of delta function. **(Lectures 10)**

Unit-3: Astrophysics

Determination of mass, radius, luminosity, temperature of a star, Stellar classification and its interpretation, H.R. diagrams of clusters. Empirical mass-Luminosity relation, Hubble's law, Hubble's constant, Age of the universe. **(Lectures 10)**

Unit-4: Elements of Computational Techniques

Programming: Introduction to Python, Data Structures: Arrays, Strings, Integer and Floating Point Arithmetic. Operators and Expressions, Functions, Control Flow: Conditionals and Loops (While Loops, For Loops), Input/Output Operations with Files, Data Analysis: plotting, data fitting, analyzing large datasets. **(Lectures 20)**

Root of functions, Iteration method, Gauss elimination method, Eigen values and Eigen vector of matrices, Interpolation, Extrapolation, Curve fitting methods, Least square fitting, integration by trapezoid and Simpson's rule, Solution of First order differential equation using Runge-Kutta method. Finite difference method. **(Lectures 10)**

Reference Books :

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edition. Elsevier.
2. Mathematical Physics, H. K. Dass and Rama Verma, S. Chand & Company Pvt. Ltd.
3. Mathematical Methods for Physicis & Engineers, K. F. Riley, M. P. Hobson, S. J. Bence, 3rd Ed., 2006, Cambridge University Press.
4. Mathematical physics by B.S. Rajput.
5. Computer oriented numerical methods by V. Rajaramanna, PHI (3rd Edition).
6. Computational Physics by Mark E. J. Newman
7. Modelling and Simulation in Python by Allen B. Downey.
8. Python crash course by Eric Matthews.
9. Python Programming by Dr. Ramesh B. Bhise (Author), Dr. Pradip V. Patil (Author), Dr. Manisha D. Dhiware (Author), Dr. Sukdev L. Kadam (Author), Dr. Upendra D. Lad (Author).

PHY-C- 02 (Classical mechanics and Quantum Mechanics- I)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course Objective:

The objective of a classical mechanics course is to provide students with a fundamental understanding of the physical laws that govern the motion of objects. These courses typically cover topics such as Lagrange's equation, Hamilton's equation of motion, small oscillations etc,. The aim of QM-I course is to equip students with the theoretical knowledge and mathematical tools necessary to understand and analyse advanced quantum mechanical systems.

Learning Outcomes:

- Understanding the distinction between discrete (bound) and continuous (scattering) spectra in quantum systems, and their implications for the behaviour of particles.
- Able to understand the bra-ket notation, a powerful mathematical framework in quantum mechanics for representing states and operators.
- Learning how to represent quantum mechanical operators as matrices and understanding their properties and applications.
- Exploring different pictures of quantum mechanics, including the Schrödinger, Heisenberg, and Interaction pictures, and their applications to various physical systems.
- Studying angular momentum in quantum mechanics, including commutation relations for angular momentum operators, eigenvalues and eigenvectors, and their relevance to physical phenomena such as particle spin and motion in centrally symmetric fields.

Course Content:

Classical Mechanics: D'Alembert's Principle, Lagrange's equation and its simple applications. Hamilton's principle, Techniques of the calculus of variations and their applications, Lagrange's equation using Hamilton's principal, Conservation theorems and symmetry properties, Hamilton's equations of motion, The principal of least action, Hamilton – Jacobi equation with example of harmonic oscillator. Canonical transformation, generating

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functions, infinitesimal generators, Poisson bracket, Poisson theorems, angular momentum, Principle of Least action. Small oscillation, Normal mode of vibration, coupled oscillator.

(Lectures 30)

Quantum Mechanics - I

Unit-1: Discrete (bound) and continuous (scattering state) spectrums, Harmonic Oscillator potential and its solution by Schrodinger equation and by operator method, Finite square well potential (bound and scattering state solutions), Three dimensional isotropic harmonic oscillator, Bra and Ket notations, Changes of Bases and unitary transformations, Matrix representation of an operator, The Schrodinger, Heisenberg and the Interaction pictures, their applications to linear harmonic oscillator. **(Lectures 20)**

Unit-2: Angular Momentum: Commutation relations for angular momentum operators, Eigen values and Eigenvectors, Pauli's spin matrices and spin eigenvectors, addition theorem, Clebsch – Gordan Coefficients, angular momentum and rotation, motion in centrally symmetric field, Hydrogen atom. **(Lectures 10)**

Reference Books :

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
2. Classical Mechanics, J. C. Uppadhyaya, Himalaya Publising House Pvt. Ltd.
3. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
4. Classical Mechanics: Rana and Joag.
5. Classical Mechanics: J.C.Upadhyaya
6. Classical Mechanics :Yashwant R. , Waghmare (PHI 1990)
7. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
8. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
9. A Text book of Quantum Mechanics, P. M. Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
10. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
11. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
12. Modern Quantum mechanics: J J Sakurai

PHY- C- 03 (Electrodynamics and Plasma Physics)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course Objective:

To provide students a fundamental understanding of electromagnetic potentials, electrodynamics of moving charge and radiating systems, electrodynamics of relativistic charged particles and the four vectors and also the plasma physics containing properties of plasma, MHD equations, plasma confinement and wave propagation in cold and magnetized cold plasma.

Learning Outcomes:

- The students will learn the nature of electromagnetic potentials and their non-uniqueness property and covariant form of different Maxwell's equations.

- They will be able to find the electromagnetic fields due to a moving point charge using the concept of LW potentials.
- They will also learn the kinetic theory of Plasma, the MHD equations, Plasma confinement and wave propagation in it etc.

