SRI VIDYA MANDIR ARTS & SCIENCECOLLEGE

(Autonomous)

[An Autonomous College Affiliated to Periyar University, Salem, Tamil Nadu]
[Accredited by NAAC with 'A' Grade with CGPA of 3.27][Recognized 2(f) & 12(B) Status under UGC Act of 1956]
Katteri – 636 902, Uthangarai (Tk), Krishnagiri (Dt)
Tamil Nadu, India
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DEGREE OF MASTER OF SCIENCE IN PHYSICS

CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS AND SYLLABUS FOR

M.Sc. PHYSICS PROGRAMME

(SEMESTER PATTERN)

(For Students Admitted in the College from the Academic Year 2023-2024 Onwards)

REGULATIONS AND SYLLABUS FOR M.Sc. PHYSICS PROGRAMME

(For Students Admitted in the College from the Academic Year 2023-2024 Onwards)

1. VISION OF THE DEPARTMENT

The vision is to enable the students compete on par with other professionals and to nurture their scientific and creative thinking by providing high quality education to face global challenges in the emerging ICT propelled "Knowledge Era"

2. MISSION OF THE DEPARTMENT

To redeem the rural students from the age-old ignorance and to isolate from the stream of modern developments, dedicate to provide free access to the rural students to enroll as students of Physics and to enlighten them on the career options available in the field of science, technology and other profession.

3. DEFINITIONS

(i) Programme: Programme means a course of study leading to the award of the degree in a discipline.

(ii) Course: Course refers to the subject offered under the Degree Programme.

4. AIMS OF THE PROGRAMME

1. Acquire a thorough understanding of the fundamentals of Physics.
2. Impart critical thinking skills and evaluation of information among students in Physics.
2. Provide in - depth knowledge of Physics to the student.
3. Capable of pursuing research in theoretical/ experimental Physics or related areas.
4. Capable of researching at least in a preliminary way.
5. Provide a conducive environment that ensures the cognitive development of students in a holistic manner.
6. Mould students as accountable citizens having awareness of most basic domain-independent knowledge, including critical thinking and communication.
7. Enable students to prepare for different research/teaching qualifications and competitive examinations, such as CSIR, SET, UPSC, TRB, and TNPSC.

PROGRAMME OUTCOMES

PO1	**Problem Solving Skill:** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
PO2	**Decision Making Skill:** Foster analytical and critical thinking abilities for data-based decision-making
PO3	**Ethical Value:** Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.
PO4	**Communication Skill:** Ability to develop communication, managerial and interpersonal skills.
PO5	**Individual and Team Leadership Skill:** Capability to lead themselves and the team to achieve organizational goals.
PO6	**Employability Skill:** Inculcate contemporary business practices to enhance employability skills in the competitive environment.
PO7	**Entrepreneurial Skill:** Equip with skills and competencies to become an entrepreneur.
PO8	**Contribution to Society:** Succeed in career endeavors and contribute significantly to society.
PO9	**Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective.
PO10	**Moral and ethical awareness/reasoning:** Ability to embrace moral/ethical values in conducting one's life.

PROGRAMME SPECIFIC OUTCOMES

PSO1	**Placement:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.
PSO2	**Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
PSO3	**Research and Development:** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development
PSO4	**Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world.
PSO5	**Contribution to the Society:** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

7. ELIGIBILITY FOR ADMISSION

A Candidate who has passed B.Sc. Physics or any other relevant Degree of Periyar University or any other University accepted by the Syndicate of the Periyar University as equivalent thereto, subject to such conditions as may be prescribed therefore are eligible for admission to Master of Science (M.Sc.) Degree Programme in Physics and shall be permitted to appear and qualify for the M.Sc. Degree Examination in Physics of this Autonomous College affiliated to Periyar University after a course of study of two academic years.

8. DURATION OF THE PROGRAMME

The Programme for the Degree of Master of Science (M.Sc.) in Physics shall consist of two academic years divided into four semesters. Each Semester consists of 90 working days.

9. FEATURES OF CHOICE BASED CREDIT SYSTEM

Under Choice Based Credit System (CBCS), a set of Courses consisting of Core Courses, Elective Courses, Skill Based Elective Courses, Ability Enhancement Compulsory Courses and Extra Disciplinary Courses are offered. This provides ample opportunity for the students to learn not only the major subjects but also interdisciplinary and application - oriented subjects.

10. SYLLABUS

The syllabus of the M.Sc. Physics Degree Programme is divided into the following Courses:

i. Core Courses
ii. Elective Courses
iii. Skill Enhancement Courses
iv. Ability Enhancement Compulsory Courses

11. PROGRAMME OF STUDY

The Programme of study for the Degree shall be in the Branch – Physics (Choice Based Credit System) with internal assessment comprised of instructions in the following subjects according to the syllabi and books prescribed from time to time.

12. CREDIT

Weightage given to each course of study is termed as Credit.

13. CREDIT SYSTEM

The weightage of credits is spread over to four different semesters during the period of study and the cumulative credit point average shall be awarded based on the credits earned by the student. A total of 92 Credits are prescribed for the M.Sc. Physics Degree Programme which is the minimum Credit requirement for the two years M.Sc. Physics Degree Programme.

SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE

(Autonomous)

Master of Science (M.Sc.) in Physics

Programme Pattern and Syllabus (CBCS)

(For Students Admitted in the College from the Academic Year 2023-2024 Onwards)

Sl. No.	Nature of the Course	Course Code	Name of the Course	Hours/ Week	Credits	Marks		
						CIA	ESE	Total
SEMESTER- I								
1	Core – I	23PPH1C01	Mathematical Physics	6	4	25	75	100
2	Core–II	23PPH1C02	Classical Mechanics and Relativity	5	4	25	75	100
3	Core–III	23PPH1C03	Linear and Non Linear Integrated Circuits and Applications	5	4	25	75	100
4	Core Practical - I	23PPHP1P01	Practical – I [Physics Experiments]	6	3	25	75	100
5	Elective –I	23PPH1E01	Choose from List -1 (Energy Physics)	4	3	25	75	100
6	Professional Competency Course			2	2	25	75	100
7	Soft Skill - I	Ability Enhancement Compulsory Course		2	2	25	75	100
Total				**30**	**22**	**175**	**525**	**700**
SEMESTER-II								
8	Core – IV	23PPH2C04	Statistical Mechanics	5	4	25	75	100
9	Core – V	23PPH2C05	Quantum Mechanics –I	6	4	25	75	100
10	Core – VI	23PPH2C06	Microprocessor 8085 and Microcontroller 8051	5	4	25	75	100
11	Core Practical - II	23PPH2P02	Practical – II [Electronics Experiments]	6	3	25	75	100
12	Elective–II	23PPH2E02	Choose any one from the list – II [Advanced Optics]	4	3	25	75	100
13	Skill Enhancement Course – I			2	2	25	75	100
14	Soft Skill - II	Ability Enhancement Compulsory Course		2	2	25	75	100
15	Internship*/Industrial Activity			-	-	-	-	-
Total				**30**	**22**	**175**	**525**	**700**

SEMESTER-III								
16	Core–VII	23PPH3C07	Quantum Mechanics – II	6	4	25	75	100
17	Core–VIII	23PPH3C08	Condensed Matter Physics	5	4	25	75	100
18	Core–IX	23PPH3C09	Electromagnetic Theory	5	4	25	75	100
19	Core Practical–III	23PPH3P03	Practical – III [Microprocessor 8085 & Microcontroller 8051]	6	3	25	75	100
20	Elective - III	23PPH3E03	Choose any one from the lists, I, II & III (Physics of Nanoscience and Technology)	4	3	25	75	100
21	Skill Enhancement Course – II			2	2	25	75	100
22	Soft Skill - III	Ability Enhancement Compulsory Course		2	2	25	75	100
Internship/Industrial Activity				-	2	-	-	-
Total				**30**	**24**	**175**	**525**	**700**
SEMESTER – IV								
23	Core – X	23PPH4C10	Nuclear and Particle Physics	6	4	25	75	100
24	Core – XI	23PPH4C11	Spectroscopy	5	4	25	75	100
25	Core – XII	23PPH4C12	Numerical Methods and Computer Programming	5	4	25	75	100
26	Core Practical–IV	23PPH4P04	Practical – IV [Numerical Methods and Computer Programming]	6	3	25	75	100
27	Project	23PPH4PR01	Project with Viva Voce	4	4	-	100	100
28	Skill Enhancement Course -III			2	2	25	75	100
29	Soft Skill -IV	Ability Enhancement Compulsory Course		2	2	25	75	100
30	Extension Activity			-	1	-	-	-
Total				**30**	**24**	**150**	**550**	**700**
CUMULATIVE TOTAL				**120**	**92**	**675**	**2125**	**2800**

Note:

CBCS– Choice Based Credit system

CIA – Continuous Internal Assessment

ESE –End Semester Examinations

ELECTIVE COURSES

List 1

1. Energy Physics
2. Crystal Growth and Thin films
3. Analysis of Crystal Structures
4. Materials Science
5. Physics of Nano Science and Technology
6. Digital Communication
7. Communication Electronics

LIST 2

8. Plasma Physics
9. Bio Physics
10. Non-linear Dynamics
11. Quantum Field Theory
12. General Relativity and Cosmology
13. Advanced Optics
14. Advanced Mathematical Physics

LIST 3

INDUSTRY ORIENTED ELECTIVE (IOE)

15. Advanced Spectroscopy
16. Microprocessor 8086 and Microcontroller 8051
17. Characterization of Materials
18. Medical Physics
19. Solid Waste Management (SWM)
20. Sewage and Waste Water Treatment and Reuse
21. Solar Energy Utilization

(**Note:** Institutions can also frame such IOE courses more suitable for their locality.)

14. DISTRIBUTION OF MARKS AND CREDITS

The distribution of marks and credits for the M.Sc. Physics Degree Programme is as follows:

Subject	Number of Courses	Credits	Total Marks	Total Credits
Core Courses (Theory)	12	12 × 4	1200	48
Core Courses (Practicals)	4	4 × 3	400	12
Core Courses (Project)	1	1×4	100	04
Elective Courses	03	3 × 3	300	09
Ability Enhancement Compulsory Course	04	4 × 2	400	08
Skill Enhancement Course	03	3 × 2	300	06
Professional Competency Course	01	1×2	100	02
Internship	-	-	-	02
Extension Activity	-	-	-	01
Grand Total	**28**		**2800**	**92**

15. EXAMINATIONS

The examinations consist of Continuous Internal Assessment (CIA) and end of semester examinations (ESE). The ESE shall be of Three Hours duration for each theory course at the end of every semester. The candidate failing in any course(s) will be permitted to appear for each failed course(s) in the subsequent examination. At the end of fourth semester, the Project Viva-voce will be conducted based on the Dissertation/Project Report of the students by the evaluation of one internal and one external examiner.

To maintain uniformity, particularly for interdepartmental transfer of credits, there shall be a uniform pattern of examination to be adopted by all the teachers offering courses. There shall be two tests, one seminar and one assignment for CIA and ESE during each semester. The distribution of Marks for CIA and ESE shall be 25 Marks and 75 Marks, respectively. Further, the distribution of CIA will be 10 Marks for test, 5 Marks for seminar, 5 Marks assignment and 5 Marks for attendance. The average of the highest two test Marks out of the three CIA tests will be taken for CIA.

16. COMPONENTS OF CONTINUOUS INTERNAL ASSESSMENT (CIA)

Components		Marks	Total Marks
Theory			
CIA I	75	(75+75 = 150/15)	25
CIA II	75	10	
Seminar		05	
Assignment		05	
Attendance		05	
Practical			
Practical Observation		15	40
Record Submission		15	
Model Exam		10	

17. QUESTION PAPER PATTERN

Bloom's Taxonomy Based Assessment Pattern

(**K1** – Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate)

(i) Theory Examinations (CIA I & CIA II = 25 Marks and ESE = 75 Marks)

Knowledge Level	Section	Marks	Description	Total Marks
K1	A (Answer ALL) Q1–Q15	15 × 1 = 15	Multiple Choice Questions (MCQ) (Three questions from each unit)	15
K2	B (Answer any THREE out of FIVE) Q16–Q20	3 × 5 = 15	Short Answers (One question from each unit)	15
K3 & K4	C (Either or Pattern) Q20–Q25	5 × 9 = 45	Descripitive/Detailed Answers (Two questions from each unit)	45
Total Marks				**75**

Passing Minimum (CIA) 50% = 12 Marks

Passing Minimum (ESE) 50% = 38 Marks

50 Marks

(ii) Project Viva-Voce

Knowledge Level	Section	Marks	Total Marks
K3, K4 & K5	Project Dissertation	75	100
	Viva-voce	25	

The candidate shall be declared to have passed the examination if the candidates secure not less than 38 Marks out of 75 Marks in the semester examination in each theory course and 12 Marks out of 25 Marks in the CIA and in total not less than 50 Marks.

For the practical course, 30 Marks out of 60 Marks in the semester examination and the record notebook taken together and 20 Marks out of 40 Marks in the CIA and in total 50 Marks. There is no passing minimum for the record notebook. However, the submission of the record notebook is necessary.

For the project work and Viva-voce, a candidate should secure 50% of the Marks for pass. The candidate should compulsorily attend the Viva - Voce examination to secure a pass in the project paper.

A Candidate who does not obtain the required minimum Marks for a pass in a Course/Practical/Project/Dissertation shall be declared Re-Appear (RA) and the candidate has to appear and pass the same at a subsequent appearance.

18. DISSERTATION

(a) Topic: The topic of the dissertation shall be assigned to the candidate before the beginning of third semester and a copy of the same should be submitted to the COE for Approval.

(b) Number of Project/Dissertation copies to be submitted by the students

The students should prepare five copies of dissertation and submit the same for the evaluation by Examiners. After evaluation, one copy is to be retained in the Library and one copy is to be submitted to the COE and the student can have the rest.

(c) Format to be followed

The format of the Project/Dissertation to be prepared and submitted by the students in Semester IV is given below:

Format for the preparation of Project Work:

i) Title Page:

TITLE OF THE PROJECT/DISSERTATION

Project Dissertation Submitted in partial fulfilment of the requirement for the award of the Degree of Master of Science in PHYSICS to the Sri Vidya Mandir Arts & Science Collge (Autonomous), Katteri – 636 902, Uthangarai, Tamil Nadu

By

(Student Name)

(Register Number)

Under the Guidance of

(Guide Name and Designation)

PG AND RESEARCH DEPARTMENT OF PHYSICS
SRI VIDYA MANDIR ARTS & SCIENCE COLLEGE
(AUTONOMOUS)
KATTERI – 636 902, UTHANGARAI
KRISHNAGIRI DISTRICT, TAMIL NADU

(Month and Year)

(ii) Bonafide Certificate:

CERTIFICATE

This is to certify that the dissertation entitled **"…….....”** submitted in partial fulfilment of the requirement fOR the award of the Degree of **MASTER OF SCIENCE IN PHYSICS** is a record of the original research work carried out by **Mr./Ms....., Reg.No. .....**during the period of his/her study in the **PG & Research Department of Physics**, **Sri Vidya Mandir Arts & Science College (Autonomous), Katteri – 636 902, Uthangarai** under my guidance and the dissertation has not formed the basis for the award of any Degree/Diploma/Associateship/Fellowship or other similar title to any other candidate of any Insititution.

Signature of Head of the Department **Signature of the Guide**

Name & Signature of the Examiner

1.

2.

(ii) Declaration Certificate:

DECLARATION

I declare that the project entitled **"…….....”** submitted in partial fulfilment of the requirement of the award of the Degree of **MASTER OF SCIENCE IN PHYSICS** is a record of the original research work done by me during ..... under the guidance of **....., PG and Research Department of Physics, Sri Vidya Mandir Arts and Science College, (Autonomous), Katteri – 636 902, Uthangarai**and it has not previously formed the basis for the award of any degree of any other similar title to any candidate of any Insititution.

Place: Katteri – 636 902 **Signature of the Student**

Date: **(Name of the Student)**

(iii) Acknowledgement:

(To be drafted by the student)

(iv) Table of Contents:

TABLE OF CONTENTS

19. MAXIMUM DURATION FOR THE COMPLETION OF THE M.Sc. PHYSICS PROGRAMME

The maximum duration for completion of the M.Sc. Physics Programme shall not exceed eight semesters.

20. COMMENCEMENT OF THIS REGULATION

This regulation and syllabus shall take effect from the academic year 2023- 2024 for students who are admitted to the first year of the Programme during the academic year 2023-2024 and thereafter.

21. GRADING

Once the Marks of the cumulative CIA and ESE are available, they will be added. The Marks thus obtained will then be graded as per details given below:

Marks and Grades:

The following table gives the marks grade points, letter grades and classification to indicate the performance of the candidate.