Course Content:

Electrodynamics

Unit-1: Electromagnetic Vector and Scalar Potentials, Wave equation. Lorentz condition. Non – Uniqueness of electromagnetic potentials and concept of gauge. **(Lectures 05)**

Unit-2: Electrodynamics of a moving charge and radiating systems: 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. **(Lectures 15)**

Unit-3: Relativistic Electrodynamics: Four Vectors, Four vectors of charge , current density and E.M Potentials. Covariance of Continuity equation and Lorentz condition. Transformation equations for the electromagnetic potentials. Invariance of Maxwell field equation. Maxwell's equation in covariance Four Tensor Form. **(Lectures 10)**

Plasma Physics

Unit-4: General properties of plasma and introductory idea of different states of matter. Kinetic theory of plasma: Boltzmann's equation, Boltzmann – Vlasov Equation, Derivation of moment equations. **(Lectures 10)**

Unit-5: Plasma Characteristics: Fundamental equations of MHD, Debye Shielding and plasma parameter. Expression of Alfven Velocity. **(Lectures 10)**

Unit-6: Plasma confinement: Pinch effect and confinement of plasma. Waves in cold plasma, Wave propagation in magnetized cold Plasma – Appleton – Hartee equation, Atmospheric Whistler , Helicons and Faraday rotation. **(Lectures 10)**

Reference Books :

1. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
2. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
3. Electrodynamics – Gupta , Kumar & Singh
4. Classical Electrodynamics : P. Sengupta(New Age International Publ)
5. Plasma Physics: Francis F. Chen (Plenum Press)
6. Introduction to Plasma Physics: B.N. Chakraborty.
7. Plasma Physics: Bittencourt
8. Magnetohydrodynamics : S.I.Pai

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PHY C/P- 04 (Practical)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course Objective:

The main objective of this practical course is to provide students the knowledge of determining wavelength of different sources of light using Grating, Michelson Interferometer and Fabry-Perot interferometer and to get expertise in determine the resolving power of a telescope and Prism.

Course outcomes:

- Students will learn experiments using Laser light, Sodium light, Interferometer, resolving power of a telescope and Prism, Holography and microwave based experiments etc.

List of Practical:

1. Determination of wavelength of Laser light using Grating .
2. Determination of thickness of thin wire using Laser light/Microscope.
3. Verification of Brewster's Law using spectrometer.
4. Determination of wavelength of Sodium light using Michelson Interferometer.
5. Determination of wavelength of Sodium light using Fabry – Perot Interferometer.
6. Resolving Power of a Telescope.
7. Resolving power of a Prism.
8. Solar Cell Characteristics.
9. Experiments based on Holography.
10. Experiments based on Microwave.

Reference Books :

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

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Semester – II

PHY- S - 05 T (Skill Development Course: Electronic Appliances)

Total credit: 05 (Theory and Practical); Full Marks: 50 (External: 35 and Internal 15)

Course Objective:

This course aims to provide students with a solid understanding of passive devices, semiconductor components, and basic concepts of radio and television communication systems. Through theoretical lectures and practical demonstrations, students will gain knowledge of the principles, characteristics, and applications of various electronic components and communication systems used in modern technology.

Learning Outcomes:

- Identify and describe the types and characteristics of passive devices.
- Explain the principles and characteristics of semiconductor devices including diodes and transistors.
- Understand the operation of rectifier circuits including half-wave, full-wave, and bridge rectifiers, and analyze the functioning of diode voltage doublers and multipliers.
- Describe the principles and applications of regulated power supplies using Zener diodes and IC voltage regulators.
- Analyze the basic concepts of radio and television communication systems.
- Describe various types of antennas such as dipole, folded dipole, Yagi, and dish antennas, and understand their design principles.
- Explain the functioning of DTH systems, mobile communication systems, and MODEMs, and their roles in modern communication technology.

Course Contents:

Unit – I

Passive Devices: Resistors: types and characteristics, colour coding; Capacitors: types and characteristics, colour coding, star and delta connections of resistors and capacitors, Chokes, transformers, Multimeter (Analog and Digital), CRO: waveforms and Lissajous figures, AF and RF oscillators, usage of bread board. **(Lectures 10)**

Unit – II

Semiconductor diode, Zener diode, LED, Transistor (configuration and characteristics), Half wave and Full wave rectifiers, Bridge rectifier, Diode voltage doubler and multiplier.
Regulated power supply, Zener diode as voltage regulator (Series and Shunt type), IC Voltage regulators, fixed positive, fixed negative, adjustable. **(Lectures 10)**

Unit - III

Basic concepts of radio transmitter and receiver, Basic concepts of TV transmitter and receiver, TV antennas, Resonance antennas and their characteristics, Dipole antenna, Folded dipole antenna, Yagi antenna, Yagi antenna design, Dish antenna, DTH system, Mobile communication system, MODEM. **(Lectures 10)**

Books References:

1. Principles of Electronics – V K Mehta, S Chand & Co. 5th Ed. 2001.
2. Functional Electronics – Ramanan.
3. Elements of Electronics – Bagde and Singh.
4. Monochrome and Colour TV – Gulati.

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5. Basic Electronics, 6th Ed. – B. Grob, Mc. Graw Hill NY 1989.

PHY-S – 05P (Skill Development Course: Electronic Appliances Practical)

Full Marks: 50 (External: 35 and Internal 15)

The Practical will be based on the theory portion of the syllabus.

List of Practical:

1. Determination of resistance of a given resistor using colour code.
2. Characteristic curve of a simple diode.
3. Characteristics curve of a Zener Diode.
4. In-put and out-put characteristics of a Transistor in (a) CE and (b) CB mode.
5. Use of diode as a full wave and half wave rectifier.
6. Study of different waveforms using CRO.