Range of Marks	Grade Points	Letter Grade	Description
90–100	9.0–10.0	O	Outstanding
80–89	8.0–8.9	D+	Excellent
75–79	7.5–7.9	D	Distinction
70–74	7.0–7.4	A+	Very Good
60–69	6.0–6.9	A	Good
50–59	5.0–5.9	B	Average
00–49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

Ci = Credits earned for course i in any semester

Gi = Grade Point obtained for course i in any semester

n = Semester in which such course were credited

For a semester:

GRADE POINT AVERAGE [GPA] = $\Sigma i\ Ci\ Gi\ /\ \Sigma i\ Ci$

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the courses}}{\text{Sum of the credits of the courses in a semester}}$$

For the entire Programme:

CUMULATIVE GRADE POINT AVERAGE [CGPA] = $\Sigma n \Sigma i Cni Gni\ /\ \Sigma n \Sigma i Cni$

$$GPA = \frac{\text{Sum of the multiplication of grade points by the credits of the entire programme}}{\text{Sum of the credits of the courses of the entire programme}}$$

22. CLASSIFICATION OF SUCCESSFUL CANDIDATES

A candidate who passes all the examinations and securing following CGPA and Grades shall be declared as follows:

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5–10.0	O+	First Class – Exemplary
9.0 and above but below 9.5	O	
8.5 and above but below 9.0	D++	First Class with Distinction
8.0 and above but below 8.5	D+	
7.5 and above but below 8.0	D	
7.0 and above but below 7.5	A++	First Class
6.5 and above but below 7.0	A+	
6.0 and above but below 6.5	A	
5.5 and above but below 6.0	B+	Second Class
5.0 and above but below 5.5	B	

23. RANKING

A candidate who qualifies for the M.Sc. Physics, passing all the Examinations in the first attempt within the minimum period prescribed for the Programme from the date of admission to the Programme and secures first or second class shall be eligible for ranking and such ranking will be confined to 10% of the total number of candidates qualified in that particular subject to a maximum of 10 ranks.

24. CONFERMENT OF THE DEGREE

No candidate shall be eligible for conferment of the Degree unless he/she has undergone the prescribed Programme of study for a period of not less than four Semesters in an Institution approved by and affiliated to the Periyar University and earns has passed the Examinations as have been prescribed.

25. TRANSITORY PROVISION

Candidates who have undergone the Programme of Study prior to the Academic Year 2023–2024 will be permitted to take the Examinations under those Regulations for a period of four

years i.e. up to and inclusive of the Examination of April 2024. Thereafter, they will be permitted to take the Examination only under the Regulations in force at that time.

PROGRAMME SYLLABUS

Program: M.Sc. Physics				
Core–I	**Course Code:** 23PPH1C01		**Course Title:** Mathematical Physics	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	6	90	4	100

COURSE OBJECTIVES

1. To equip students with the mathematical techniques needed for understanding theoretical treatment in different courses taught in their program
2. To extend their manipulative skills to apply mathematical techniques in their fields
3. To help students apply Mathematics in solving problems of Physics

UNIT I: LINEAR VECTOR SPACE AND MATRICES

Linear Vector Space: Basic Concepts – Definitions - Examples of Vector Space – Linear Independence - Scalar Product- Orthogonality – Gram-Schmidt Orthogonalization Procedure.

Matrices: Types of Matrices and their properties, Rank of a Matrix - Conjugate of a matrix - Adjoint of a matrix - Inverse of a matrix - Hermitian and Unitary Matrices - Trace of a matrix- Transformation of matrices - Characteristic equation - Eigen values and Eigen vectors - Cayley–Hamilton theorem –Diagonalization

UNIT II: COMPLEX ANALYSIS

Review of Complex Numbers -de Moivre's theorem-Functions of a Complex Variable- Differentiability -Analytic functions- Harmonic Functions- Complex Integration- Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula -Taylor's Series - Laurent's Expansion- Zeros and poles – Residue theorem and its Application.

UNIT III: TENSORS AND GROUP THEORY

Tensors: Introduction to tensors – Tensor transformation - Contravarient, Covariant tensors – Rank of a tensor – Symmetric and Anti-symmetric tensor.

Groups and their basic Properties: Group – Basic properties – Abelian group – Isomorphic group – Similarity transformation and classes – Group multiplication tables

Representation of Groups: Symmetric elements – Transformation, Matrix representation – Point groups – Reducible and irreducible representations – Great orthogonality theorem – Construction of character tables for point groups C_{2V} - XY_2 bent symmetrical type molecule - and C_{3V} - XY_3 Pyrimdal type molecule- Structure of character tables.

UNIT IV: FOURIER TRANSFORMS AND LAPLACE TRANSFORMS

Fourier Transforms: Definitions -Fourier transform and its inverse - Transform of Gaussian function and Dirac delta function -Fourier transform of derivatives - Cosine and sine transforms - Convolution theorem.

Laplace Transforms: Laplace transform and its inverse - Transforms of derivatives and integrals – Differentiation and integration of transforms - Dirac delta functions.

UNIT V:DIFFERENTIAL EQUATIONS

Bessel and Hermite polynomials - Generating function - Orthogonality properties - Recurrence relations – Legendre and Laguerre polynomials - Generating function - Rodrigue formula – Orthogonality properties – Butterworth Polynamials.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

BOOKS FOR STUDY

1. George Arfken and Hans J Weber, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press, (2012).
2. P.K. Chattopadhyay, 2013, Mathematical Physics (2nd edition), New Age, New Delhi
3. A W Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt. Ltd., India

4. B. D. Gupta, 2009, Mathematical Physics (4th edition), Vikas Publishing House, New Delhi.
5. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.

BOOKS FOR REFERENCE

1. E. Kreyszig, 1983, Advanced Engineering Mathematics, Wiley Eastern, New Delhi,
2. D. G. Zill and M. R. Cullen, 2006, Advanced Engineering Mathematics, 3rd Ed. Narosa, New Delhi.
3. S. Lipschutz, 1987, Linear Algebra, Schaum's Series, McGraw - Hill, New York 3. E. Butkov, 1968, Mathematical Physics Addison - Wesley, Reading, Massachusetts.
4. P. R. Halmos, 1965, Finite Dimensional Vector Spaces, 2nd Edition, Affiliated East West, New Delhi.
5. C. R. Wylie and L. C. Barrett, 1995, Advanced Engineering Mathematics, 6 th Edition, International Edition, McGraw-Hill, New York

WEB SOURCES

1. www.khanacademy.org
2. https://youtu.be/LZnRlOA1_2I
3. http://hyperphysics.phy-astr.gsu.edu/hbase/hmat.html#hmath
4. https://www.youtube.com/watch?v=_2jymuM7OUU&list=PLhkiT_RYTEU27vS_SlED56gNjVJGO2qaZ
5. https://archive.nptel.ac.in/courses/115/106/115106086/

COURSE OUTCOMES (CO):

At the end of the course the student will be able to:

CO1	Understand use of bra-ket vector notation and explain the meaning of complete orthonormal set of basis vectors, and transformations and be able to apply them	K1, K2
CO2	Able to understand analytic functions, do complex integration, by applying Cauchy Integral Formula. Able to compute many real integrals and infinite sums via complex integration.	**K2, K3**
CO3	Analyze characteristics of matrices and its different types, and the process of diagonalization.	**K4**
CO4	Solve equations using Laplace transform and analyze the Fourier transformations of different function, grasp how these transformations can speed up analysis and correlate their importance in technology	**K4, K5**
CO5	To find the solutions for physical problems using linear differential equations and to solve boundary value problems using Green's function. Apply special functions in computation of solutions to real world problems	**K2, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

Mappingof COs with POs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2

CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	3

Program: M.Sc. Physics				
Core–II		**Course Code:** 23PPH1C02		**Course Title:** Classical Mechanics
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	5	90	4	100

COURSE OBJECTIVES

1. To understand fundamentals of classical mechanics.
2. To understand Lagrangian formulation of mechanics and apply it to solve equation of motion.
3. To understand Hamiltonian formulation of mechanics and apply it to solve equation of motion.

4. To discuss the theory of small oscillations of a system.
5. To learn the relativistic formulation of mechanics of a system.

UNIT -I: PRINCIPLES OF CLASSICAL MECHANICS AND LAGRANGIAN FORMULATION

Mechanics of a system of particles: Conservation laws for a system - Constraints and its classifications – Generalized coordinates – Degrees of freedom – Principle of virtual work - D'Alembert's principle – Cyclic coordinates - Lagrange's Equations – Applications of Lagrange's formulation – Compound pendulum – Simple pendulum – Atwood's machine - Projectile motion– Calculus of variations: Hamilton's principle – Lagrange's equation from Hamilton's principle.

UNIT -II: HAMILTONIAN FORMULATION

Hamiltonian of a system – Phase space – Conjugate momentum - Cyclic coordinates – Integrals of Hamilton's equations – Hamilton's canonical equations of motion – Deduction of canonical equations from a variational principle – Applications – One dimensional simple harmonic oscillator –Motion of particle in a central field of force – Hamiltonian for a charged particle in an electromagnetic field – Principle of least action.

UNIT- III: CANONICAL TRANSFORMATION AND HAMILTON-JACOBI THEORY

Canonical transformation – Advantage – Examples of Canonical transformations – Condition for a transformation to be Canonical – Infinitesimal Canonical transformation – Hamilton–Jacobi method – Hamilton–Jacobi partial differential equation – Hamilton–Jacobi equation for principal function, and characteristic function – Harmonic oscillator problem by Hamilton – Jacobi method – Kepler's problem solution by Hamilton–Jacobi method - Action angle variables.

UNIT -IV: SMALL OSCILLATIONSANDPOISSON BRACKET

Lagrangian equations of motion for small oscillations – Normal coordinates and normal frequencies of vibration – Vibrations of a linear triatomic molecule – Euler's angles rotating coordinate system - Poisson brackets – Properties of Poisson bracket – Invariance of Poisson brackets to canonical transformations – Equation of motion in Poisson bracket form- Motion of symmetrical top under the action of gravity

UNIT- V: RELATIVITY

Inertial and non-inertial frames – Lorentz transformation equations – length contraction and time dilation – relativistic addition of velocities – Einstein's mass-energy relation – Minkowski's space – four vectors – position, velocity, momentum, acceleration and force in for vector notation and their transformations

BOOKS FOR STUDY:

1. S. L. Gupta, V. Kumar, H.V. Sharma, Classical Mechanics, Pragati Prakashan Educational Publishers, Meerut (2007). [Unit Covered: 1–5: Pages : 1–19, 20–40, 48–65, 96–115, 345–343, 125–140, 150–185, 245–290, 325–348].
2. G. Aruldhas, Classical Mechanics, Prentice - Hall of India Pvt. Ltd., New Delhi (2008). [Unit Covered: 1–5: Pages: 1–20, 40–50, 61–85, 77–96, 135–167, 171–189, 195–219, 230–251].

BOOKS FOR REFERENCE

1. H. Goldstein, C. Poole and J. Safko, Classical Mechanics, Pearson Education Asia, New Delhi (2002).
2. K.C. Gupta, Classical Mechanics of Particles and Rigid Bodies, New Age International, New Delhi (1997).
3. J.C. Upadhaya, Classical Mechanics, Himalaya Publishing House Pvt. Ltd., Bangalore Second Edition (2017).
4. S.N. Biswas, Classical Mechanics, Books and Allied Ltd., Kolkata (1998).
5. N.C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw Hill Publishing Company Ltd., New Delhi (1991).
6. R.G. Takwa, Introduction to Classical Mechanics, Himalaya Publishing House Pvt. Ltd., Bangalore (2010).

COURSEOUTCOMES(CO)

At the end of the course the student will be able to:

CO1	Understand the fundamentals of classical mechanics.	K2
CO2	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	**K3**
CO3	Apply the principles of Lagrangian and Hamiltonian mechanics to solve the equations of motion of physical systems.	**K3, K5**
CO4	Analyze the small oscillations in systems and determine their normal modes of oscillations.	**K4, K5**

CO5	Understand and apply the principles of relativistic kinematics to the mechanical systems.	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	2	2
CO2	2	3	3	3	2	2	2	3	2	2
CO3	2	3	3	3	2	2	2	3	2	2
CO4	2	3	3	3	2	2	2	3	2	2
CO5	2	3	3	3	2	2	2	3	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	3	3	2	3	2
CO2	2	3	3	3	3	3	3	2	2	2
CO3	3	3	3	2	2	3	3	2	3	2
CO4	3	3	3	3	2	3	3	2	2	2
CO5	3	2	3	3	2	3	3	2	2	2

Program: M.Sc. Physics				
Core–III	**Course Code:**23PPH1C03		**Course Title:** Linear and Digital ICs and Applications	
Semester I	**Hours/Week** 5	**Total Hours** 75	**Credits** 4	**Total Marks** 100

COURSE OBJECTIVES

- To acquire knowledge about operational amplifiers and waveform generators.
- To understand the theories of combinational and sequential logic circuits.
- To habituate the concepts of data converter and active filters.

UNIT I: OPERATIONAL AMPLIFIER AND ANALOG COMPUTATION

Operational Amplifier –Definition and Block diagram of Operational Amplifier - Electrical Parameters – Offset and Null Connection – Offset Error and Correction - Inverting Single Input Summing Amplifier – Three Input Averaging Amplifier - Differential Amplifier - General Linear Applications – Voltage to Current Converter – Current to Voltage Converter- Simultaneous equations and differential equations- Instrumentation amplifier- Log and Antilog amplifiers- Analog multiplication and division – Internal circuitary of operational amplifier (Only for Study).

UNIT II: LINEAR IC'S - WAVEFORM GENERATORS

Sine wave Oscillator - Wien's Bridge Oscillator and Phase shift oscillator – Square wave generator – Triangular wave generator - Saw-tooth generator – Quadrature Oscillator - Pulse generator — 555 Timer IC - Internal Architecture and working – Astable multi vibrator - Voltage controlled oscillator - Monostable multi vibrator - Schmidt trigger – Squarer - Phase Locked Loop (PLL) - Application of PLL in Television Transmission.

UNIT III: COMBINATIONAL LOGIC CIRCUITS

NAND/ NOR as Universal building blocks – Half and Full Adders - Half and Full Subtractors – 4 bit binary Adder and Subtractor - 4 bit BCD Adder and Subtractor - Encoder and Decoder- Multiplexer and Demultiplexer - Memory Devices – ROM – RAM – EPROM.

UNIT IV: SEQUENTIAL LOGIC CIRCUITS

Flip Flops- RS Flip flop, Clocked RS Flip flop, D-type Flip flop, JK Flip flop, T Flip flop and M/S JK Flip flop, Counters- Synchronous, Asynchronous (Up and Down) and Modulus counters- BCD counters- Shift registers- Ring counter as divide by N counter- Johnson counter - Applications.

UNIT V: DATA CONVERTERS AND ACTIVE FILTERS

Digital to analog converter - Binary weighted and R/2R ladder type- Accuracy and resolution - Dual slope digital to analog converter – Analog to digital converter - Simultaneous conversion -

Counter method - Successive approximation method.

Active filters – Low pass, High Pass, Band pass, Band stop - Second order Butter worth design – Multiple Feedback filter circuit.

BOOKS FOR STUDY:

1. Ramakant A Gayakwad, Op-Amps and Linear Integrated Circuits, Fourth Edition, Pearson, Prentice Hall (2000).
2. Anil K Maini, Digital Electronics, Principles, Devices and Appications, John Wiley and Sons Limited (2007).
3. Donald P Leach & Albert Paul Malvino, Digital Principles and Applications, Seventh Edition, Tata McGraw Hill Education Private Limited, New Delhi (2011).

BOOKS FOR REFERENCE:

1. Jacob Millman, Christes C. Halkias, Integrated Electronics: Analog and Digital Circuits and Systems, Second Edition, Mc-Graw Hill, Kogakusha, Japan (2011).
2. Thomas L. Floyd, David Buchla, Basic Operational Amplifiers and Linear Integrated Circuits, Second Edition, Prentice Hall (1999).

COURSE OUTCOMES (CO)

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

CO Number	CO Statement	Knowledge Level
CO1	Acquire elaborate knowledge about operational amplifier and its	K1 & K2

	applications	
CO2	Understand the concepts of oscillators & multivibrators and its applications in electronic devives.	K2 & K3
CO3	Gain the knowledge of basic digital circuits and memory devices.	K3 & K4
CO4	Develope the practical knowdege in the field of registers and counters.	K5 & K6
CO5	Understand the working principles of data converting circuits and active filters.	K5

K1– Remember, K2– Understand, K3– Apply, K4 –Analyze, K5– Evaluate, K6 – Create

Mapping of COs with POs

CO	PO1	PO2	PO3	PO4	PO5
CO1	M	M	S	S	S
CO2	M	S	S	M	S
CO3	S	S	S	S	S
CO4	S	S	S	S	S
CO5	S	S	S	S	S

S – Strong, M – Medium, L – Low

COURSEOUTCOMES(CO)

At the end of the course the student will be able to:

CO1	Learn about the basic concepts for the circuit configuration for the design of linear integrated circuits and develops skill to solve problems	K1, K5

CO2	Develop skills to design linear and non-linear applications circuits using Op-Amp and design the active filters circuits.	**K3**
CO3	Gain knowledge about PLL, and develop the skills to design the simple circuits using IC 555 timer and can solve problems related to it.	**K1, K3**
CO4	Learn about various techniques to develop A/D and D/A converters.	**K2**
CO5	Acquire the knowledge about the CMOS logic, combinational and sequential circuits	**K1, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	2	2	3	3	3	2
CO2	3	3	3	3	1	3	3	3	2	1
CO3	3	3	3	3	1	3	3	3	2	1
CO4	3	3	3	3	1	3	3	3	2	1
CO5	3	3	3	2	1	1	2	3	2	1

Program: M.Sc. Physics				
Practical–I	**CourseCode:**23PPH1P01		**Course Title:** Advanced Physics Experiments	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
I	6	120	3	100

COURSE OBJECTIVES

- To understand the concept of mechanical behavior of materials and calculation of same using appropriate equations.
- To calculate the thermodynamic quantities and physical properties of materials.
- To analyze the optical and electrical properties of materials.