PHY-C- 06 (Quantum Mechanics -II and Nanophysics)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course Objective:
This course aims to delve deeper into the realm of quantum mechanics, exploring advanced topics such as approximation methods, scattering theory, relativistic quantum mechanics, and the fascinating field of nanophysics. Students will gain insights into the theoretical foundations of quantum mechanics as well as its applications in understanding the behavior of nanoparticles and nanostructures.

Learning Outcomes:

- Understand and apply approximation methods in quantum mechanics, including time-independent perturbation theory and variational methods, to analyze the behavior of quantum systems under external influences.
- Analyze the theory of scattering, including the scattering of particles by spherically symmetric potentials, partial wave analysis, and the Born-Approximation.
- Explore relativistic quantum mechanics, including the Klein-Gordon equation and the Dirac equation, and understand their implications for describing the behavior of particles at high speeds and energies.
- Gain knowledge of nanophysics, including the properties of individual nanoparticles, methods of synthesis, and the unique characteristics of carbon nanostructures.
- Understand the preparation and properties of quantum nanostructures.

Quantum Mechanics-II

Unit-1: Approximation method in QM: Time independent perturbation theory, non-degenerate and degenerate cases, Stark effect, Time dependent perturbation theory and Fermi's golden rule, Einstein's A and B coefficients. Variational methods, Application to ground state of Hydrogen atom and first excited state of harmonic oscillator. **(Lectures 14)**

Unit-2: Theory of Scattering: Collision in 3D and α – scattering, Laboratory and Centre of mass reference frames, Scattering amplitude, differential scattering cross section and total

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scattering cross section. Scattering by spherically symmetric potentials, Partial wave analysis and phase shifts, Born approximation. **(Lectures 14)**

Unit-3: Relativistic QM: Klein-Gordon equation and its merits and demerits, Dirac equation, probabilities and current densities, Magnetic moment and spin of electron, free particle solution of Dirac equation and interpretation of negative energy states. **(Lectures 12)**

Nanophysics

Unit-1: Properties of individual nanoparticles: Metal nanoclusters, magic numbers, modelling of nanoparticles, Bulk to nano transitions, Methods of synthesis: RF Plasma, Chemical methods, Thermolysis, Pulse LASER method. **(Lectures 8)**

Unit-2: Carbon Nanostructures: Nature of carbon clusters, discovery of C_{60}, Carbon Nanotube synthesis, electrical and mechanical properties. **(Lectures 5)**

Unit-3: Quantum Wells, Wires and Dots: Preparation of quantum nanostructures, size effects, conduction electron and dimensionality, properties dependent on density of states.

(Lectures 7)

Reference Books:

1. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
2. Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
3. A Text book of Quantum Mechanics, P. M. Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
4. Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
5. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
6. Modern Quantum mechanics: J J Sakurai.
7. Quantum Mechanics, Concepts and applications by N. Zettili, Wiley (2^{nd} Ed).
8. Introduction to Nanotechnology : Pook and Owen
9. Quntum Dots: Jack, Hawylak and Wojs.
10. Introduction to Nanotechnology: Charles P. Poole, Frank J. Owens, Wiley.
11. Nanotechnology: Basic Sciences and emerging technologies , Mick Wilson, Kamali Kannangara, Geo T. Smith.

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PHY C- 07 (Atomic, Molecular and Laser Physics)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course Objective:

This course aims to provide students with a comprehensive understanding of atomic and molecular spectra from a quantum mechanical perspective, along with the principles and applications of laser technology. Students will learn about the quantum states of electrons in atoms, molecular spectra, and the operation of various types of lasers, as well as their nonlinear interactions with matter.

Learning Outcomes:

- Understand the quantum states of electrons in atoms, including the hydrogen atom spectrum, fine structure, and hyperfine structure.
- Analyze the spectroscopic terms and selection rules for atomic transitions, including the effects of relativistic corrections and external fields.
- Explore the rotational, vibrational, and electronic spectra of diatomic molecules, and understand the principles of infrared and Raman spectroscopy.
- Gain knowledge of X-ray emission and absorption processes, electron spin resonance (ESR), and nuclear magnetic resonance (NMR), and their applications in spectroscopy.
- Understand the principles of laser operation, including Q-switching, mode-locking, and laser rate equations, and analyze the characteristics and applications of various types of lasers.
- Explore the nonlinear interaction of light with matter, including laser-induced multi-photon processes and second harmonic generation, and understand their applications in nonlinear optics.

Course content:

Atomic Physics (Quantum Approach)

Unit-1: Quantum states of an electron in an atom, Stern – Gerlach experiment, Hydrogen atom spectrum, spectrum of Helium and Alkali atoms, Fine Structures, Relativistic correction for energy levels of Hydrogen, Spectroscopic terms and selection rules, Hyperfine structure and isotopic shift. Two electron system, Lande's 'g' factor, Landes interval rule, equivalent and in-equivalent electronic states of two electron systems. Singlet and triplet series of two electron system, Hartee - Fock equation, Series spectra in alkali elements and alkaline earth elements, L – S and J – J coupling, Width of spectral line, Normal and anomalous Zeeman effect, Paschen – Back effect, Stark effect. **(Lectures 25)**

Molecular Spectra (Quantum Approach)

Unit-2: Rotational and Vibration spectra for diatomic molecules:Electronic spectra of diatomic molecules, Vibrational analysis of band system, Frank Condon principle, Infrared spectra and Raman spectra of diatomic molecules. **(Lectures 10)**