I(a). ADVANCED PHYSICS EXPERIMENTS

(Any *ten* Experiments)

1. Determination of Young's Modulus and Poison's ratio by Elliptic fringes - Cornu's Method
2. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method
3. Determination of Viscosity of the given liquid – Meyer's disc.
4. Determination of Stefan's constant of radiation from a hot body.
5. Measurement of Coefficient of linear expansion- Air wedge Method
6. Determination of Permittivity of a liquid using an RFO
7. Measurement of Susceptibility of liquid - Quincke's method.
8. B-H loop using Anchor ring.
9. B-H curve using CRO.
10. Measurement of Magnetic Susceptibility - Guoy's method.
11. Determination of Thickness of the enamel coating on a wire by diffraction
12. Determination of Rydberg's Constant - Hydrogen Spectrum
13. FP Etalon
14. LG Plate.
15. Arc spectrum: Copper
16. Determination of Solar constant.
17. Determination of Thickness of air film. - Solar spectrum – Hartmann's formula. Edser and Butler fringes
18. Measurement of Band gap energy- Thermistor
19. Determination of Planck Constant – LED Method

I (b). ADVANCED PHYSICS EXPERIMENTS

(Any *ten* Experiments)

1. Determination of Specific charge of an electron – Thomson's method.
2. Determination of e/m - Millikan's method.
3. Determination of Compressibility of a liquid using Ultrasonics .
4. Miscibility measurements using ultrasonic diffraction method.
5. Determination of Wavelength, Separation of wavelengths - Michelson Interferometer
6. Determination of Thickness of thin film. - Michelson Interferometer
7. GM counter – Characteristics, inverse square law and absorption coefficient.
8. GM counter – Feather's analysis: Range of Beta rays.
9. Measurement of Conductivity - Four probe method.
10. Arc spectrum – Iron.
11. Iodine absorption spectra.
12. Molecular spectra – ALO band.
13. Molecular spectra – CN bands.
14. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
15. Determination of Diffraction pattern of light with circular aperture using Diode/He-Ne laser.
16. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
17. Determination of Refractive index of liquids using diode Laser/ He – Ne Laser.
18. Determination of Numerical Aperature and Acceptance angle of optical fibres using Laser Source.
19. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square ,Receiver end transmitter behavior, Radiation Pattern - Microwave test bench
20. Measurement of Dielectricity - Microwave test bench.
21. Hall Effect in Semiconductor. Determine the Hall coefficient, carrier concentration and carrier mobility.
22. UV-Visible spectroscopy – Verification of Beer-Lambert's law and identification of wavelength maxima – Extinction coefficient

23. Interpretation of vibrational spectra of a given material.
24. Detrmination of I – V Characteristics and efficiency of solar cell.

BOOKS FOR REFERENCE:

1. Advanced Practical Physics, S.P Singh, PragatiPrakasan.
2. Practical Physics, Gupta and Kumar, PragatiPrakasan.
3. Kit Developed for doing experiments in Physics- Instruction manual, R.Srinivasan K.R Priolkar, Indian Academy of Sciences.
4. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd:
5. A course on experiment with He-Ne Laser, R.SSirohi, John Wiley & Sons (Asia) Pvt.ltd

COURSE OUTCOMES (CO):

At the end of the course the student will be able to:

CO1	Understand the strength of material using Young's modulus.	K2
CO2	Acquire knowledge of thermal behaviour of the matetials.	**K1**
CO3	Understand theoretical principles of magnetism through the experiments.	**K2**
CO4	Acquire knowledge about arc spectrum and applications of laser	**K1, K3**
CO5	Improve the analytical and observation ability in Physics Experiments	**K3, K5**
CO6	Conduct experiments on applications of FET and UJT	**K4**
CO7	Analyze various parameters related to operational amplifiers.	**K4**
CO8	Understand the concepts involved in arithmatic and logical circuits using IC's	**K2**
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	**K1**
CO10	Analyze the applications of counters and registers	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

Mapping of Cos with POs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	2	2	2	1	2	3
CO2	2	2	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	2	2	2
CO6	2	2	2	3	3	1	1	1	3	3
CO7	2	2	3	3	3	1	1	1	3	3
CO8	3	3	3	3	3	3	2	2	3	3
CO9	3	3	3	3	3	3	1	1	1	1
CO10	3	3	3	3	3	3	1	1	1	1

Program: M.Sc.Physics

Core–IV	CourseCode:23PPH2C04	Course Title: Statistical Mechanics		
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	6	75	4	100

COURSEOBJECTIVES

1. Tounderstandinglawsofthermodynamicsandasystematicdefinitionofthermodynamicpotentialsas the general formalism of thermodynamics.
2. Tooverviewfoundationsofequilibriumstatisticalphysicsasthemicroscopictheoryofmatterand fields.

UNIT I: STATISTICAL MECHANICS AND THERMODYNAMICS

Foundations of statistical mechanics - Specification of states of a system - Micro canonical ensemble - Phase space – Entropy - Connection between statistics and thermodynamics – Entropy of an ideal gas using the micro canonical ensemble - Entropy of mixing and Gibb's paradox.

UNIT II: PHASETRANSITIONS

Thermodynamic potentials - Phase Equilibrium - Gibb's phase rule - Phase transitions and Ehrenfest's classifications –Third law of Thermodynamics. Order parameters – Landau's theory of phase transition - Critical indices - Scale transformations and dimensional analysis.

UNIT III:CANONICAL AND GRAND CANONICAL ENSEMBLES

Trajectories and density of states - Liouville's theorem - Canonical and grand canonical ensembles - Partition function - Calculation of statistical quantities - Energy and density fluctuations.

UNIT IV:CLASSICAL AND QUANTUM STATISTICS

Density matrix - Statistics of ensembles - Statistics of indistinguishable particles - Maxwell-Boltzmann statistics - Fermi-Dirac statistics – Ideal Fermi gas – Degeneracy - Bose-Einstein statistics - Plank radiation formula - Ideal Bose gas - Bose-Einstein condensation.

UNIT V: REAL GAS,ISING MODEL AND FLUCTUATIONS

Cluster expansion for a classical gas - Virial equation of state – Calculation of the first Virial coefficient in the cluster expansion - Ising model - Mean-field theories of the Ising model in three, two and one dimensions - Exact solutions in one dimension. Correlation of space-time dependent fluctuations - Fluctuations and transport phenomena - Brownian motion - Langevin's theory - Fluctuation-dissipation theorem - The Fokker-Planck equation

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. S. K. Sinha, 1990, Statistical Mechanics, Tata McGraw Hill, New Delhi.
2. B. K. Agarwal and M. Eisner, 1998, Statistical Mechanics, Second Edition New Age International, New Delhi.
3. J. K. Bhattacharjee, 1996, Statistical Mechanics: An Introductory Text, Allied Publication, New Delhi.
4. F. Reif, 1965, Fundamentals of Statistical and Thermal Physics, McGraw -Hill, New York.
5. M. K. Zemansky, 1968, Heat and Thermodynamics, 5th edition, McGraw-Hill New York.

REFERENCE BOOKS

1. R. K. Pathria, 1996, Statistical Mechanics, 2nd edition, Butter WorthHeinemann, New Delhi.
2. L. D. Landau and E. M. Lifshitz, 1969, Statistical Physics, Pergamon Press, Oxford.
3. K. Huang, 2002, Statistical Mechanics, Taylor and Francis, London
4. W. Greiner, L. Neiseand H.Stoecker, Thermodynamics and Statistical Mechanics, Springer Verlang, New York.
5. A. B. Gupta, H. Roy, 2002, Thermal Physics, Books and Allied, Kolkata.

WEB SOURCES

1. https://byjus.com/chemistry/third-law-of-thermodynamics/
2. https://web.stanford.edu/~peastman/statmech/thermodynamics.html
3. https://en.wikiversity.org/wiki/Statistical_mechanics_and_thermodynamics
4. https://en.wikipedia.org/wiki/Grand_canonical_ensemble
5. https://en.wikipedia.org/wiki/Ising_model

COURSE OUTCOMES (CO):

At the end of the course the student will be able to:

CO1	To examine and elaborate the effect of changes in thermodynamic quantities on the states of matter during phase transition	K5
CO2	To analyze the macroscopic properties such as pressure, volume, temperature, specific heat, elastic moduli etc. using microscopic properties like intermolecular forces, chemical bonding, atomicity etc. Describe the peculiar behaviour of the entropy by mixing two gases Justify the connection between statistics and thermodynamic quantities	**K4**
CO3	Differentiate between canonical and grand canonical ensembles and to interpret the relation between thermodynamical quantities and partition function	**K1**
CO4	To recall and apply the different statistical concepts to analyze the behaviour of ideal Fermi gas and ideal Bose gas and also to compare and distinguish between the three types of statistics.	**K4, K5**
CO5	To discuss and examine the thermodynamical behaviour of gases under fluctuation and also using Ising model	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	1	2	3	1	1	3
CO2	3	3	3	1	1	2	3	1	1	3
CO3	3	3	3	1	1	2	3	2	1	3
CO4	3	3	3	1	1	2	3	2	1	3
CO5	3	3	3	1	1	2	3	1	1	3

Program: M.Sc.Physics				
Core–V	**CourseCode:**23PPH2C05		**Course Title:** Quantum Mechanics-I	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	6	75	4	100

COURSE OBJECTIVES

1. To develop the physical principles and the mathematical background important to quantum mechanical descriptions.
2. To describe the propagation of a particle in a simple, one-dimensional potential.
3. To formulate and solve the Schrodinger's equation to obtain eigenvectors and energies for particle in a three-dimensional potential.
4. To explain the mathematical formalism and the significance of constants of motion, and see their relation to fundamental symmetries in nature
5. To discuss the Approximation methods like perturbation theory, Variational and WKB methods for solving the Schrödinger equation.

UNIT I: BASIC FORMALISM

Interpretation of the wave function – Time dependent Schrodinger equation –Time independent Schrodinger equation – Stationary states – Ehrenfest's theorem – Linear vector space – Linear operator – Eigen functions and Eigen Values – Hermitian Operator – Postulates of Quantum Mechanics – Simultaneous measurability of observables – General Uncertainty relation

UNIT II: ONE DIMENSIONAL AND THREE-DIMENSIONAL ENERGY EIGEN VALUE PROBLEMS

Square – well potential with rigid walls – Square well potential with finite walls – Square potential barrier – Alpha emission – Bloch waves in a periodic potential – Kronig-penny square – well periodic potential – Linear harmonic oscillator: Operator method – Particle moving in a spherically symmetric potential – System of two interacting particles – Hydrogen atom – Rigid rotator

UNIT III: GENERAL FORMALISM

Dirac notation – Equations of motions – Schrodinger representation – Heisenberg representation – Interaction representation – Coordinate representation – Momentum representation – Symmetries and conservation laws – Unitary transformation – Parity and time reversal

UNIT IV: APPROXIMATION METHODS

Time independent perturbation theory for non-degenerate energy levels – Degenerate energy levels – Stark effect in Hydrogen atom – Ground and excited state – Variation method – Helium atom – WKB approximation – Connection formulae (no derivation) – WKB quantization – Application to simple harmonic oscillator.

UNIT V: ANGULAR MOMENTUM

Eigenvalue spectrum of general angular momentum – Ladder operators and their algebra – Matrix representation – Spin angular momentum – Addition of angular momenta – CG Coefficients – Symmetry and anti – symmetry of wave functions – Construction of wave-functions and Pauli's exclusion principle.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics, 2nd edition(37th Reprint),Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, Quantum Mechanics, 2nd edition, Prentice Hall of India, New Delhi, 2009.
3. David J Griffiths, Introduction to Quantum Mechanics. 4th edition, Pearson, 2011.
4. SL Gupta and ID Gupta, Advanced Quantum Theory and Fields, 1st Edition, S.Chand& Co., New Delhi, 1982.
5. A. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4thEdition, Macmillan, India, 1984.

REFERENCE BOOKS

1. E. Merzbacher, Quantum Mechanics, 2nd Edition, John Wiley and Sons, New York, 1970.
2. V. K. Thankappan, Quantum Mechanics, 2nd Edition, Wiley Eastern Ltd, New Delhi, 1985.
3. L. D. Landau and E. M. Lifshitz, Quantum Mechanics, 1st edition, Pergomon Press, Oxford, 1976.
4. S. N. Biswas, Quantum Mechanics, Books and Allied Ltd., Kolkata, 1999.
5. V. Devanathan, Quantum Mechanics, 2nd edition, Alpha Science International Ltd, Oxford , 2011.

WEB SOURCES

1. http://research.chem.psu.edu/lxjgroup/download_files/chem565-c7.pdf
2. http://www.feynmanlectures.caltech.edu/III_20.html
3. http://web.mit.edu/8.05/handouts/jaffe1.pdf
4. https://hepwww.pp.rl.ac.uk/users/haywood/Group_Theory_Lectures/Lecture_ 1.pdf
5. https://theory.physics.manchester.ac.uk/~xian/qm/chapter3.pdf

COURSE OUTCOMES(CO):

At the end of the course the student will be able to:

CO1	Demonstrates a clear understanding of the basic postulates of quantum mechanics which serve to formalize the rules of quantum Mechanics	**K1, K5**
CO2	Is able to apply and analyze the Schrodinger equation to solve one dimensional problems and three dimensional problems	**K3, K4**
CO3	Can discuss the various representations, space time symmetries and formulations of time evolution	**K1**
CO4	Can formulate and analyze the approximation methods for various quantum mechanical problems	**K4, K5**
CO5	To apply non-commutative algebra for topics such as angular and spin angular momentum and hence explain spectral line splitting.	**K3, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

Mapping of Cos with POs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3
CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	3	2	3	2	2	3
CO2	3	3	3	3	3	S	3	2	2	3
CO3	2	3	3	2	3	2	3	2	2	3

CO4	3	3	3	3	3	2	3	3	2	3
CO5	3	3	3	2	3	S	3	3	2	3

Program: M.Sc.Physics				
Practical–II	**CourseCode:**23PPH2P02		**Course Title:** Electronics Experiments	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
II	6	120	4	100

COURSE OBJECTIVES

- To observe the applications of FET and UJT.
- To study the different applications of operational amplifier circuits.
- To learn about Combinational Logic Circuits and Sequential Logic Circuits

II(a). ELECTRONICS EXPERIMENTS

(Any *ten* Experiments)

1. Construction of relaxation oscillator using UJT
2. FET CS amplifier- Frequency response, input impedance, output impedance
3. Study of important electrical characteristics of IC741.
4. V- I Characteristics of different colours of LED.
5. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
6. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
7. Construction of Schmidt trigger circuit using IC 741 for a given hysteresis- application as squarer.
8. Construction of square wave Triangular wave generator using IC 741
9. Construction of a quadrature wave using IC 324
10. Construction of pulse generator using the IC 741 – application as frequency divider
11. Construction of Op-Amp- 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
12. Study of Binary to Gray and Gray to Binary code conversion.
13. Study of R-S, clocked R-S and D-Flip flop using NAND gates

14. Study of J-K, D and T flip flops using IC 7476/7473
15. Arithmetic operations using IC 7483- 4 bit binary addition and subtraction.
16. Study of Arithmetic logic unit using IC 74181
17. Construction of Encoder and Decoder circuits using ICs.

II(b). ELECTRONICS EXPERIMENTS

(Any *ten* Experiments)

1. IC 7490 as scalar and seven segment display using IC7447
2. Solving simultaneous equations – IC 741 / IC LM324.
3. Op-Amp –Active filters : Low pass, High pass and Band pass filters (Second Order) Batter worth filter.
4. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
5. Construction of second order butterworth multiple feedback narrow band pass filter
6. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193
7. Construction of square wave generator using IC 555 – Study of VCO.
8. Construction of Schmidt triggers circuit using IC555 for a given hysteresis – Application as squarer.
9. Construction of pulse generator using the IC 555 – Application as frequency divider.
10. BCD to Excess- 3 and Excess 3 to BCD code conversion.
11. Study of binary up / down counters - IC 7476 / IC7473
12. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474
13. Study of synchronous parallel 4-bit binary up/down counter using IC 74193
14. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493
15. Study of Modulus Counter.
16. Construction of Multiplexer and Demultiplexer using ICs.

BOOKS FOR REFERENCE:

1. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
2. Electronic Laboratory Primer a design approach, S. Poornachandra, B.Sasikala, Wheeler Publishing, New Delhi.

3. Electronic lab manual Vol I, K ANavas, Rajath Publishing.
4. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition
5. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.
6. An advanced course in Practical Physics, D.Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd.

COURSE OUTCOMES (CO)

COURSE OUTCOMES(CO):

At the end of the course the student will be able to:

CO1	Understand the strength of material using Young's modulus	K2
CO2	Acquire knowledge of thermal behaviour of the materials	K1
CO3	Understand theoretical principles of magnetism through the experiments.	K2
CO4	Acquire knowledge about arc spectrum and applications of laser	K1
CO5	Improve the analytical and observation ability in Physics Experiments	K4
CO6	Conduct experiments on applications of FET and UJT	K5
CO7	Analyze various parameters related to operational amplifiers	K4
CO8	Understand the concepts involved in arithmetic and logical circuits using IC's	K2
CO9	Acquire knowledge about Combinational Logic Circuits and Sequential Logic Circuits	K3
CO10	Analyze the applications of counters and registers	K4
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	2	2	S	S	2	2	2	3	3
CO2	2	2	S	S	S	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3

CO10	3	3	3	3	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	S	S	2	2	2	3	3
CO7	2	2	S	S	S	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

Program: M.Sc. Physics				
Core–VI	**CourseCode:**23PPH3C07		**Course Title:** Quantum Mechanics-II	
Semester III	**Hours/Week** 6	**Total Hours** 75	**Credits** 4	**Total Marks** 100

COURSE OBJECTIVES

1. Formal development of the theory and the properties of angular momenta, both orbital and spin
2. To familiarize the students to the crucial concepts of scattering theory such as partial wave analysis and Barn approximation.
3. Time-dependent Perturbation theory and its application to study of interaction of an atom with the electromagnetic field
4. To give the students a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts
5. To introduce the concept of covariance and the use of Feynman graphs for depicting different interactions

UNIT 1: SCATTERING THEORY

Scattering Cross Section – Differential and total cross section – Laboratory and centre of mass reference system - Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for ‘s’ wave – Optical theorem.

UNIT II: PERTURBATION THEORY

Time dependent perturbation theory – Constant and harmonic perturbations – Fermi Golden rule – Transition probability Einstein’s A and B Coefficients – Adiabatic approximation – Sudden approximation – Semi – classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation

UNIT III: RELATISVISTIC QUANTUM MECHANICS

Klein – Gordon equation – Charge and current densities – Dirac matrices – Dirac equation – Plane wave solutions – Interpretation of negative energy states – Antiparticles – Spin of electron – Magnetic moment of an electron due to spin.

UNIT IV: DIRAC EQUATION

Covariant form of Dirac Equation – Properties of the gamma matrices – Traces – Relativistic invariance of Dirac equation – Probability Density – Current four vector – Bilinear covariant – Feynman’s theory of positron (Elementary ideas only without propagation formalism)

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION

Classical fields – Euler Lagrange equation – Hamiltonian formulation – Noether's theorem – Quantization of real and complex scalar fields – Creation, Annihilation and Number operators – Fock states – Second Quantization of K-G field.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics,2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. Nouredine Zettili, Quantum Mechanics concepts and applications, 2nd Edition, Wiley, 2017.
6. Sathya Prakash and Swati, Quantum Mechanics, Kedar Nath Ram Nath, Meerut, India (2019).

REFERENCE BOOKS

1. P. A. M. Dirac, The Principles of Quantum Mechanics, 4th Edition, Oxford University Press, London, 1973.
2. B. K. Agarwal & Hari Prakash, Quantum Mechanics, 7th reprint, PHI Learning Pvt. Ltd., New Delhi, 2009.
3. Deep Chandra Joshi, Quantum Electrodynamics and Particle Physics,1stedition,I.K.International Publishing house Pvt. Ltd., 2006
4. Ghatak and S. Lokanathan, Quantum Mechanics: Theory and Applications, 4th Edition, Macmillan India, New Delhi.
5. E. Merzbacher, Quantum Mechanics, 2nd edition, John Wiley and Sons, New York, 1970

WEB SOURCES

1. https://ocw.mit.edu/courses/physics/8-05-quantum-physics-ii-fall-2013/lecture notes/MIT8_05F13_Chap_09.pdf
2. http://www.thphys.nuim.ie/Notes/MP463/MP463_Ch1.pdf
3. http://hep.itp.tuwien.ac.at/~kreuzer/qt08.pdf
4. https://www.cmi.ac.in/~govind/teaching/rel-qm-rc13/rel-qm-notes-gk.pdf

5. https://web.mit.edu/dikaiser/www/FdsAmSci.pdf

COURSE OUTCOMES(CO):

At the end of the course the student will be able to:

CO1	Familiarize the concept of scattering theory such as partial wave analysis and Born approximation	**K1**
CO2	Give a firm grounding in relativistic quantum mechanics, with emphasis on Dirac equation and related concepts	**K2**
CO3	Discuss the relativistic quantum mechanical equations namely, Klein-Gordon and Dirac equations and the phenomena accounted by them like electron spin and magnetic moment	**K1, K4**
CO4	Introduce the concept of covariance and the use of Feynman graphs for depicting different interactions	**K1, K3**
CO5	Demonstrate an understanding of field quantization and the explanation of the scattering matrix.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	3	3	3
CO2	3	3	2	3	3	3	3	3	3	3
CO3	3	2	2	3	3	2	3	3	3	3
CO4	2	1	1	3	3	1	2	2	3	3
CO5	2	1	1	3	3	2	2	2	3	3

Program:M.Sc.Physics		
Core–X	**CourseCode:**21PPH4C10	**CourseTitle:** CondensedMatterPhysics

Semester	Hours/Week	TotalHours	Credits	TotalMarks
IV	6	90	4	100

COURSEOBJECTIVES

1. To describe various crystal structures, symmetry and to differentiate different types of bonding.
2. To construct reciprocal space, understand the lattice dynamics and apply it to concept of specific heat.
3. To critically assess various theories of electrons in solids and their impact in distinguishing solids.
4. Outline different types of magnetic materials and explain the underlying phenomena.
5. Elucidation of concepts of superconductivity, the underlying theories – relate to current areas of research.

UNIT I: CRYSTAL PHYSICS

Types of lattices - Miller indices – Symmetry elements and allowed rotations - Simple crystal structures – Atomic Packing Factor- Crystal diffraction - Bragg's law – Scattered Wave Amplitude - Reciprocal Lattice (sc, bcc, fcc). Diffraction Conditions - Laue equations - - Structure factor - Atomic form factor - Inert gas crystals - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding (general ideas).

UNIT II: LATTICE DYNAMICS

Lattice with two atoms per primitive cell - First Brillouin zone - Group and phase velocities - Quantization of lattice vibrations - Phonon momentum - Inelastic scattering by phonons – Einstein Model - Debye’s theory of lattice heat capacity - Thermal Conductivity of solids - Umkalapp processes.

UNIT III: THEORY OF METALS AND SEMICONDUCTORS

Free electron gas in three dimensions - Electronic heat capacity - Wiedemann-Franz law - Band theory of metals and semiconductors - Bloch theorem - Kronig-Penney model – Origin of Band gap -Semiconductors - Intrinsic carrier concentration – Temperature Dependence - Mobility - Impurity conductivity – Impurity states – Fermi level - Hall effect - Fermi surfaces and construction - Experimental methods in Fermi surface studies - de Hass-van Alphen effect .

UNIT IV: MAGNETISM

Diamagnetism - Quantum theory of paramagnetism - Rare earth ion - Hund's rule - Quenching of orbital angular momentum - Adiabatic demagnetization - Quantum theory of ferromagnetism - Curie point - Exchange integral - Heisenberg's interpretation of Weiss field - Ferromagnetic domains - Bloch wall - Spin waves - Quantization - Magnons - Thermal excitation of magnons - Curie temperature and susceptibility of ferrimagnets - Theory of antiferomagnetism - Neel temperature.

UNIT V

Superconductivity: Experimental facts: Occurrence - Effect of magnetic fields - Meissner effect – Critical field – Critical current - Entropy and heat capacity - Energy gap - Microwave and infrared properties - Type I and II Superconductors.

Theoretical Explanation: Thermodynamics of super conducting transition - London equation - Coherence length – Isotope effect - Cooper pairs – Bardeen Cooper Schrieffer (BCS) Theory – BCS to Bose – Einstein Condensation (BEC) regime- Nature of paring and condensation of Fermions. Single particle tunneling - Josephson tunneling - DC and AC Josephson effects - High temperature Superconductors – SQUIDS.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. C. Kittel, 1996, Introduction to Solid State Physics, 7th Edition, Wiley, New York.
2. Rita John, Solid State Physics, Tata Mc-Graw Hill Publication.
3. A. J. Dekker, Solid State Physics, Macmillan India, New Delhi.
4. M. Ali Omar, 1974, Elementary Solid State Physics – Principles and Applications, Addison - Wesley
5. H. P. Myers, 1998, Introductory Solid State Physics, 2nd Edition, Viva Book, New Delhi.

REFERENCE BOOKS

1. J. S. Blakemore, 1974 , Solid state Physics, 2nd Edition, W.B. Saunder, Philadelphia
2. H. M. Rosenburg, 1993, The Solid State, 3rd Edition, Oxford University Press, Oxford.
3. J. M. Ziman, 1971, Principles of the Theory of Solids, Cambridge University Press, London.
4. C. Ross-Innes and E. H. Rhoderick, 1976, Introduction to Superconductivity, Pergamon, Oxford.
5. J. P. Srivastava, 2001, Elements of Solid State Physics, Prentice-Hall of India, New Delhi.

WEB SOURCES

1. http://www.physics.uiuc.edu/research/electronicstructure/389/389-cal.html
2. http://www.cmmp.ucl.ac.uk/%7Eaph/Teaching/3C25/index.html
3. https://www.britannica.com/science/crystal
4. https://www.nationalgeographic.org/encyclopedia/magnetism/
5. https://www.brainkart.com/article/Super-Conductors_6824/

COURSE OUTCOMES (CO)

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

CO1	Student will be able to list out the crystal systems, symmetries allowed in a system and also the diffraction techniques to find the crystal structure	**K1**
CO2	Students will be able to visualize the idea of reciprocal spaces, Brillouin Zone and their extension to band theory of solids.	**K1, K2**
CO3	Student will be able to comprehend the heat conduction in solids	**K3**
CO4	Student will be able to generalize the electronic nature of solids from band theories.	**K3, K4**
CO5	Student can compare and contrast the various types of magnetism and conceptualize the idea of superconductivity.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	2	2	2	2	2	2	2
CO2	3	2	3	2	3	2	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	2	2	2	2	2	2	2	2	2	3
CO5	2	2	2	2	2	2	2	2	2	3

Program: M.Sc.Physics

Core–VIII	CourseCode:23PPH3C09	Course Title: Electromagnetic Theory and Plasma Physics		
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
III	5	90	4	100

Course Objectives

1. To acquire knowledge about boundary conditions between two media and the technique of method of separation of variables
2. To understand Biot – Savart's law and Ampere's circuital law
3. To comprehend the physical ideas contained in Maxwell's equations, Coulomb & Lorentz gauges, conservation laws
4. To assimilate the concepts of propagation, polarization, reflection and refraction of electromagnetic waves
5. To grasp the concept of plasma as the fourth state of matter

UNIT I: ELECTROSTATICS

Boundary value problems and Laplace equation – Boundary conditions and uniqueness theorem – Laplace equation in three dimension – Solution in Cartesian and spherical polar coordinates – Examples of solutions for boundary value problems.

Polarization and displacement vectors - Boundary conditions - Dielectric sphere in a uniform field – Molecular polarizability and electrical susceptibility – Electrostatic energy in the presence of dielectric – Multipole expansion.

UNIT II:MAGNETOSTATICS

Biot-Savart's Law - Ampere's law - Magnetic vector potential and magnetic field of a localized current distribution - Magnetic moment, force and torque on a current distribution in an external field - Magneto static energy - Magnetic induction and magnetic field in macroscopic media - Boundary conditions - Uniformly magnetized sphere.

UNIT III: MAXWELL EQUATIONS

Faraday's laws of Induction - Maxwell's displacement current - Maxwell's equations - Vector and scalar potentials - Gauge invariance - Wave equation and plane wave solution- Coulomb and Lorentz gauges - Energy and momentum of the field - Poynting's theorem - Lorentz force - Conservation laws for a system of charges and electromagnetic fields.

UNIT IV: WAVE PROPAGATION

Plane waves in non-conducting media - Linear and circular polarization, reflection and refraction at a plane interface - Waves in a conducting medium - Propagation of waves in a rectangular wave guide.

Inhomogeneous wave equation and retarded potentials - Radiation from a localized source - Oscillating electric dipole

UNIT V: ELEMENTARY PLASMA PHYSICS

The Boltzmann Equation - Simplified magneto-hydrodynamic equations - Electron plasma oscillations - The Debye shielding problem - Plasma confinement in a magnetic field - Magneto-hydrodynamic waves - Alfven waves and magnetosonic waves.

UNIT VI: PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. D. J. Griffiths, 2002, Introduction to Electrodynamics, 3rd Edition, Prentice-Hall of India, New Delhi.
2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, Foundations of Electromagnetic Theory, 3rd edition, Narosa Publishing House, New Delhi.
3. J. D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd. New Delhi.
4. J. A. Bittencourt, 1988, Fundamentals of Plasma Physics, Pergamon Press, Oxford.
5. Gupta, Kumar and Singh, Electrodynamics, S. Chand & Co., New Delhi

REFERENCE BOOKS

1. W. Panofsky and M. Phillips, 1962, Classical Electricity and Magnetism, Addison Wesley, London.
2. J. D. Kraus and D. A. Fleisch, 1999, Electromagnetics with Applications, 5th Edition, WCB McGraw-Hill, New York.
3. B. Chakraborty, 2002, Principles of Electrodynamics, Books and Allied, Kolkata.

4. P. Feynman, R. B. Leighton and M. Sands, 1998, The Feynman Lectures on Physics, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA.

WEB SOURCES

1. http://www.plasma.uu.se/CED/Book/index.html
2. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html
3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html
4. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/
5. https://www.cliffsnotes.com/study-guides/physics/electricity-and-magnetism/electrostatics

COURSE OUTCOMES(CO):

At the end of the course the student will be able to:

CO1	Solve the differential equations using Laplace equation and to find solutions for boundary value problems	**K1, K5**
CO2	Use Biot-Savart's law and Ampere circuital law to find the magnetic induction & magnetic vector potential for various physical problems	**K2, K3**
CO3	Apply Maxwell's equations to describe how electromagnetic field behaves in different media	**K3**
CO4	Apply the concept of propagation of EM waves through wave guides in optical fiber communications and also in radar installations, calculate the transmission and reflection coefficients of electromagnetic waves	**K3, K4**
CO5	Investigate the interaction of ionized gases with self-consistent electric and magnetic fields	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

Mapping of COs with POs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	3	1	3
CO2	3	3	3	1	2	2	3	3	1	3
CO3	3	3	3	1	2	2	3	3	1	3
CO4	3	3	3	1	2	2	3	3	1	3
CO5	3	3	3	1	2	2	3	3	1	3

Program:M.Sc.Physics				
Practical- III	**CourseCode:**23PPH4P04		**Course Title:** PRACTICAL IV: "MICROPROCESSOR 8085 AND MICROCONTROLLER 8051"	
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
III	6	60	4	100

Course Objectives

1. To understand the theory and working of Microprocessor, Microcontroller and their applications
2. To use microprocessor and Microcontroller in different applications

Practical IV: MICROPROCESSOR 8085 AND MICROCONTROLLER 8051
(ANY SIXTEEN EXPERIMENTS)

1. 8-bit addition and subtraction, multiplication and division
2. Sum of a set of N data (8-bit number), picking up the smallest and largest number in an array. Sorting in ascending and descending order
3. Code conversion (8-bit number): a) Binary to BCD b) BCD to binary
4. Addition of multi byte numbers, Factorial
5. Clock program- 12/24 hours-Real time application – Six Digits Hexa Decimal and Decimal Counters
6. Interfacing of LED – Binary up/down counter, BCD up/down counter and N/2N up/down counter
7. Interfacing of seven segment display
8. Interfacing of 8-bit R / 2R ladder DAC (IC 741) – Wave form generation – Square, Rectangular, Triangular, Saw tooth and Sine waves

9. DAC 0800/ DAC 1048 interface and wave form generation (Unipolar/ Bipolar output)
10. ADC 0809 interface
11. Interfacing of DC stepper motor – Clockwise, Anti-clockwise, Angular movement and Wiper action
12. Interfacing of Temperature Controller and Measurement
13. Water level detector
14. Elevator
15. Traffic Light Controller
16. Key board Interface
17. Addition, Subtraction, Multiplication and Division of 8-bit numbers.
18. Sum of a series of 8-bit numbers
19. Average of N numbers
20. Factorial of number
21. Fibonacci series of N terms
22. Multi byte Addition / Subtraction Sorting
23. g in ascending and descending order – Picking up smallest and largest number
24. LED interface – Binary up/down counter, BCD up/down counter, Ring and twisted ring counter.
25. Interfacing seven segment displays
26. DAC 0800 / 1408 interface and wave form generation
27. ADC interfacing
28. Stepper motor interfacing
29. Temperature controller and Measurements
30. Traffic light controller

TEXT BOOKS

1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008)
2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay,The 8051 Microcontroller and Embedded Systems, Pearson Education (2008).
3. V. Vijayendran, 2005, Fundamentals of Microprocessor-8085”,
4. 3rd Edition S. Visvanathan Pvt, Ltd.
5. The 8085 Microprocessor, Architecture, Programming and Interfacing – K. Udaya Kumar, S. Uma Shankar, Pearson
6. Fundamentals of Microprocessors and Microcontrollers - B. Ram, Dhanpat Rai Publications

REFERENCE BOOKS

1. W. A. Tribel, Avtar Singh, "The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.
2. Microprocessor and Its Application - S. Malarvizhi, Anuradha Agencies Publications
3. Microprocessor Architecture, Program And Its Application With 8085 - R.S. Gaonkar, New Age International (P) Ltd
4. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi.
5. J. Uffrenbeck, "The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.