Unit-3: Basic principles of X- Ray, X-Ray emission and absorption, Electron Spin Resonance (ESR), and Nuclear Magnetic Resonance (NMR). **(Lectures 05)**

LASER

Unit-4: Requisites for producing LASER light, Q – Switching, Mode locking theory, (Homogenous line), Laser rate equations (four level LASER and Quasi three level LASER systems), propagation of a LASER pulse through a dispersive medium. Basic principles and

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and working of CO_2, LASER and qualitative description of longitudinal and TE- LASER systems, Excimer LASER, Dye LASER, Semiconductor LASER, spin – flip Roman LASER, Plasma recombination LASER. **(Lectures 15)**

Unit-5: Non Linear interaction of light with matter: LASER induced multiphoton process and their applications, Second order Harmonic generation. **(Lectures 05)**

Suggested books:

1. Introduction to Atomic Spectra by H. E. White, McGraw Hill.
2. Atomic spectra and atomic structure, G. Herzberg, Dover Pub, 2nd Ed.
3. Molecular Structure & Spectroscopy , G. Aruldhas: Prentice Hall of India, New Delhi.
4. Fundamental of molecular spectroscopy,Colin N Banwell & Elaine & M. McCash, Tata McGraw- Hill publishing company Limited.
5. Introduction to Atomic, molecular and Laser Physics. D.K. Roy & S.N. Thakur.
6. Introduction to Atomic & Molecular Physics by B. Narayan
7. LASER Fundamentals : Silfvast (Cambridge University , Press)
8. LASER's : Siegman (Univ. Science Books , USA)
9. Elements of Quantum Optics : Meystre and Sargent(Spriger – Verlag)
10. LASER Physics : Srgent, Scully and Lamb .
11. Essentials of LASER and non – linear optics : Baruah, PragatiPrakashan, Meerut)

PHY-C/P- 08 (Electronics Practical)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Objective:

Explore Zener diode, FET, and MOSFET characteristics. Analyze uni-junction transistor behavior. Design transistor amplifiers. Study logic gates. Investigate operational amplifier applications. Construct Hartley oscillator. Examine SCR characteristics. Design adder circuits. Investigate AD and DA converters.

Learning outcomes:

- To Understand the operation and characteristics of Zener diodes and their applications in voltage regulation.
- Analyze the behaviour and performance of FETs, MOSFETs, and Unijunction transistors in electronic circuits.
- Design and analyse transistor amplifiers in the common emitter mode for specific applications.
- Demonstrate proficiency in designing and implementing basic and universal logic gates for digital circuitry.
- Apply operational amplifiers in differentiator and integrator circuits, construct Hartley oscillators, and analyse the behaviour of SCR, half and full adders, and AD/DA converters.

Course content:

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1. ZENER DIODE – CHARACTERISTICS & STABILISATION

2. FET – Characteristics.

3. MOSFET - Characteristics.

4. Unijunction Transistor – Characteristics.

5. Transistor Amplifier (CE – Mode)

6. Basic Logic gates and from Universal Gates.

7. Op – Amplifier – Differentiator & Integrator.

8. Hartley oscillator.

9. Characteristics of SCR.

10. Half and full Adder.

11. AD and DA Converter.

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Semester – III

PHY -OE-09: Open Elective: Basic Applied Physics

Total credit: 05 Full Marks: 100 (External: 70 and Internal 30)

Course Objective:

This course aims to provide students with a foundational understanding of key concepts in electronics, laser physics, nanophysics, and solid-state physics. Students will learn about the principles and applications of basic electronic components, laser technology, nanomaterials, and crystal structures.

Learning Outcomes:

- Understand the concepts of intrinsic and extrinsic semiconductors, and analyze the operation and applications of diodes and transistors.
- Apply elementary Boolean algebra to design logic gates, and perform conversion of decimal numbers into binary numbers.
- Gain knowledge of laser physics, including the principles of laser action and the properties of different types of lasers and understand their applications.
- Explore the fundamentals of nanophysics, nanotechnology, and nanoscience, and understand the synthesis methods of Nano-materials.
- Understand the crystalline state of matter, including concepts such as unit cells, symmetry operations, Bravais lattice, Miller indices, and diffraction of X-rays by Bragg's law.

Unit-1: Basic Electronics: Idea of intrinsic and extrinsic semiconductors, p-n junction diode, Zener diode, LED, BJT, FET with their applications, Elementary Boolean algebra, conversion of decimal numbers into binary numbers, Basic and Universal logic gates. **(Lectures 20)**

Unit-2: Laser Physics: Principle of laser action, properties of laser, Idea of He-Ne laser, Ruby laser, CO_2 laser, Dye laser, p-n diode laser with their applications. **(Lectures 20)**

Unit-3: Nanophysics: Idea of Nano-Technology and Nono-Science, size effects, idea of quantum well, quantum wires and quantum dots and carbon C_{60}, CVD and PLD methods for the synthesis of nano materials. **(Lectures 10)**

Unit-4: Solid State Physics: Crystalline state of matter, unit cells, symmetry operations, Bravais lattice, Miller indices, diffraction of X-rays by Bragg's law. **(Lectures 10)**

Recommended Books:

1. Physics of Semiconductor Devices, S. M. Sze, Wiley-Eastern Ltd (1981)
2. Integrated Electronics, J. Milman and C. C. Halkias, McGraw Hill (1972)
3. LASER Fundamentals : Silfvast (Cambridge University , Press)
4. LASER's : Siegman (Univ. Science Books , USA)