COURSE OUTCOMES (CO):

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

CO1	Develop the programming skills of Microprocessor	**K5**
CO2	Appreciate the applications of Microprocessor programming	**K3**
CO3	Understand the structure and working of 8085 microprocessor and apply it.	**K1, K3**
CO4	Acquire knowledge about the interfacing peripherals with 8085 microprocessor.	**K1, K4**
CO5	Acquire knowledge about the interfacing 8051 microcontroller with various peripherals.	**K1, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	3	2	2	1	3	2
CO2	2	1	3	3	3	2	2	1	3	2
CO3	3	3	1	3	3	2	2	1	3	2
CO4	3	3	3	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	2	2	3	3	2	2	1	3	2

CO2	2	1	3	3	3	2	2	1	3	2
CO3	3	3	1	3	3	2	2	1	3	2
CO4	3	3	3	3	3	2	2	1	3	2
CO5	3	3	3	3	3	2	2	1	3	2

Program: M.Sc. Physics		
Core: IX	**Course Code:**23PPH4C04	**Course Title:** Nuclear and Particle Physics

Semester	Hours/Week	Total Hours	Credits	Total Marks
IV	4	60	4	100

Course Objectives

1. Introduces students to the different models of the nucleus in a chronological order
2. Imparts an in-depth knowledge on the nuclear force, experiments to study it and the types of nuclear reactions and their principles
3. Provides students with details of nuclear decay with relevant theories
4. Exposes students to the Standard Model of Elementary Particles and Higgs boson

UNIT I: NUCLEAR MODELS

Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror pair - Bohr wheeler theory of fission – Shell model – Spin-orbit coupling – Magic numbers – Angular momenta and parity of ground states – Magnetic moment – Schmidt model – Electric quadrapole moment - Bohr and Mottelson collective model – Rotational and Vibrational bands.

UNIT II : NUCLEAR FORCES

Nucleon – Nucleon interaction – Tensor forces – Properties of nuclear forces – Ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – Effective range theory – Spin dependence of nuclear forces - Charge Independence and Charge Symmetry – Isospin Formalism.

UNIT III: NUCLEAR REACTIONS

Kinds of nuclear reactions – Reaction kinematics – Q-value – Partial wave analysis of scattering and reaction cross section – Scattering length – Compound nuclear reactions – Reciprocity theorem – Resonances – Breit Wigner one level formula – Direct reactions - Nuclear Chain reaction – four factor formula.

UNIT IV:NUCLEAR DECAY

Beta decay – Continuous Beta spectrum – Fermi theory of beta decay - Comparative Half-life – Fermi Kurie Plot – mass of neutrino – allowed and forbidden decay — neutrino physics – Helicity - Parity violation - Gamma decay – multipole radiations – Angular Correlation - internal conversion – Nuclear isomerism – Angular momentum and Parity selection rules.

UNIT V: ELEMENTARY PARTICLES

Classification of Elementary Particles – Types of Interaction and conservation laws – Families of elementary particles – Isospin – Quantum Numbers – Strangeness – Hypercharge and Quarks – SU (2) and SU (3) groups-Gell Mann matrices– Gell Mann Okuba Mass formula-Quark Model. Standard model of particle physics – Higgs boson.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. D. C. Tayal – Nuclear Physics – Himalaya Publishing House (2011)
2. K. S. Krane – Introductory Nuclear Physics – John Wiley & Sons (2008)
3. R. Roy and P. Nigam – Nuclear Physics – New Age Publishers (1996)
4. S. B. Patel – Nuclear Physics – An introduction – New Age International Pvt Ltd Publishers (2011)
5. S. Glasstone – Source Book of Atomic Energy – Van Nostrand Reinhold Inc.,U.S.- 3rd Revised edition (1968)

REFERENCE BOOKS

1. L. J. Tassie – The Physics of elementary particles – Prentice Hall Press (1973)
2. H. A. Enge – Introduction to Nuclear Physics – Addison Wesley, Publishing Company. Inc. Reading. New York, (1974).
3. Kaplan – Nuclear Physics – 1989 – 2nd Ed. – Narosa (2002)
4. Bernard L Cohen – Concepts of Nuclear Physics – McGraw Hill Education (India) Private Limited; 1 edition (2001)
5. B.L. Cohen, 1971, Concepts of Nuclear Physics, TMCH, New Delhi.

WEB SOURCES

1. http://bubl.ac.uk/link/n/nuclearphysics.html
2. http://www.phys.unsw.edu.au/PHYS3050/pdf/Nuclear_Models.pdf
   http://www.scholarpedia.org/article/Nuclear_Forces
3. https://www.nuclear-power.net/nuclear-power/nuclear-reactions/
4. http://labman.phys.utk.edu/phys222core/modules/m12/nuclear_models.html

5. https://www.ndeed.org/EducationResources/HighSchool/Radiography/radioactivedecay.html

COURSE OUTCOMES(CO):

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

CO1	Gain knowledge about the concepts of helicity, parity, angular correlation and internal conversion.	**K1, K5**
CO2	Demonstrate knowledge of fundamental aspects of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of radiation and matter.	**K2, K3**
CO3	Use the different nuclear models to explain different nuclear phenomena and the concept of resonances through Briet-Weigner single level formula	**K3**
CO4	Analyze data from nuclear scattering experiments to identify different properties of the nuclear force.	**K3, K4**
CO5	Summarize and identify allowed and forbidden nuclear reactions based on conservation laws of the elementary particles.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	1	2	1	2	2	2
CO3	3	3	1	2	1	2	1	1	2	2
CO4	3	3	2	3	2	3	2	2	3	3
CO5	3	3	2	3	2	3	2	3	3	3

Program: M.Sc. Physics				
CORE -X	**CourseCode:** 23PPH4C10		**Course Title:** Spectroscopy	
Semester	**Hours/Week**	**Total Hours**	**Credits**	**Total Marks**
IV	5	60	4	100

- To gain basic concepts of molecular vibrations.
- To understand the theory and applications of vibrational, rotational and resonance spectroscopy.

UNIT -I: INFRARED SPECTROSCOPY

IR Spectroscopy – Theory and Principle – FTIR Spectroscopy - FTIR Instrumentation-sampling methods – Issues surrounding the KBr Pellet Method – Transmittance and Reflectance Techniques - Attenuated Total Internal Reflection Techniques – Single bounce ATR and Multiple Bounce ATR - Advantages of FTIR- ATR Spectroscopy – Applications.

UNIT - II: RAMAN SCATTERING

Vibrational and Rotational Raman spectra – Mutual Exclusion principle – Raman spectrometer - Polarization of Raman Scattering light - Structure Determination through IR and Raman spectroscopy – Phase transitions – Resonance Raman Scattering - A brief description – SERS-CARS-remote sense Raman Spectroscopy.

UNIT - III: VIBRATIONAL ANALYSIS

Selection rules for Raman and IR vibrational normal modes – Raman and IR activity - C_{2V} and C_{3V} point groups – Distribution of normal modes among the active species – Projection Operator - Representation of Molecular Vibrations in Symmetry co-ordinates Interpretation of vibrational spectra: External factors - Internal factors: Hydrogen bonding, Coupling of vibrations, Fermi resonance, Electronic effects, Solid state effects, Group vibrations, Finger print regions, Stretching and bending vibrations

UNIT - IV: MICROWAVE SPECTROSCOPY

Rotational spectra of diatomic molecules – Polyatomic molecules – Linear and symmetric top molecules – Hyperfine structure and quadrapole moment of linear molecules – Experimental techniques – Stark effect.

UNIT - V: NMR, ESR AND MB SPECTROSCOPY

Quantum theory of NMR – Bloch equations – Design of CW NMR Spectrometer – Principle and block diagram of PT NMR – Chemical Shift – Application to molecular structure.

Quantum Theory of ESR – Design of ESR Spectrometer – Hyperfine Structure – Anisotropic systems – Triplet State study of ESR – Applications – Crystal defects - Biological studies, MBS – Brief description and application.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

BOOKS FOR STUDY:

1. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, Tata Mc Graw Hill, Fourth Edition, New Delhi (1994).
2. G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall of India Pvt, Ltd. New Delhi (2001).
3. D. N. Satyanarayana, Vibrational Spectroscopy and Applications, New Age International Publication (2004).
4. Puranik, Group Theory Applications to Molecular Vibrations, Chand & Co Publications

BOOKS FOR REFERENCE:

1. D. D. Jyaji and M.D Yadav, Spectroscopy, Amol Publications (1991).
2. Attaur Rahman, Nuclear Magnetic Resonance, Spinger Verlag (1986).

3. D. A. Lang, Raman Spectroscopy, Mc Graw- Hill International (1977).
4. Raymond Chang, Basic Principles of Spectroscopy Mc Graw-Hill Kogakusha, Tokyo (1980).

WEB SOURCES

1. https://www.youtube.com/watch?v=0iQhirTf2PI
2. https://www.coursera.org/lecture/spectroscopy/introduction-3N5D5
3. https://www.coursera.org/lecture/spectroscopy/infrared-spectroscopy-8jEee
4. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
5. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu

COURSE OUTCOMES(CO):

At the end of the course the student will be able to:

CO1	Understand fundamentals of rotational spectroscopy, view molecules as elastic rotors and interpret their behaviour. Able to quantify their nature and correlate them with their characteristic properties.	**K2**
CO2	Understand the working principles of spectroscopic instruments and theoretical background of IR spectroscopy. Able to correlate mathematical process of Fourier transformations with instrumentation. Able to interpret vibrational spectrum of small molecules.	**K2, K3**
CO3	Interpret structures and composition of molecules and use their knowledge of Raman Spectroscopy as an important analytical tool	**K5**
CO4	Use these resonance spectroscopic techniques for quantitative and qualitative estimation of a substances	**K4**
CO5	Learn the electronic transitions caused by absorption of radiation in the UV/Vis region of the electromagnetic spectrum and be able to analyze a	**K1, K5**

	simple UV spectrum.	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	3	3	3	2
CO3	3	2	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Program:M.Sc.Physics				
Core - XI	**CourseCode:**23PPH4C11		**Course Title:** NUMERICAL METHODS AND COMPUTER PROGRAMMING IN C	
Semester IV	**Hours/Week** 5	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To make students to understand different numerical approaches to solve a problem.
2. To understand the basics of programming

UNIT I: SOLUTIONS OF EQUATIONS

Zeros or Roots of an equation - Non-linear algebraic equation and transcendental equations - Zeros of polynomials –Roots of polynomials, nonlinear algebraic equations and transcendental equations using Bisection and Newton-Raphson methods – Convergence of solutions in Bisection and Newton-Raphson methods – Limitations of Bisection and Newton-Raphson methods.

UNIT II: LINEAR SYSTEM OF EQUATIONS

Simultaneous linear equations and their matrix representation– Inverse of a Matrix – Solution of simultaneous equations by Matrix inversion method and its limitations – Gaussian elimination method – Gauss Jordan method – Inverse of a matrix by Gauss elimination method - Eigen values and eigenvectors of matrices – Direct method - Power method and Jacobi Method to find the Eigen values and Eigen vectors.

UNIT III: INTERPOLATION AND CURVE FITTING

Interpolation with equally spaced points - Newton forward and backward interpolation - Interpolation with unevenly spaced points - Lagrange interpolation – Curve fitting – Method of least squares – Fitting a polynomial.

UNIT IV: DIFFERENTIATION, INTEGRATION AND SOLUTION OF DIFFERENTIAL EQUATIONS

Numerical differentiation – Numerical integration – Trapezoidal rule – Simpson's rule – Error estimates – Gauss-Legendre, Gauss-Laguerre, Gauss-Hermite and Gauss-Chebyshev quadrature – solution of ordinary differential equations – Euler and RungaKutta methods.

UNIT V: PROGRAMMING WITH C

Flow-charts – Integer and floating point arithmetic expressions – Built-in functions – Executable and non-executable statements – Subroutines and functions – Programs for the following computational methods: (a) Zeros of polynomials by the bisection method, (b) Zeros of polynomials/non-linear equations by the Newton-Raphson method, (c) Newton's forward and backward interpolation, Lagrange Interpolation, (d) Trapezoidal and Simpson's Rules, (e) Solution of first order differential equations by Euler's method.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. V. Rajaraman, 1993, Computer oriented Numerical Methods, 3rd Edition. PHI, New Delhi
2. M. K .Jain, S. R. Iyengar and R. K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Edition, New Age Intl., New Delhi
3. S. S. Sastry, Introductory Methods of Numerical analysis, PHI, New Delhi
4. F. Scheid, 1998, Numerical Analysis, 2nd Edition, Schaum's series, McGraw Hill, New York.
5. W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, 1992, Numerical Recipes in FORTRAN, 2nd Edition, Cambridge Univ. Press

REFERENCE BOOKS

1. S. D. Conte and C. de Boor, 1981, Elementary Numerical analysis-an algorithmic approach, 3rd Edition, McGraw Hill,)
2. B. F. Gerald, and P. O. Wheatley, 1994, Applied Numerical analysis, 5th Edition, Addison-Wesley, MA.
3. B. Carnagan, H. A. Luther and J. O. Wilkes, 1969, Applied Numerical Methods, Wiley, New York.
4. S. S. Kuo, 1996, Numerical Methods and Computers, Addison-Wesley.
5. V. Rajaraman, Programming in FORTRAN / Programming in C, PHI, New Delhi

WEB SOURCES

1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman

2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=1682874
3. https://nptel.ac.in/course/122106033/
4. https://nptel.ac.in/course/103106074/
5. https://onlinecourses.nptel.ac.in/noc20_ma33/preview

COURSE OUTCOMES(CO):

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

CO1	Recall the transcendental equations and analyze the different root finding methods. Understand the basic concept involved in root finding procedure such as Newton Raphson and Bisection methods, their limitations.	**K1, K2**
CO2	Relate Simultaneous linear equations and their matrix representation Distinguish between various methods in solving simultaneous linear equations.	**K5**
CO3	Understand, how interpolation will be used in various realms of physics and Apply to some simple problems Analyze the newton forward and backward interpolation	**K2, K3**
CO4	Recollect and apply methods in numerical differentiation and integration. Assess the trapezoidal and Simson's method of numerical integration.	**K3, K4**
CO5	Understand the basics of C-programming and conditional statements.	**K2**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3
CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	1	1	2	3	2	2	3
CO2	3	2	3	1	1	2	3	2	2	3

CO3	3	2	3	1	1	2	3	2	2	3
CO4	3	2	3	1	1	2	3	2	2	3
CO5	3	2	3	1	1	2	3	2	2	3

Program:M.Sc.Physics				
CorePractical - IV	**CourseCode:**23PPH3P03		**CourseTitle:**NUMERICAL METHODS AND COMPUTER PROGRAMMING	
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
IV	6	90	4	100

Course Objectives

1. The aim and objective of the course on Computational Practical is to familiarize the of M.Sc. students with the numerical methods used in computation and programming using any high level language such as C/FORTRAN
2. To equip the computational skill using various mathematical tools.
3. To apply the software tools to explore the concepts of physical science.
4. To approach the real time activities using physics and mathematical formulations.

List of Experiments

(Any Sixteen Experiments)

1. Lagrange interpolation with Algorithm, Flow chart and output.
2. Newton forward interpolation with Algorithm, Flow chart and output.
3. Newton backward interpolation with Algorithm, Flow chart and output.
4. Curve-fitting: Least squares fitting with Algorithm, Flow chart and output.
5. Numerical integration by the trapezoidal rule with Algorithm, Flow chart and output.
6. Numerical integration by Simpson's rule with Algorithm, Flow chart and output.
7. Numerical solution of ordinary first-order differential equations by the Euler method with Algorithm, Flow chart and output.
8. Numerical solution of ordinary first-order differential equations by the Runge- Kutta method with Algorithm, Flow chart and output.
9. Finding Roots of a Polynomial - Bisection Method –
10. Finding Roots of a Polynomial - Newton Raphson Method –
11. Solution of Simultaneous Linear Equation by Gauss elimination method.
12. Solution of Ordinary Differential Equation by Euler
13. Runge Kutta Fourth Order Method for solving first order Ordinary Differential Equations
14. Newton's cotes formula
15. Trapezoidal rule
16. Simpson's 1/3 rule
17. Simpson's 3/8 rule
18. Boole's rule
19. Gaussian quadrature method (2 point and 3 point formula)
20. Giraffe's root square method for solving algebraic equation

TEXT BOOKS

1. Numerical methods using Matlab – John Mathews & Kurtis Fink, Prentice Hall, New Jersey 2006
2. Numerical methods in Science and Engineering - M.K. Venkataraman, National Publishing Co. Madras, 1996
3. V. Rajaraman, 1993, Computer Oriented Numerical Methods, 3rd Ed. (Prentice-Hall, New Delhi.
4. M.K. Jain, S.R. Iyengar and R.K. Jain, 1995, Numerical Methods for Scientific and Engineering Computation, 3rd Ed. New Age International, New Delhi.
5. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI, New Delhi.

REFERENCE BOOKS

1. S.D. Conte and C. de Boor, 1981, Elementary Numerical Analysis, An Algorithmic Approach, 3rd Ed., International Ed. (McGraw-Hill).
2. B.F. Gerald and P.O. Wheately, 1994, Applied Numerical Analysis, 5th Edition, Addison Wesley, Reading, MA.
3. B. Carnahan, H.A. Luther and J.O. Wikes, 1969, Applied Numerical Methods (Wiley, New York.
4. S.S. Kuo, 1996, Numerical Methods and Computers, Addison - Wesley, London.
5. V. Rajaraman, Programming in FORTRAN/ Programming in C, PHI, New Delhi.