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5. LASER Physics :Sergent, Scully and Lamb .
6. Introduction to Nanotechnology : Pook and Owen
7. Introduction to Nanotechnology: Charles P. Poole, Frank J. Owens Wiley Intrersc.
8. Nanotechnology: Basic Sciences and emerging technologies, Mick Wilson,Kamali Kannangara, Geo T. Smith.
9. Crystallography and Solid State Physics, A. R. Verma and O. N. Srivastava
10. Solid State Physics, A. J. Deckker
11. Introduction to Solid State Physics, C. Kittel
12. Elements of Solid State Physics, J. P. Srivastava

PHY-C- 10 (Solid State Physics and Statistical Mechanics)

Total credit: 05 Full Marks: 100 (External: 70 and Internal 30)

Course Objective:
This course aims to provide students with a comprehensive understanding of solid-state physics and statistical mechanics. Students will learn about the thermal properties of solids, dielectrics, ferroelectrics, superconductivity, and the foundational principles of quantum statistics.

Learning Outcomes:

- Understand the concepts of lattice vibrations and thermal properties of solids.
- Gain knowledge of dielectrics and ferroelectrics, including Lorentz field equations, dipole moment, polarizability, Landau's theory of phase transitions, and piezoelectricity.
- Explore the phenomenon of superconductivity, including the occurrence of superconductivity, and the thermodynamics of superconducting transitions.
- Learn the foundation of quantum statistics and understand quantum mechanical ensemble theory.
- Study the statistical mechanics of interacting systems, including the cluster expansion of classical and quantum mechanical systems.

Contents:

Solid State Physics

Unit-1: Lattice vibrations and thermal properties of solids, Phonon and phonon momentum, Mono-atomic one-dimensional lattice and Diatomic lattice vibrations. Dispersion relations, Optical and Acoustical Modes (Lectures 08).

Unit-2: Dielectrics and Ferroelectrics. Lorentz field equations, Dipole moment, Polarizability, Classification of ferroelectric materials, Landau's theory of phase transitions , Anti-Ferroelectricity, and piezoelectricity. (Lectures 07)

Unit-3: Superconductivity: Occurrence of superconductivity, Destruction of superconductivity by magnetic fields, Meissner's effect. Type-I and Type-II superconductors, BCS Theory, Thermodynamics of superconducting transitions, London equations. (Lectures 10)

Statistical Mechanics

Unit-1: Foundation of Quantum Statistics: Entropy of an ideal gas, Entropy of mixing and Gibb's Paradox, Liouville's Theorem (Quantum Treatment). (Lectures 05)

Unit-2: Quantum Mechanical Ensemble Theory: Density Matrix, Statistical thermodynamics of gas in Micro-Canonical, Canonical and Grand-Canonical ensembles. quantum Mechanical Ensembles, Partition Functions, calculation of different statistical quantities. (Lectures 10)

Unit-3: Quantum Statistics: Properties of Ideal Bose and Fermi Gases, BE Condensation, Superfluidity in Liquid He-II, Low temperature behaviour of Bose and Fermi Gases. (Lectures 12)

Unit-4: Statistical mechanics of interacting systems: Cluster expansion of classical gas, Derivation of Virial-coefficients, cluster expansion of quantum mechanical system, Ising Model. (Lectures 08)

Reference Books:

Solid State Physics:

1. Crystallography and Solid State Physics, A. R. Verma and O. N. Srivastava
2. Solid State Physics, M. Ali Omar
3. Solid State Physics, A. J. Deckker
4. Introduction to Solid State Physics, Kittel
5. Solid State Physics, R. L. Singhal
6. Elements of Solid State Physics, J. P. Srivastava
7. Solid State Physics Theory, Applications and Problems, S. L. Kakani& C. Hemraja
8. Solid State Physics, Ashcroft and Mermin.

Statistical Mechanics:

1. Statistical Mechanics :Satyaprakash and JP Agrawal
2. Statistical Mechanics : Gupta and Kumar
3. Statistical Mechanics: BK Agrawal and M Eisner
4. Fundamental of statistical and Thermal Physics :Rief
5. Statistical Mechanics: RK Patharia
6. Statistical Mechanics by K Huang.

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PHY C- 11 (Nuclear, Particle Physics & General Electronics)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course Objective:
This course aims to provide students with a comprehensive understanding of nuclear and particle physics, covering topics such as nuclear interactions, nuclear reactions, nuclear models, nuclear decay, and elementary particle physics. Additionally, it introduces students to the fundamentals of digital systems in general electronics.

Learning Outcomes:

- Understand the principles of nuclear interactions and learn about various types of nuclear reactions.
- Explore nuclear models and gain knowledge of nuclear decay processes and conservation laws.
- Introduce students to elementary particle physics, including the quark hypothesis, quark model, classification of elementary particles.
- Understand the basics of digital systems.