COURSEOUTCOMES(CO)

At the end of the course the student will be able to:

CO1	Program with the C Program/ FORTRAN with the C or any other high level language	**K1**
CO2	Use various numerical methods in describing/solving physics problems.	**K4**
CO3	Solve problem, critical thinking and analytical reasoning as applied to scientific problems.	**K5**
CO4	To enhance the problem-solving aptitudes of students using various numerical methods.	**K5**
CO5	To apply various mathematical entities, facilitate to visualise any complicate tasks.	**K3**
CO6	Process, analyze and plot data from various physical phenomena and interpret their meaning	**K4**
CO7	Identify modern programming methods and describe the extent and limitations of computational methods in physics	**K1**
CO8	Work out numerical differentiation and integration whenever routine are not applicable.	**K5**
CO9	Apply various interpolation methods and finite difference concepts.	**K4**
CO10	Understand and apply numerical methods to find out solution of algebraic equation using different methods under different conditions, and numerical solution of system of algebraic equation.	**K1, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 – Evaluate		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	2	2	3	3	2	2	2	3	3

CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	2	2	3	3	2	2	2	3	3
CO2	2	2	3	3	3	2	2	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	2	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
CO6	2	2	2	3	3	2	2	2	3	3
CO7	2	2	3	3	3	2	2	3	3	3
CO8	3	3	3	3	3	3	3	3	3	3
CO9	3	3	3	3	3	3	3	3	3	3
CO10	3	3	3	3	3	3	3	3	3	3

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** ENERGY PHYSICS	
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
I/III	4	60	4	100

Course Objectives

1. To learn about various renewable energy sources.
2. To know the ways of effectively utilizing the oceanic energy.
3. To study the method of harnessing wind energy and its advantages.
4. To learn the techniques useful for the conversion of biomass into useful energy.
5. To know about utilization of solar energy.

UNIT I:INTRODUCTION TO ENERGY SOURCES

Conventional and Non-Conventional Energy ourcesand Their Availability–Prospects of Renewable Energy Sources– Energy from other sources–Chemical Energy–Nuclear Energy–Energy Storage and Distribution.

UNIT II:ENERGY FROM THE OCEANS

Energy utilization–Energy from tides–Basic principle of Tidal Power–Utilization of Tidal Energy – Principle of Ocean Thermal Energy Conversion Systems.

UNIT III:WIND ENERGY SOURCES

Basic principles of wind energy conversion–Power in the wind–Forces in the Blades– Wind energy conversion–Advantages and Disadvantages of Wind Energy Conversion Systems (WECS) - Energy storage–Applications of wind energy.

UNIT IV:ENERGY FROM BIOMASS

Biomass conversion Technologies– Wet and Dry process– Photosynthesis -Biogas Generation: Introduction–basic process: Aerobic and Anaerobic Digestion – Advantages of anaerobic

digestion–Factors Affecting Bio Digestion and Generation of gas- Bio gas from Waste Fuel–Properties of biogas-Utilization of biogas.

UNIT V:SOLAR ENERGY SOURCES

Solar radiation and its measurements–Solar cells: Solar cells for direct conversion of solar energy to Electric powers–Solar cell parameter–Solar cell electrical characteristics– Efficiency–Solar Water Heater –Solar Distillation– Solar Cooking–Solar Greenhouse – Solar Pond and its Applications.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. G.D. Rai, 1996, Non – convention sources of, 4th edition, Khanna publishers, New Delhi.
2. S. Rao and Dr. ParuLekar, Energy technology.
3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983).
4. Solar energy, principles of thermal collection and storage by S. P. Sukhatme, 2nd edition, Tata
5. McGraw-Hill Publishing Co. Lt., New Delhi (1997).
6. Energy Technology by S. Rao and Dr. Parulekar.

REFERENCE BOOKS

1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York.
2. Applied solar energy, A. B. Meinel and A. P. Meinal
3. John Twidell and Tony Weir, Renewable energy resources, Taylor and Francis group, London and New York.
4. Renewal Energy Technologies: A Practical Guide for Beginners C.S. Solanki-PHI Learning
5. Introduction to Non-Conventional Energy Resources -Raja et. al., Sci. Tech Publications

WEBSOURCES

1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1

2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/
3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy
4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/
5. https://www.acciona.com/renewable-energy/solar-energy/

COURSE OUTCOMES(CO):

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

CO1	To identify various forms of renewable and non-renewable energy sources	**K1**
CO2	Understand the principle of utilizing the oceanic energy and apply it for practical applications.	**K2**
CO3	Discuss the working of a windmill and analyze the advantages of wind energy.	**K3**
CO4	Distinguish aerobic digestion process from anaerobic digestion.	**K3, K4**
CO5	Understand the components of solar radiation, their measurement and apply them to utilize solar energy.	**K2, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MAPPING WITH PROGRAM OUTCOMES:

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	3	3	3
CO2	2	3	3	3	2	2	2	3	3	3
CO3	2	3	3	3	2	2	2	3	3	3
CO4	2	3	3	3	2	2	2	3	3	3
CO5	2	3	3	3	2	2	2	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	3	2	2	2	3	3	3
CO2	2	3	3	3	2	2	2	3	3	3
CO3	2	3	3	3	2	2	2	3	3	3
CO4	2	3	3	3	2	2	2	3	3	3
CO5	2	3	3	3	2	2	2	3	3	3

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** CRYSTAL GROWTH AND THIN FILMS	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To acquire the knowledge on Nucleation and Kinetics of crystal growth
2. To understand the Crystallization Principles and Growth techniques
3. To study various methods of Crystal growth techniques
4. To understand the thin film deposition methods
5. To apply the techniques of Thin Film Formation and thickness Measurement

UNIT I:CRYSTAL GROWTH KINETICS

Basic Concepts, Nucleation and Kinetics of growth Ambient phase equilibrium - Super saturation - equilibrium of finite phases equation of Thomson - Gibbs - Types of Nucleation - Formation of critical Nucleus - Classical theory of Nucleation - Homo and heterogeneous formation of 3D nuclei - rate of Nucleation - Growth from vapour phase solutions, solutions and melts - Epitaxial growth - Growth mechanism and classification - Kinetics of growth of epitaxial films

UNIT II: CRYSTALLIZATION PRINCIPLES

Crystallization Principles and Growth techniques Classes of Crystal system - Crystal symmetry - Solvents and solutions - Solubility diagram - Super solubility - Expression for super saturation - Metastable zone and introduction period - Miers TC diagram - Solution growth - Low and high temperatures solution growth - Slow cooling and solvent evaporation methods - Constant temperature bath as a Crystallizer.

UNIT III: GEL, MELT AND VAPOUR GROWTH

Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques -

Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.

UNIT IV:THIN FILM DEPOSITION METHODS

Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, Pulsed LASER deposition, Cathodic Sputtering, RF Magnetron sputtering, MBE, Chemical Vapour Deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.

UNIT V: THIN FILM FORMATION

Thin Film Formation and Thickness Measurement Nucleation, Film growth and structure - Various stages in Thin Film formation, Thermodynamics of Nucleation, Nucleation theories, Capillarity model and Atomistic model and their comparison. Structure of Thin Film, Roll of substrate, Roll of film thickness, Film thickness measurement - Interferometry, Ellipsometry, Micro balance, Quartz Crystal Oscillator techniques.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. V. Markov Crystal growth for beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition
2. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008)
3. M. Ohora and R. C. Reid, “Modeling of Crystal Growth Rates from Solution”
4. 4. D. Elwell and H. J. Scheel, “Crystal Growth from High Temperature Solution”
5. Heinz K. Henish, 1973, “Crystal Growth in Gels”, Cambridge University Press. USA.

REFERENCE BOOKS

1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986)
2. P. Ramasamy and F. D. Gnanam, 1983, “UGC Summer School Notes”.
3. P. Santhana Raghavan and P. Ramasamy, “Crystal Growth Processes”, KRU Publications.
4. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, New York

5. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London.

COURSE OUTCOMES:

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

CO1	Acquire the Basic Concepts, Nucleation and Kinetics of crystal growth	K1
CO2	Understand the Crystallization Principles and Growth techniques	**K2, K4**
CO3	Study various methods of Crystal growth techniques	**K3**
CO4	Understand the Thin film deposition methods	**K2**
CO5	Apply the techniques of Thin Film Formation and thickness Measurement	**K3, K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	1	2	1	3	2	2	2	2
CO2	3	3	1	3	1	2	3	2	2	1
CO3	3	2	1	3	1	2	3	3	3	1
CO4	3	2	1	2	1	2	3	3	3	1
CO5	2	3	3	3	1	3	3	3	3	2

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** ANALYSIS OF CRYSTALSTRUCTURES	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To teach the concept of crystal structures and symmetry, and diffraction theory
2. To provide students with a background to X-ray generation, scattering theory and experimental diffraction from single crystals
3. To provide instruction on the methods and basis for determining low-molecular weight crystal structures using X-ray Crystallography
4. To give the students a background to the instrumentation used for powder diffraction and structure refinement using Rietveld method
5. To teach the different levels of structure exhibited by proteins and nucleic acids and methods used in protein crystallography.

UNIT I:CRYSTAL LATTICE

Unit Cell and Bravais Lattices - Crystal Planes and Directions - Basic Symmetry Elements Operations - Translational Symmetries - Point Groups - Space Groups - Equivalent Positions - Bragg's Law - Reciprocal Lattice Concept -Laue Conditions - Ewald and Limiting Spheres - Diffraction Symmetry - Laue Groups.

UNIT II:DIFFRACTION

X-Ray Generation, Properties - Sealed Tube, Rotating Anode, Synchrotron Radiation - Absorption - Filters and Monochromators Atomic Scattering Factor - Fourier Transformationand Structure Factor - Anomalous Dispersion - Laue, Rotation/Oscillation, Moving Film Methods-

Interpretation of Diffraction Patterns - Cell Parameter Determination - Systematic Absences - Space Group Determination.

UNIT III:STRUCTURE ANALYSIS

Single Crystal Diffractometers - Geometries - Scan Modes - Scintillation and Area Detectors - Intensity Data Collection - Data Reduction - Factors Affecting X-Ray Intensities - Temperature And Scale Factor - Electron Density - Phase Problem - Normalized Structure Factor - Direct Method Fundamentals and Procedures -Patterson Function and Heavy Atom Method - Structure Refinement - Least Squares Method - Fourier and Difference Fourier Synthesis - R Factor - Structure Interpretation - Geometric Calculations - Conformational Studies - Computer Program Packages.

UNIT IV:POWDER METHODS

Fundamentals of powder diffraction - Debye Scherrer method - Diffractometer Geometries - Use Of Monochromators and Soller silts - Sample Preparation and Data Collection - Identification Of Unknowns - Powder Diffraction Files (ICDD) - Rietveld Refinement Fundamentals - Profile Analysis - Peak Shapes - Whole Pattern Fitting - Structure Refinement Procedures – Auto-Indexing – Structure Determination From Powder Data - New Developments. Energy Dispersive X-Ray Analysis – Texture Studies - Crystallite Size Determination - Residual Stress Analysis - High and Low Temperature andHigh Pressure Crystallography (Basics Only).

UNIT V:PROTEIN CRYSTALLOGRAPHY

Globular and Fibrous Proteins, Nucleic Acids - Primary, Secondary, Tertiary and Quaternary Structures - Helical and Sheet Structures - Ramachandran Map and Its Significance – Crystallization Methods For Proteins - Factors Affecting Protein Crystallization - Heavy Atom Derivatives – Methods used to Solve Protein Structures - Anomalous Dispersion Methods.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism.

TEXT BOOKS

1. Azaroff, L.V., "Elements of X-Ray Crystallography", Techbooksl, New York, 1992.
2. Blundell, T.L. and Johnson, L., "Protein Crystallography", Academic Press, New York, 1986.
3. Cullity, B.D. and Stock,S.R. "Elements of X-ray Diffraction", Pearson, 2014.
4. H.L. Bhat, Introduction to Crystal Growth Principles and Practice CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2015.
5. B.R. Pamplin, Crystal Growth, Pergamon Press, Oxford, 1975.

REFERENCE BOOKS

1. Glusker, J.P. and Trueblood, K.N. Crystal Structure Analysis: A Primer", Oxford University, Press, New York, 1994.
2. Ladd, M.F.C. and Palmer, R.A., "Structure Determination by X-ray Crystallography", Plenum Press, New York, 3rd Edition, 1993.
3. Stout, G.H. and Jensen, L."X-ray Structure Determination, A Practical Guide", Macmillan:,New York, 1989.
4. Woolfson, M.M. "An Introduction to X-ray Crystallography" Cambridge University Press, New York, 1997.
5. Sam Zhang, Lin Ki, Ashok Kumar, Materials Characterization Techniques, CRC Press, Taylor & Francis Group, Boca Raton, Florida, 2009

WEB SOURCES

1. https://archive.nptel.ac.in/courses/112/106/112106227/
2. https://archive.nptel.ac.in/courses/104/108/104108098/
3. https://www.digimat.in/nptel/courses/video/102107086/L11.html
4. https://onlinecourses.nptel.ac.in/noc19_cy35/previewhttps://onlinecourses.nptel.ac.in/noc19_cy35/preview
5. https://nptel.ac.in/courses/104/104/104104011/

COURSE OUTCOMES(CO):

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

CO1	Understand crystal symmetry and reciprocal lattice concept for X-ray diffraction	**K2**
CO2	Gain a working knowledge of X-ray generation, X-ray photography with Laue, oscillation and moving film methods, and space group determination	**K1,K3**
CO3	Get an exposure to crystal structure determination using program packages	**K1,K4**
CO4	Understand the instrumentation used for powder diffraction, data collection, data interpretation, and structure refinement using Rietveld method	**K2, K4**
CO5	Get an insight into the structural aspects of proteins and nucleic acids,	**K5**

	crystallization of proteins and methods to solve protein structures	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	2	1	2	2	2
CO2	3	3	3	2	2	2	1	2	2	2
CO3	3	3	2	2	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	3	2	1	2	2	2
CO2	3	3	3	2	2	2	1	2	2	2
CO3	3	3	2	2	2	2	2	2	2	2
CO4	3	2	2	2	2	2	2	2	2	2
CO5	3	2	2	2	2	2	2	2	2	2

Program:M.Sc.Physics				
Elective	**CourseCode:**21PPH3E01		**Course Title:** MATERIALS SCIENCE	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To gain knowledge on optoelectronic materials
2. To learn about ceramic processing and advanced ceramics
3. To understand the processing and applications of polymeric materials
4. To gain knowledge on the fabrication of composite materials
5. To learn about shape memory alloys, metallic glasses and nanomaterials

UNIT I:OPTOELECTRONIC MATERIALS

Importance of Optical Materials – Properties: Band Gap and Lattice Matching – Optical Absorption and Emission – Charge Injection, Quasi-Fermi Levels and Recombination – Optical Absorption, Loss and Gain. Optical Processes in Quantum Structures: Inter-Band and Intra-Band Transitions Organic Semiconductors. Light Propagation in Materials – Electro-Optic Effect and Modulation, Electro-Absorption Modulation – Exciton Quenching.

UNIT II :CERAMIC MATERIALS

Ceramic Processing: Powder Processing, Milling and Sintering – Structural Ceramics: Zirconia, Almina, Silicon Carbide, Tungsten Carbide – Electronic Ceramics – Refractories – Glass and Glass Ceramics

UNIT III : POLYMERIC MATERIALS

Polymers and Copolymers – Molecular Weight Measurement – Synthesis: Chain Growth Polymerization – Polymerization Techniques – Glass Transition Temperature and Its Measurement – Viscoelasticity – Polymer Processing Techniques – Applications: Conducting Polymers, Biopolymers and High Temperature Polymers.

UNIT IV : COMPOSITE MATERIALS

Particle Reinforced Composites – Fiber Reinforced Composites – Mechanical Behavior – Fabrication Methods of Polymer Matrix Composites and Metal Matrix Composites – Carbon/Carbon Composites: Fabrication and Applications.

UNIT V:NEW MATERIALS

Shape Memory Alloys: Mechanisms of One-way and Two-way Shape Memory Effect, Reverse Transformation, Thermo-Elasticity and Pseudo-Elasticity, Examples and Applications -Bulk Metallic Glass: Criteria for Glass Formation and Stability, Examples and Mechanical Behavior - Nanomaterials: Classification, Size Effect on Structural And Functional Properties, Processing and Properties of Nano Crystalline Materials, Single Walled and Multi Walled Carbon Nanotubes

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Jasprit Singh, Electronic and optoelectronic properties of semiconductor structures, Cambridge University Press, 2007
2. P. K. Mallick. Fiber-Reinforced Composites. CRC Press, 2008.
3. V. Raghavan, 2003, Materials Science and Engineering, 4th Edition, Prentice- Hall India, New Delhi(For units 2,3,4 and 5)
4. G.K. Narula, K.S. Narula and V.K. Gupta, 1988, Materials Science, Tata McGraw-Hill
5. M. Arumugam, 2002, Materials Science, 3rd revised Edition, Anuratha Agencies

REFERENCE BOOKS

1. B. S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday. Textbook of Nanoscience and Nanotechnology. Springer-Verlag, 2012.
2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). Shape Memory and Super Elastic Alloys: Technologies and Applications. Wood head Publishing Limited, 2011.
3. Lawrence H. VanVlack, 1998. Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint,

Addison-Wesley.

4. H. Iabch and H. Luth, 2002, Solid State Physics – An Introduction to Principles of Materials Science, 2nd Edition, Springer.
5. D. Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008.

WEB SOURCES

1. https://onlinecourses.nptel.ac.in/noc20_mm02/preview
2. https://nptel.ac.in/courses/112104229
3. https://archive.nptel.ac.in/courses/113/105/113105081
4. https://nptel.ac.in/courses/113/105/113105025/
5. https://eng.libretexts.org/Bookshelves/Materials_Science/Supplemental_Modules_(Materials_Science)/Electronic_Properties/Lattice_Vibrations

COURSE OUTCOMES(CO):

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

CO1	Acquire knowledge on optoelectronic materials	K1
CO2	Be able to prepare ceramic materials	**K3**
CO3	Be able to understand the processing and applications of polymeric materials	**K2, K3**
CO4	Be aware of the fabrication of composite materials	**K5**
CO5	Be knowledgeable of shape memory alloys, metallic glasses and nanomaterials	**K1**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	3	3	2	2	2	2	1	2	3
CO2	2	3	3	2	2	2	2	1	2	2
CO3	2	3	2	2	2	2	2	2	2	2
CO4	1	3	2	3	2	3	2	2	2	2
CO5	2	3	2	2	2	2	2	2	2	2

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** PHYSICS OF NANOSCIENCE AND TECHNOLOGY	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. Physics of Nanoscience and Technology is concerned with the study, creation, manipulation and applications at nanometer scale.
2. To provide the basic knowledge about nanoscience and technology.
3. To learn the structures and properties of nanomaterials.
4. To acquire the knowledge about synthesis methods and characterization techniques and its applications.

UNIT I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY

Fundamentals of NANO – Historical Perspective on Nanomaterial and Nanotechnology -– Classification of Nanomaterials – Metal and Semiconductor Nanomaterials - 2D, 1D, 0D nanostructured materials - Quantum dots – Quantum wires – Quantum wells - Surface effects of

nanomaterials.

UNIT II: PROPERTIES OF NANOMATERIALS

Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanical behavior: Elastic properties – strength - ductility - superplastic behavior - Optical properties: - Surface Plasmon Resonance – Quantum size effects - Electrical properties - Conductivity, Ferroelectrics and Dielectrics - Magnetic properties – Super Para Magnetism – Diluted magnetic semiconductor (DMS).

UNIT III : SYNTHESIS AND FABRICATION

Physical vapour deposition - Chemical vapour deposition - Sol-Gel – Wet deposition techniques - Electrochemical Deposition Method – Plasma Arching - Electrospinning method - Ball Milling Technique - Pulsed Laser Deposition - Nanolithography: Photolithography – Nanomanipulator.

UNIT IV: CHARACTERIZATION TECHNIQUES

Powder X-ray diffraction – X-ray photoelectron spectroscopy (XPS) - UV-visible spectroscopy – Photoluminescence - Scanning electron microscopy (SEM) - Transmission electron microscopy (TEM) - Scanning probe microscopy (SPM) - Scanning tunneling microscopy (STM) – Vibrating sample Magnetometer.

UNIT V: APPLICATIONS OF NANOMATERIALS

Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters – Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – Biological Tags - Drug Delivery - Photodynamic Therapy - Energy: Fuel Cells - Rechargeable Batteries - Supercapacitors - Photovoltaics.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).
2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
3. Introduction to

Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).
5. Nanotechnology and Nanoelectronics, D.P. Kothari,
6. V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt. Ltd, New Delhi. (2018)

REFERENCE BOOKS

1. Nanostructures and Nanomaterials – Huozhong Gao – Imperial College Press (2004).
2. Richard Booker and Earl Boysen, (2005) Nanotechnology, Wiley Publishing Inc. USA
3. Nano particles and Nano structured films; Preparation, Characterization and Applications, J. H. Fendler John Wiley and Sons. (2007)
4. Textbook of Nanoscience and Nanotechnology, B. S. Murty, et al., Universities Press. (2012)
5. The Nanoscope (Encyclopedia of Nanoscience and Nanotechnology), Dr. Parag Diwan and Ashish Bharadwaj (2005) Vol. IV - Nanoelectronics Pentagon Press, New Delhi.

WEBSOURCES

1. www.its.caltec.edu/feyman/plenty.html
2. http://www.library.ualberta.ca/subject/nanoscience/guide/index.cfm
3. http://www.understandingnano.com
4. http://www.nano.gov
5. http://www.nanotechnology.com

COURSE OUTCOMES(CO):

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

CO1	Understand the basic of nanoscience and explore the different types of nanomaterials and should comprehend the surface effects of the nanomaterials.	**K1, K2**

CO2	Explore various physical, mechanical, optical, electrical and magnetic properties nanomaterials.	**K1**
CO3	Understand the process and mechanism of synthesis and fabrication of nanomaterials.	**K2, K3**
CO4	Analyze the various characterization of Nano-products through diffraction, spectroscopic, microscopic and other techniques.	**K4**
CO5	Apply the concepts of nanoscience and technology in the field of sensors, robotics, purification of air and water and in the energy devices.	**K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	1	1	3	3	3	3
CO2	3	3	3	2	1	1	3	3	3	3
CO3	3	3	2	2	1	1	3	3	3	3
CO4	3	3	3	2	1	1	3	3	3	3
CO5	3	3	2	2	1	1	3	3	3	3

Program:M.Sc.Physics

Elective	**CourseCode:**	**Course Title:** DIGITAL COMMUNICATION		
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
I/II/III	4	60	4	100

Course Objectives

1. To understand the use of Fourier, transform in analyzing the signals
2. To learn about the quanta of transmission of information
3. To make students familiar with different types of pulse modulation
4. To have an in depth knowledge about the various methods of error controlling codes
5. To acquire knowledge about spread spectrum techniques in getting secured communication

UNIT I: SIGNAL ANALYSIS

Fourier transforms of gate functions, Delta functions at the origin – Two delta function and periodic delta function – Properties of Fourier transform – Frequency shifting –Time shifting - Convolution –Graphical representation – Convolution theorem – Time Convolution theorem – Frequency Convolution theorem –Sampling theorem.

UNIT II: INFORMATION THEORY

Communication system – Measurement of information – Coding – Bandot Code CCITT Code – Hartley Law – Noise in an information Carrying Channel- Effects of noise- Capacity of noise in a channel – Shannon Hartley theorem –Redundancy.

UNIT III: PULSEMODULATION

Pulse Amplitude Modulation - Natural Sampling – Instantaneous sampling - Transmission of PAM Signals -Pulse width modulation – Time division multiplexing – Band width requirements for PAM Signals. Pulse Code Modulation –Principles of PCM –Quantizing noise – Generation and demodulation of PCM -Effects of noise –Companding – Advantages and application

UNIT IV: ERROR CONTROL CODING

Introduction to Linear Block Codes, Hamming Codes, BCH Coding, RS Coding, Convolutional Coding, Coding Grain Viterbi Coding

UNIT V: SPREAD SPECTRUM SYSTEMS

Pseudo Noise Sequences, Generation And Correlation Properties, Direct Sequence Spread Spectrum Systems, Frequency Hop Systems, Processing Gain, Anti-Jam and Multipath Performance

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. B.P. Lathi, Communication system, Wiley Eastern.
2. George Kennedy, Electronic Communication Systems, 3rd Edition, Mc Graw Hill.
3. Simon Haykin, Communication System, 3rd Edition, John Wiley & Sons.
4. George Kennedy and Davis, 1988, Electronic Communication System, Tata McGraw Hill 4th Edition.

5. Taub and Schilling, 1991, "Principles of Communication System", Second edition Tata McGraw Hill.

REFERENCE BOOKS

1. John Proakis, 1995, Digital Communication, 3rd Edition, McGraw Hill, Malaysia.
2. M. K. Simen, 1999, Digital Communication Techniques, Signal Design and Detection, Prentice Hall of India.
3. Dennis Roddy and Coolen, 1995, Electronics communications, Prentice Hall of India IV Edition.
4. Wave Tomasi, 1998, "Advanced Electronics communication System" 4th Edition Prentice Hall, Inc.
5. M.Kulkarni, 1988, "Microwave and Radar Engineering", Umesh Publications.

WEB SOURCES

1. http://nptel.iitm.ac.in/
2. http://web.ewu.edu/
3. http://www.ece.umd.edu/class/enee630.F2012.html
4. http://www.aticourses.com/Advanced%20Topics%20in%20Digital%20Signals
5. http://nptel.iitm.ac.in/courses/117101051.html

COURSE OUTCOMES(CO):

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

CO1	Apply the techniques of Fourier transform, convolution and sampling theorems in signal processing	K1, K3
CO2	Apply different information theories in the process of study of coding of information, storage and communication	**K3**
CO3	Explain and compare the various methods of pulse modulation techniques	**K4**
CO4	Apply the error control coding techniques in detecting and correcting errors-able to discuss, analyze and compare the different error control coding	**K3, K4**
CO5	Apply, discuss and compare the spread spectrum techniques for secure	**K3, k5**

	communications	
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	1	2	2	3	2	2	3
CO2	3	3	3	1	2	2	3	2	2	3
CO3	3	3	3	1	2	2	3	2	2	3
CO4	3	3	3	1	2	2	3	2	2	3
CO5	3	3	3	1	2	2	3	2	2	3

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	2	3	2	2	3
CO2	3	3	3	1	2	2	3	2	2	3
CO3	3	3	3	1	2	2	3	2	2	3
CO4	3	3	3	1	2	2	3	2	2	3
CO5	3	3	3	1	2	2	3	2	2	3

Program:M.Sc.Physics				
Elective	**CourseCode:**	**Course Title:** COMMUNICATIONELECTRONICS		
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To comprehend the transmission of electromagnetic waves thorough different types of antenna and also to acquire knowledge about the propagation of waves through earth's atmosphere and along the surface of the earth
2. To gain knowledge in the generation and propagation of microwaves
3. To acquire knowledge about radar systems and its applications and also the working principle of colour television
4. To learn the working principle of fiber optics and its use in telecommunication
5. To understand the general theory and operation of satellite communication systems

UNIT I:ANTENNAS AND WAVE PROPAGATION

Radiation Field and Radiation Resistance of Short Dipole Antenna-Grounded Antenna-Ungrounded Antenna-Antenna Arrays-Broadside and End Side Arrays-Antenna Gain-Directional High Frequency Antennas-Sky Wave-Ionosphere- Eclesand Larmor Theory- MagnentoIonic Theory-Ground Wave Propagation

UNIT II:MICROWAVES

Microwave Generation - Multi Cavity Klystron-Reflex Klystron-Magnetron Travelling Wave Tubes (TWT) and Other Microwave Tubes-MASER-Gunn Diode-Wave Guides-Rectangular Wave Guides-Standing Wave Indicator and Standing Wave Ratio(SWR)

UNIT III:RADAR ANDTELEVISION

Elements of a Radar System-Radar Equation-Radar Performance Factors Radar Transmitting Systems-Radar Antennas-Duplexers-Radar Receivers and Indicators-Pulsed Systems-Other Radar Systems- ColourTV Transmission and Reception-Colour Mixing Principle-Colour Picture Tubes-Delta Gun Picture Tube-PIL Colour Picture Tube-Cable TV, CCTV And Theatre TV

UNIT IV:OPTICAL FIBER

Propagation of Light in an Optical Fibre-Acceptance Angle-Numerical Aperture-Step and Graded Index Fibres-Optical Fibresas a Cylindrical Wave Guide-Wave Guide Equations-Wave Guide Equations an Step Index Fibres - Fibre Losses and Dispersion-Applications

UNIT V:SATELLITECOMMUNICATION

Orbital Satellites-Geostationary Satellites-Orbital Patterns-Satellite System Link Models-Satellite System Parameters-Satellite System Link Equation Link Budget-INSAT Communication Satellites

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable AndCommunication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Handbook of Electronics by Gupta and Kumar, 2008 edition.
2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.
3. Taub and Schilling, principles of communication systems, second edition, Tata Mc Graw Hill (1991).
4. M. Kulkarani, Microwave and radar engineering, Umesh Publications, 1998.
5. Mono Chrome and colour television, R. R. Ghulathi

REFERENCE BOOKS

1. Electronic communications – Dennis Roody and Coolen, Prentice Hall of India, IV edition, 1995.
2. Wayne Tomasi, Advanced electronics communication systems, fourth edition, Prentice Hall of India, 1998
3. Dennis Roddy and Coolen, 1995, Electronics communications, Prentice Hall of India IV Edition.
4. Wayne Tomasi,1998 “Advanced Electronics communication System” 4th edition, Prentice Hall of India, 1998
5. S. Salivahanan, N. Suersh Kumar & A. Vallavaraj, 2009, Electronic Devices and Circuits, Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition.

WEB SOURCES

1. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/
2. https://www.polytechnichub.com/difference-analog-instruments-digital-instruments/
3. http://nptel.iitm.ac.in/
4. http://web.ewu.edu/
5. http://nptel.iitm.ac.in/

COURSE OUTCOMES(CO):

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

CO1	Discuss and compare the propagation of electromagnetic waves through sky and on earth's surface Evaluate the energy and power radiated by the different types of antenna	**K1, K5**
CO2	Compare and differentiate the methods of generation of microwaves analyze the propagation of microwaves through wave guides- discuss and compare the different methods of generation of microwaves	**K4**
CO3	Classify and compare the working of different radar systems- apply the principle of radar in detecting locating, tracking, and recognizing objects of various kinds at considerable distances – discuss the importance of radar in military- elaborate and compare the working of different picture tube	**K3**
CO4	Classify, discuss and compare the different types of optical fiber and also to justify the need of it-discover the use of optical fiber as wave guide	**K1, K3**
CO5	Explain the importance of satellite communication in our daily life-distinguish between orbital and geostationary satellites elaborate the linking of satellites with ground station on the earth	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	2	2	3	2	1	3
CO2	3	3	3	1	2	2	3	2	1	3
CO3	3	3	3	1	2	2	3	2	1	3
CO4	3	3	3	1	2	2	3	2	1	3
CO5	3	3	3	1	2	2	3	2	1	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	2	2	3	2	1	3
CO2	3	3	3	1	2	2	3	2	1	3
CO3	3	3	3	1	2	2	3	2	1	3
CO4	3	3	3	1	2	2	3	2	1	3
CO5	3	3	3	1	2	2	3	2	1	3

Program:M.Sc.Physics				
Elective	**CourseCode:**2		**Course Title:** PLASMA PHYSICS	
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
I/II/III	4	60	4	100

Course Objectives

1. To explore the plasma universe by means of in-site and ground-based observations.
2. To understand the model plasma phenomena in the universe.
3. To explore the physical processes which occur in the space environment.

UNIT I: FUNDAMENTAL CONCEPTS OF PLASMA

Kinetic pressure in a partially ionized - Mean free path and Collision cross section - Mobility of charged particles - Effect of magnetic field on the mobility of ions and electrons-Thermal conductivity- Effect of magnetic field- Quasi- neutrality of plasma Debye shielding distance - Optical properties of plasma.

UNIT II: MOTION OF CHARGED PARTICLES IN ELECTRIC ANDMAGNETIC FIELD

Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and Magnetic Fields- Motion of charged particle inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement - Motion of an electron in a time varying electric field- Magneto-hydrodynamics - Magneto-hydrodynamic equations – Condition for Magneto Hydrodynamic Behaviour.

UNIT III: PLASMA OSCILLATIONS AND WAVES

Introduction, theory of simple oscillations - Electron oscillation in a plasma – Derivations of plasma oscillations by using Maxwell's equation - Ion oscillation and waves in a magnetic field - thermal effects on plasma oscillations - Landau damping - Hydro magnetic waves - Oscillations in an electron beam.

UNIT IV: PLASMA DIAGNOSTICS TECHNIQUES

Single probe method - Double probe method - Use Of Probe Technique For Measurement Of Plasma Parameters in Magnetic Field - Microwave Method - Spectroscopic Method - -Laser as atool for Plasma Diagnostics-X-Ray Diagnostics of Plasma - Acoustic Method - Conclusion.

UNIT V: APPLICATIONS OF PLASMA PHYSICS

Magneto hydrodynamic Generator - Basic theory - Principle of Working-Fuel in MHD Generator - Generation of Microwaves Utilizing High Density Plasma - Plasma Diode.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Plasma Physics- Plasma State of Matter - S. N. Sen,PragatiPrakashan, Meerut.
2. Introduction to Plasma Physics-M. UmanKrall, N. A., and A. W. Trivelpiece. Principles of Plasma Physics. Berkeley, CA: San Francisco Press, 1986. ISBN: 9780911302585.Tanenbaum, B. S. Plasma Physics. New York, NY: McGraw-Hill, 1967. ISBN: 9780070628120.
3. Goldston, R. J., and P. H. Rutherford. Introduction to Plasma Physics. Philadelphia, PA: IOP Publishing, 1995. ISBN: 9780750301831.
4. Hutchinson, I. H. Principles of Plasma Diagnostics. Cambridge, UK: Cambridge University Press, 2005. ISBN: 9780521675741.