Course content:

Nuclear and Particle Physics

Unit-1: Nuclear Interactions: n-p & p-p scattering at low energy- General theory, Scattering Cross-Section, Scattering length, Effective Range theory, Meson theory of Nuclear Force, Yukawa interaction, Charge independence and Charge symmetry of Nuclear forces, Spin-dependence of Nuclear forces, Coherent and Non-coherent Scattering, Isospin formalism. **(Lectures 15)**

Unit-2: Nuclear Reactions: Type of Nuclear Reactions, Q values and Threshold energy, Conservation laws, Direct and Compound Nuclear reaction Mechanisms, Compound Nucleus theory, Resonance Scattering, BREIT-Wigner one level formula. **(Lectures 10)**

Unit-3: Nuclear Models: Liquid Drop Model & Shell Model- Introduction, Theory and Applications, Semi-empirical Mass Formula, Bohr-Wheeler theory of Fission. **(Lectures 10)**

Unit-4: Nuclear Decay: Beta Decay, Shape of the beta spectrum, Fermi's theory of Beta-decay, Parity violation and experimental verification. **(Lectures 7)**

Unit-5: Elementary Particle Physics: Introduction to Quark hypothesis, Quark model and Elementary particles (Hadrons and Leptons). Idea of Isospin and strangeness, Types of interactions. **(Lectures 7)**

General Electronics

Unit-1: Digital Systems: Basic logic gates and logic families, Flip-flops (R-S type, T-type, D-type, J-K type, J-K edge triggered, J-K Master/Slave), Shift register, ripple counter, Synchronous counter. (Lectures 11)

Recommended Books:

Nuclear and Particle Physics

1. Nuclear Physics, D. C. Tayal
2. Nuclear Physics, Yadav and Pandya

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3. Nuclear Physics, S. N. Ghoshal
4. Nuclear Physics, I. Kaplan
5. Nuclear Physics, Roy and Nigam
6. Introduction to Nuclear Physics, S. B. Patel
7. Introduction to Particle Physics, M. P. Khanna
8. Elementary Particle Physics, D. J. Griffiths

General Electronics

1. Physics of Semiconductor Devices, S. M. Sze, Wiley-Eastern Ltd (1981)
2. Solid state electronic devices, Ben G. Streetman, Prentice Hall, Englewood Cliffs. NJ (1999)
3. Semiconductor Devices, M. S. Tyagi, Wiley (India)
4. Electronic Devices, L. Floyd, Pearson Education New York (2004)
5. Transistors, Dennis Le Crissitte, Prentice Hall India Pvt. Ltd (1963)
6. Integrated Electronics, J. Milman and C. C. Halkias, McGraw Hill (1972)
7. Semiconductor Devices and Applications, A.Mottershed, New Age Int Pub.
8. Semiconductor Device Technology, M. Goodge, McMillan (1983)

PHY C/P- 12 (CMP Practical)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Objective:

The objectives encompass experimental exploration of various phenomena such as determining magnetic field strength and resonance frequency via E.S.R, establishing operating voltage for G.M. Counter, measuring energy band gap using the Four Probe method, determining Hall coefficient and angle in Hall-effect, calculating Planck's constant, measuring dielectric constants of solid and liquid samples, analysing modulation index, studying hysteresis loss, observing behaviour of free-running multivibrator, and understanding different modes in lattice vibration using lattice dynamics kit.

Learning outcomes:

- Gain proficiency in utilizing E.S.R. to determine magnetic field strength and resonance frequency, enhancing skills in experimental setup and data analysis.
- Develop understanding of G.M. Counter operation by determining its optimal operating voltage for accurate radiation detection.
- Acquire practical knowledge of the Four Probe method to determine energy band gaps in materials, improving experimental techniques and data interpretation skills.
- Deepen understanding of semiconductor physics by determining Hall coefficient and Hall angle in the Hall-effect experiment, refining measurement techniques and analytical skills.
- Enhance understanding of fundamental physics principles by determining Planck's constant, measuring dielectric constants, analyzing modulation index, studying

hysteresis loss, observing free-running multivibrator behavior, and exploring lattice dynamics.

Course content:

1. Determination of Magnetic field strength and Resonance frequency using E. S. R.

2. Determination of Operating voltage of G. M. Counter

3.Determination of Energy Band Gap using Four Probe method

4. Determination of Hall coefficient and Hall angle in Hall-effect

5. Determination of Planck's constant

6. Measurement of Dielectric constants of solid and liquid samples

7. Determination of modulation index..

8. Study of Hysteresis loss in given sample.

9. Free running Multivibrator.

10. Lattice dynamics.

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Semester – IV

PHY-E - 13 (Electronics Special)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course objective:

To gain the knowledge of op-amp and their different types, oscillators and multivibrators, modulation and demodulation in communication systems, different types of memory devices. Students will also have understanding of Radar system, satellite, antenna, microprocessor and impact of different waveguides in the propagation of em waves.

Learning outcome:

- The students will learn the functions of different op-amp, oscillators, multivibrators, communication system including microwave communication.
- They will also able to understand the importance of different types of memory devices and nature of waveguides in electromagnetic wave propagation.

Course contents:

Unit-1: Operational Amplifier : Differential Amplifier – Circuit Configuration, Dual Input, Balanced Output Differential Amplifier, DC and AC analysis, Inverting and Non – Inverting Inputs, CMRR , Constant Current , Bias Level Translator . Block Diagram of an Operational Amplifier. Open Loop Configuration.Inverting and Non – Inverting amplifiers. Op – amp with negative feed back. Voltage Follower. Input bias current, Input Offset current, Total output offset voltage, Adder, Substractor, Differentiator and Integrator. (Lectures 20)

Unit-2: Oscillators : Oscillators Principles – Types, Frequency, Stability Response. The Phase shift Oscillators. Wein Bridge Oscillatorble Oscillators.Multivibrators – Monostable, astable and Bistable. Comparators, Square wave and Triangular Wave Generators .Using Op – Amp only. (Lectures 10)

Unit-3: Communication Electronics : Amplitude Modulation, Generation of AM waves, Demodulation of AM waves, DSBSC Modulation, Generation of DSBSC waves, Coherent direction of DSNSC waves, SSB Modulation, Generation and Detection of SSB waves.Vestigal side band Modulator, Frequency Division Multiplexing (FDM). (Lectures 10)

Unit-4: Memory Devices : ROM , RAM and its applications, SRAM, DRAM, CMOS, NMOS, Non Volatile magnetic, Optical and Ferroelectric Memories, charge Coupled Devices. (Lectures 10)

Unit-5: Microwave Devices : Velocity Modulation, Two – Cavity Klystrons and Reflex Klystrons, Magnetrons, Travelling Wave Tubes, Wave Modes. (Lectures 10)

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Electronics Special -II

PHY-E- 14 (Electronics Special)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course objective:

This course aims to provide comprehensive understanding of Radar Systems including Radar Block Diagram and Range Equation; Satellite Communications covering Orbits, Antenna Angles, and Link Equations; Microprocessors focusing on INTEL 8085 architecture and Machine Language Programming; and Microwave Communications & Wave Guides fundamentals including Microwave Transmission and Optical Fibres.

Learning outcomes:

- Upon completion of this course, students will demonstrate a comprehensive understanding of Radar Systems, Satellite Communications, Microprocessors, and Microwave Communications.
- They will acquire skills in analysing radar performance, designing communication systems, programming microprocessors, and optimizing microwave communication systems.
- Additionally, they will develop an understanding of wave guides and introductory knowledge of optical fibres, preparing them for modern communication technologies.

Unit-1: Radar Systems: Radar Block Diagram, Radar Range Equation, Minimum detectable Signal, receiver Noise, Signal to noise ratio. **(Lectures 8)**

Unit-2: Satellite Communications: Introducing Satellite Orbits and Geostationary Satellites, Antenna Look Angles, Satellite Classifications, spacing and Frequency allocation, Satellite Link Models – Up Link , Down Link, Cross Link Models, satellite Link Equations. **(Lectures 15)**

Unit-3: Microprocessors: Introduction to Microprocessors, Microcontrollers and Microcomputers, Architecture and Internal operation of INTEL 8085. Instruction OP codes. Operands and Mnemonic Constructing Machine Language code for Instructions , Instructions Execution Timing Diagram, Instruction Word Size and Addressing Modes, Instruction Set, Stacks, Subroutines and Interrupts. Machine and Assembly Language Programming. (Lectures 25)

Unit-4: Microwave Communications: Advantages of microwave Transmission, Loss in Free Space, Atmospheric Effects on Propagation, Ground reflection, Fading Sources. (Lectures 5)

Unit – 5: Wave Guides: Modes of propagation in wave guides, Rectangular wave guide, Cylindrical wave guide and characteristics of propagation of electromagnetic waves. Simple idea of optical-fibres. (Lectures 07)

Reference Books:

1. A handbook of Electronics – Gupta and Kumar.
2. Advanced Electronic Communication System – Wayne Tomasi.

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3. Digital Principles and Applications – A.P. Malvino and Donald P. Leach.
4. Microprocessor Architecture, Programming and Applications with 8085/8086 – Ramesh S. Gaonkar.

PHY-E – 15/P (Special Electronics Practical)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course objective: To acquire comprehension of A/D and D/A converters, waveforms generated by mono-stable and bi-stable multivibrators, pulse amplitude modulation, waveform generation and storage amplification, microprocessors, klystrons, and network theorems, among other topics.

Learning outcome: The students will have a solid understanding of the selected practical topics, complementing their theoretical knowledge

List of Practical:

1. Study of Converters- A to D and D to A.
2. Study of waveform of MonostableMultivibrator using Oscilloscope.
3. Study of waveform of Bistablemultivibrator using Oscilloscope.
4. Study of Pulse Amplitude Modulation & Demodulation.
5. Study of BCD to seven segments.
6. Addition, Subtraction, Multiplication using 8085/8086.
7. Optical Fibre- Measurement of loss in dB of patchcords.
8. Waveform generation & Storage Amplifier.
9. Network Analysis- Thevenin's& Norton's theorem.
10. Characteristics of Klystron.

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Semester – IV

CONDENSED MATTER PHYSICS (CMP) Special-I

PHY-E - 13 (CONDENSED MATTER PHYSICS (CMP) Special-I)

Total credit: 05 Full Marks: 100 (External: 70 and Internal 30)

Course objective:

To provide knowledge and wider understanding of Lattice dynamics of crystals with mono and diatomic bases, scattering phenomena of neutron with phonon, interactions of solids with em fields, plasmons, polarons, polaritons and also the magnetic properties of solids with their quantum theories.

Learning outcomes:

- The students will learn about the lattice vibrations with mono and diatomic basis and the concept of optical and acoustical frequencies.
- They will also able to learn the interaction of solids with e.m. fields, dielectrics, plasmons, polaritons and quantum magnetic properties of solids.

Course contents:

Unit-1: *Lattice Dynamics and Optical Properties of Solids:* Vibration of crystals with monatomic basis, dispersion, Brillouin zones, phase and group velocities. Vibration (one dimensional) of crystals with diatomic basis, dispersion, Brillouin zones, acoustic and optical modes of vibration, frequency gap and effect of mass ratio on it, quantization of elastic waves, phonons, vibration in three dimensional lattice, phonon density and states Van Hove singularities, scattering of neutrons by phonons. (Lectures 20)

Unit-2: *Interaction of solid with e.m. field*: Drude model, macroscopic theory of optical constants, dispersion and absorption, dispersion formula. (Lectures 05)

Unit-3: *Dielectrics, Plasmons, Polarons and Polaritons:* Macroscopic dielectric constant, Mechanism of polarization, electronic polarisability, ionic polarisability, molecular field in a dielectric, Clausius-Mossotti equation, frequency dependence of different polarizabilities, dielectric constant and alternating fields, Clausius-Mossotti catastrophe, permanent polarization and ferroelectricity, classification of ferroelectric crystals, their properties and applications, plasma oscillations and plasmons, experimental setup for plasma excitation, ionic polarization, long wavelength limiting frequency of optical modes in crystals, Interaction of e.m. waves with optical modes (polaritons), electron-phonon interaction in ionic crystals (polarons). (Lectures 20)

Unit-4:*Magnetic properties of solids*: Quantum theories of diamagnetism, paramagnetism and ferromagnetism, Curie point and Neel temperature, Weiss Molecular field theory, Heisenberg's exchange, Interaction in ferromagnets, non-integral values of magnetization in Fe, Co and Ni, antiferromagnetism, ferrimagnetism, direct exchange and superexchange, spin waves and magnons, ferrites, their properties and applications, soft and hard magnetic materials. (Lectures 15)

CONDENSED MATTER PHYSICS (CMP) Special-II

PHY-E- 14: CONDENSED MATTER PHYSICS (CMP)

Total credit: 05; Full Marks: 100 (External: 70 and Internal 30)

Course objective:

To provide larger understanding of electronic properties of solids, crystal imperfections and their applications and properties and behaviours of superconducting materials.

Learning outcomes:

- Students will learn about the various electronic properties of solids, crystal imperfection and their role and broad idea of superconductivity with their applications etc.

Unit-1: *Electronic Properties of Solids*: Nearly free electron model and energy bands in one dimension, Tight-binding approximation, Wigner-Seitz cellular method, orthogonalized plane wave method, pseudopotential method, Fermi surface and its experimental determination: Magnetoresistance, cyclotron resonance, de Haas- Van Alphen effect, magneto-acoustic effect, quantum Hall effect, quantum wells and superlattices. (Lectures 20)

Unit-2: *Crystal Imperfection*: Importance and types of imperfections, point defects, vacancy defects in elemental solids, Schottky defect in ionic crystals, self interstitial defect in elemental solids, colour or F-centres, excitons, Dislocations, edge and screw dislocations, interpretation of slip, dislocation identity, estimation of dislocation density from X-ray diffraction measurements, energies of dislocations, stability of a dislocation loop, critical radius, role of dislocation in crystal growth and plastic deformation, solid solutions. (Lectures 20)

Unit-3: *Superconductivity*: manifestations of energy gap, Cooper pairing due to phonons, BCS theory of superconductivity, Ginzsburg-Landau theory and application to Josephson effect: d-c Josephson effect, a-c Josephson effect, Macroscopic quantum interference, Vortices and type II superconductors, high temperature superconductivity (elementary). Flux quantization, properties of high T_c superconductors, Cuprate superconductors and their theories, SQUID MAGLEV and principle of high speed trains, superconducting magnets. (Lectures 20)

REFERENCE BOOKS:

1. Ashcroft &Mermin, *Solid State Physics.*
2. C. Kittel, *Introduction to Solid State Physics.*
3. C.Kittel, *Quantum Theory of Solids.*
4. A. J. Dekker, *Solid State Physics.*
5. M. Ali Omar, *Elementary Solid State Physics.*
6. J.P. Srivastava, *Elements of Solid State Physics.*
7. J. Callaway, *Quantum Theory of Solids.*

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PHY-E – 15/P: CONDENSED MATTER PHYSICS (CMP) –Practical

Total credit: 05 Full Marks: 100 (External: 70 and Internal 30)

Course objective: To have practical knowledge about band gap of semiconductor, Hall coefficient, how to determine the Planck's constant, concept of g-factor, dielectric constant, e/m ratio, optical and acoustical modes in a lattice vibration and BH loop.

Learning outcomes:

- By doing these experiments, students will have complete understanding of the theories related to Band gap, Planck's constant, dielectric constants of different materials, e/m values, concept of g-factor and the lattice vibrations.

1. Measurement of resistance of a semiconductor by four probe method at different temperatures and determination of band gap.
2. (i) Measurement of Hall coefficient of given semiconductor.
   (ii) Identification of semiconductor and estimation of charge carrier concentration.
3. Determination of Planck's constant.
4. Determination of Lande's g-factor using ESR spectrometer.
5. Determination of Dielectric constants of Solids and Liquids.
6. Lattice dynamics
7. Determination of e/m by Milikon Oil drop experiment.
8. Determination of e/m by Helical method.
9. BH loop experiment.

PHY-D – 16 (Dissertation/Project)

Total credit: 05 Full Marks: 100

Course Objectives:

The objectives of the course is to facilitate students to carry out extensive research and develop as self-guided learning and analytical skills through problem and gap identification, development of research methodology, interpretation of findings and presentation of results.

Learning Outcomes: After completion of the course, the learners will be able to:

- Gain in-depth knowledge in the major field of study.
- Design and justify research methodology.
- Utilize appropriate research methodology for data collection
- Analyze the collected data and draws conclusions accordingly.

This course will be based on preliminary research oriented topics both in theory and experiments. The teachers who will act as supervisor for the project will float projects and any one of them will be allocated to the student at the end of semester-II. At the completion of the project by the semester end the student will submit Project Report in the form of dissertation which will be examined by the examiners. The examination shall consist of

(a) Preparation of Dissertation / Project (b) Presentation (b) Comprehensive viva-voce.

The examiners of the project report will comprise one external and one Internal/Project supervisor. The distribution of marks for the project work will be as follows.

(a) Dissertation-	50 Marks
(b) Presentation-	25 Marks
(c) Viva-voce examination	25 Marks

Rajesh