REFERENCE BOOKS

1. Chen, F. F. Introduction to Plasma Physics. 2nd ed. New York, NY: Springer, 1984. ISBN: 9780306413322.
2. Introduction to Plasma Theory-D.R. Nicholson
3. Shohet, J. L. The Plasma State. San Diego, CA: Academic Press Inc., 1971. ISBN: 9780126405507.
4. Hazeltine, R. D., and F. L. Waelbroeck. The Framework of Plasma Physics. Boulder, CO: Westview Press, 2004. ISBN: 9780813342139.
5. Huddlestone, R. H., and S. L. Leonard. Plasma Diagnostic Techniques. San Diego, CA: Academic Press, 1965

WEB SOURCES

1. https://fusedweb.llnl.gov/Glossary/glossary.html
2. http://farside.ph.utexas.edu/teaching/plasma/lectures1/index.html
3. http://www.plasmas.org/
4. http://www.phy6.org/Education/whplasma.html

5. http://www.plasmas.org/resources.htm

COURSE OUTCOMES(CO):

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

CO1	Understand the collision, cross section of charged particles and to able to correlate the magnetic effect of ion and electrons in plasma state.	**K1, K2**
CO2	Understand the plasma and learn the magneto-hydrodynamics concepts applied to plasma.	**K2**
CO3	Explore the oscillations and waves of charged particles and thereby apply the Maxwell's equation to quantitative analysis of plasma.	**K1, K3**
CO4	Analyze the different principle and techniques to diagnostics of plasma.	**K2, K5**
CO5	Learn the possible applications of plasma by incorporating various electrical and electronic instruments.	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	2	1	2	3	3
CO3	3	3	2	2	1	2	1	3	3	3
CO4	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	2	1	2	3	3
CO3	3	3	2	2	1	2	1	3	3	3
CO4	3	3	3	2	1	2	1	3	3	3
CO5	3	3	3	2	1	2	1	3	3	3

Program:M.Sc.Physics				
Elective		**CourseCode:**21PPH3E01		**Course Title:** Bio PHYSICS
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To understand the physical principles involved in cell function maintenance.
2. To understand the fundamentals of macromolecular structures involved in propagation of life.
3. To understand the biophysical function of membrane and neuron.
4. To understand various kinds of radiation and their effects on living system and to know the hazards posed by such radiations and the required precautions.
5. To understand the physical principles behind the various techniques available for interrogating biological macromolecules.

UNIT I: CELLULAR BIOPHYSICS

Architecture and Life Cycle of cells – Organelles of Prokaryotic and Eukaryotic cell – Cell size and shape – Fine structure of Prokaryotic and Eukaryotic cell organization – Compartment & assemblies membrane system – Extracellular matrix - Molecular mechanisms of Vesicular traffic - Electrical activities of cardiac and neuronal cells.

UNIT II: MOLECULAR BIOPHYSICS

Macromolecular structure: Protein structure – amino acids, peptide bonds, primary, secondary, tertiary and quaternary structures of proteins
Nucleic acid structure: nucleosides and nucleotides, RNA structure, DNA structure and conformation.
Special Bio-macromolecules: Metalloproteins, nucleoproteins, ribozymes, chaperons and prions.

UNIT III:MEMBRANEAND NEURO BIOPHYISCS

Models membranes - Biological membranes and dynamics – Membrane Capacitors – Transport across cell and organelle membranes – Ion channels.
Nervous system: Organization of the nervous system –Membrane potential – Origins of membrane potential - Electrochemical potentials – Nernst equation – Goldman equation.

UNIT IV: RADIATION BIO PHYSICS

X-Ray: Effects on bio-macromolecules – Gamma Radiation: Molecular effects of gamma radiation, Radiation effects on nucleic acids and membranes, Effects on cell and organelles – UV radiation: Effects on bio-macromolecules and proteins – Radiation hazards and protection – use of radiations in cancer.

UNIT V: PHYSICAL METHODS IN BIOLOGY

Spectroscopy: UV-Visible absorption spectrophotometry – Optical Rotatory Dispersion (ORD) – Structure Determination: X-ray Crystallography, Electron spin resonance (ESR) and biological applications. Chromatography: Thin layer chromatography (TLC), Gas liquid chromatography (GLC) – Centrifugation: Differential centrifugation, density gradient centrifugation. Electrophoresis: Gel electrophoresis, polyacrylamide gel electrophoresis.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. The cell: A molecular approach, Geoffrey M. Cooper, ASM Press, 2013.
2. Biophysics, VasanthaPattabhi, N. Gautham, Narosa Publishing, 2009
3. Biophysics, P. S. Mishra VK Enterprises, 2010.
4. Biophysics, M. A Subramanian, MJP Publishers, 2005.
5. Bioinstrumentation, L. Veerakumari, MJP Publishers, 2006.

REFERENCE BOOKS

1. Chemical Biophysics by Daniel A Beard (Cambridge University Press, 2008).
2. Essential cell biology by Bruce Albert et al (Garland Science)
3. Biophysics, W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin (1983).
4. Membrane Biophysics by Mohammad Ashrafuzzaman, Jack A. Tuszynski, (Springer science & business media).
5. Biological spectroscopyby Iain D. Campbell, Raymond A. Dwek

WEB SOURCES

1. General Bio: http://www.biology.arizona.edu/DEFAULT.html
2. Spectroscopy: http://www.cis.rit.edu/htbooks/nmr/inside.htm
3. Electrophoresis:http://learn.genetics.utah.edu/content/labs/gel/
4. Online biophysics programs: http://mw.concord.org/modeler/
5. https://blanco.biomol.uci.edu/WWWResources.html

COURSE OUTCOMES (CO):

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

CO1	Understand the structural organization and function of living cells and should able to apply the cell signaling mechanism and its electrical activities.	**K2, K3**
CO2	Comprehension of the role of biomolecular conformation to function.	**K1**
CO3	Conceptual understanding of the function of biological membranes and also to understand the functioning of nervous system.	**K2, K5**
CO4	To know the effects of various radiations on living systems and how to prevent ill effects of radiations.	**K1, K5**
CO5	Analyze and interpret data from various techniques viz., spectroscopy, crystallography, chromatography etc.,	**K4**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	1	2	1	3	3	2
CO2	3	3	3	2	1	2	1	3	3	2
CO3	3	3	3	3	1	1	2	3	3	2
CO4	3	3	3	2	1	1	2	3	3	3
CO5	3	3	3	3	1	1	2	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	1	2	1	3	3	2
CO2	3	3	3	2	1	2	1	3	3	2
CO3	3	3	3	3	1	1	2	3	3	2
CO4	3	3	3	2	1	1	2	3	3	3
CO5	3	3	3	3	1	1	2	3	3	3

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** NONLINEAR DYNAMICS	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To school the students about the analytical and numerical techniques of nonlinear dynamics.
2. To make the students understand the concepts of various coherent structures.
3. To train the students on bifurcations and onset of chaos.
4. To educate the students about the theory of chaos and its characterization.
5. To make the students aware of the applications of solitons, chaos and fractals.

UNIT I:GENERAL

Linear waves- Ordinary differential equations(ODEs)-Partial differential equations(PDEs)-Methods to solve ODEs and PDEs.- Numerical methods – Linear and Nonlinear oscillators-Nonlinear waves-Qualitative features

UNIT II:COHERENT STRUCTURES

Linear and Nonlinear dispersive waves - Solitons – K_dB equation – Basic theory of K_dB equation –Ubiquitous soliton equations – AKNS Method, Backlund transformation, Hirotabilinearization method, Painleve analysis - Perturbation methods- Solitons in Optical fibres - Applications.

UNIT III: BIFURCATIONS AND ONSET OF CHAOS

One dimensional flows – Two dimensional flows – Phase plane – Limit cycles – Simple bifurcations – Discrete Dinamical system – Strange attractors – Routes to chaos.

UNITV:APPLICATIONS

Soliton based communication systems – Solition based computation – Synchronization of chaos – Chaos based communication – Cryptography – Image processing – Stochastic – Resonance – Chaos based computation – Time Series analysis.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics: Integrability, Chaos and Patterns. Springer, 2003.
2. A. Hasegawa and Y. Kodama, Solitons in Optical Communications. Oxford Press, 1995.
3. Drazin, P. G. Nonlinear Systems. Cambridge University Press, 2012. ISBN: 9781139172455.
4. Wiggins, S. Introduction to Applied Nonlinear Dynamical Systems and Chaos. Springer, 2003. ISBN: 9780387001777.

5. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Westview Press, 2014. ISBN: 9780813349107.

REFERENCE BOOKS

1. G. Drazin and R. S. Johnson. Solitons: An Introduction. Cambridge University Press, 1989.
2. M. Lakshmanan and K. Murali. Chaos in Nonlinear Oscillators. World Scientific, 1989.
3. S. Strogatz. Nonlinear Dynamics and Chaos. Addison Wesley, 1995.
4. Hao Bai-Lin, Chaos (World Scientidic, Singapore, 1984).
5. Kahn, P. B., Mathematical Methods for Scientists & Engineers (Wiley, NY, 1990)

WEB SOURCES

1. https://www.digimat.in/nptel/courses/video/108106135/L06.html
2. http://digimat.in/nptel/courses/video/115105124/L01.html
3. https://www.digimat.in/nptel/courses/video/108106135/L01.html
4. http://complex.gmu.edu/neural/index.html
5. https://cnls.lanl.gov/External/Kac.php

COURSE OUTCOMES(CO):

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

CO1	Gain knowledge about the available analytical and numerical methods to solve various nonlinear systems.	**K1, K4**
CO2	Understand the concepts of different types of coherent structures and their importance in science and technology.	**K2**
CO3	Learn about simple and complex bifurcations and the routes to chaos	**K1, K2**
CO4	Acquire knowledge about various oscillators, characterization of chaos and fractals.	**K1**
CO5	To analyze and evaluate the applications of solutions in telecommunication, applications of chaos in cryptography, computations and that of fractals.	**K3, K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**

CO1	3	3	3	2	2	1	2	2	2	2
CO2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	2	2	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	2	1	2	2	2	2
CO2	3	2	2	2	2	2	2	2	2	2
CO3	2	2	2	2	2	2	2	2	2	2
CO4	2	2	2	2	2	1	2	2	2	2
CO5	1	2	2	2	2	2	2	2	2	2

Program:M.Sc.Physics		
Elective - I	**CourseCode:**21PPH3E01	**Course Title:** QUANTUM FIELD THEORY

Semester	Hours/Week	TotalHours	Credits	TotalMarks
I	4	60	4	100

Course Objectives

1. To school the students about the analytical and numerical techniques of nonlinear dynamics.
2. To make the students understand the concepts of various coherent structures.
3. To train the students on bifurcations and onset of chaos.
4. To educate the students about the theory of chaos and its characterization.
5. To make the students aware of the applications of solitons, chaos and fractals.

UNIT I:SYMMETRY PRINCIPLES

Relativistic kinematics, Relativistic waves, Klein-Gordon (KG) equation as a relativistic wave equation, treatment of the KG equation as a classical wave equation: its Lagrangian and Hamiltonian, Noether's theorem and derivation of Energy-Momentum and Angular Momentum tensors as consequence of Poincaré symmetry, Internal symmetry and the associated conserved current.

UNIT II:QUANTIZATION OF KLEIN-GORDAN FIELD

Canonical quantization of the KG field, solution of KG theory in Schrödinger and Heisenberg pictures, expansion in terms of creation and annihilation operators, Definition of the vacuum and N-particle eigenstates of the Hamiltonian, Vacuum expectation values, Propagators, Spin and statistics of the KG quantum.

UNIT III:QUANTIZATION OF DIRAC FIELD

Review of Dirac equation and its quantization, use of anti-commutators, creation and destruction operators of particles and antiparticles, Dirac propagator, Energy, Momentum and angular momentum, spin and statistics of Dirac quanta.

UNIT IV:QUANTIZATION OF ELECTROMAGNETIC FIELDS

Review of free Maxwell's equations, Lagrangian, Gauge Transformation and Gauge Fixing, Hamiltonian, Quantization in Terms of Transverse Delta Functions, Expansion in terms of Creation Operators, Spin, Statistics and Propagator of the Photon.

UNIT V:PERTURBATIVE INTERACTION AT TREE LEVEL

Introduction to Interacting Quantum Fields, Wick's Theorem, Feynman Diagram, Examples from Quantum Electrodynamics at the tree level: Positron-Electron and Electron-Electron Scattering.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. J. D. Bjorkenand S. D. Drell, Relativistic Quantum Fields David
2. An Introduction to Quantum Field Theory by M. Peskin and D. V. Schroeder
3. Quantum Field theory: From Operators to Path Integrals, 2nd edition by Kerson Huang
4. Quantum Field Theory by Mark Srednicki
5. Quantum Field Theory by Claude Itzykson and Jean Bernard Zuber.

REFERENCE BOOKS

1. V. B. Berestetskii, E. M. Lifshitz and L. P. Pitaevskii, Quantum Electrodynamics
2. Introduction to the Theory of Quantized Fields by N. N. Bogoliubov and D. V. Shirkov (1959)
3. Quantum Field Theory by L. H. Ryder (1984)
4. Quantum Field Theory by L. S. Brown (1992)
5. Quantum Field Theory: A Modern Introduction by M. Kaku (1993)

WEB SOURCES

1. https://homepages.dias.ie/ydri/QFTNOTES4v2.pdf
2. https://www.scirp.org/(S(i43dyn45teexjx455qlt3d2q))/reference/referencespapers.aspx?referenceid=2605249
3. https://archive.nptel.ac.in/courses/115/106/115106065/
4. http://www.nhn.ou.edu/~milton/p6433/p6433.html
5. https://plato.stanford.edu/entries/quantum-field-theory/

COURSE OUTCOMES(CO):

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

CO1	Understand the interconnection of Quantum Mechanics and Special Relativity	K1
CO2	Enable the students to understand the method of quantization to various field	**K2**

CO3	Employ the creation and annihilation operators for quantization	**K5**
CO4	Summarizes the interacting field, in quantum domain, and gives a discussion on how perturbation theory is used here.	**K1, K3**
CO5	Understand the concept of Feynman diagram	**K2**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	2	3	3	2	3
CO2	3	3	3	2	3	3	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	3	3	3	2	3	3	3	3	2	3
CO5	3	3	3	2	3	3	3	3	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	3	2	3	3	2	3
CO2	3	3	3	2	3	3	3	3	2	3
CO3	3	3	3	2	3	2	3	3	2	3
CO4	3	3	3	2	3	3	3	3	2	3
CO5	3	3	3	2	3	3	3	3	2	3

Program:M.Sc.Physics		
Elective - I	**CourseCode:**	**Course Title:**

		GENERAL RELATIVITY AND COSMOLOGY		
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
I/II/III	4	60	4	100

Course Objectives

1. To give an introduction to students in the areas of general relativity and cosmology

UNIT I:TENSORS

Tensors in Index Notation - Kroneckerand Levi CivitaTensors - Inner and Outer Products - Contraction - Symmetric and Antisymmetric Tensors - Quotient Law - Metric Tensors - Covariant And Contravariant Tensors - Vectors - The Tangent Space - Dual Vectors - Tensors - Tensor Products - The Levi- CivitaTensor - Tensors in Riemann Spaces

UNIT II:TENSORS FIELD

Vector-Fields, Tensor-Fields, Transformation Of Tensors - Gradient And Laplace Operator In General Coordinates - Covariant Derivatives And Christoffel Connection - Elasticity: Field Tensor - Field Energy Tensor - Strain Tensor - Tensor Of Elasticity- Curvature Tensor

UNIT III:GENERAL RELATIVITY

The Space Time Interval - The Metric - Lorentz Transformations - Space-Time Diagrams - World-Lines - Proper Time - Energy-Momentum Vector - Energy-Momentum Tensor - Perfect Fluids - Energy-Momentum Conservation - Parallel Transport - The Parallel Propagator - Geodesics - Affine Parameters - The Riemann Curvature Tensor - Symmetries of the Riemann Tensor - The Bianchi Identity

UNIT IV:TENSOR IN RELATIVITY

Ricci and Einstein Tensors - Weyl Tensor - Killing Vectors - The Principle of Equivalence - Gravitational Redshift - Gravitation as Space-Time Curvature - The Newtonian Limit - Physics in Curved Space-Time - Einstein's Equations - The Weak Energy Condition - Causality - Spherical Symmetry - The Schwarzschild Metric - Perihelion Precession

UNIT V:COSMOLOGY

Expansion of the Universe - Thermal History - and The Standard Cosmological Model - Friedmann - Robertson-Walker Type Models of The Universe - Primordial Inflation and The

Theory of Cosmological Fluctuations - Theory and Observations of The Cosmic Microwave Background Andof The Large-Scale Structure of The Universe - Dark Matter and Dark Energy - Theoretical Questions and Observational Evidence - Inflation - Origin of Galaxies and Other Open Problems

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. M. R. Spiegel, Vector Analysis, Schaum'a outline series, McGraw Hill, New York, 1974.
2. James Hartle, Gravity: An introduction to Einstein's general relativity, San Francisco, Addison-Wesley, 2002
3. Sean Carroll, Spacetime and Geometry: An Introduction to General Relativity, (Addison-Wesley, 2004).
4. Jerzy Plebanskiand Andrzej Krasinski, An Introduction to General Relativity and Cosmology, Cambridge University Press 2006
5. Meisner, Thorne and Wheeler: Gravitation W. H. Freeman & Co., San Francisco 1973

REFERENCE BOOKS

1. Robert M. Wald: Space, Time, and Gravity: the Theory of the Big Bang and Black Holes, Univ. of Chicago Press.
2. J. V. Narlikar, Introduction to Cosmology, Jones &Bartlett 1983
3. Steven Weinberg, Gravitation and Cosmology, New York, Wiley, 1972.
4. Jerzy Plebanski and Andrzej Krasinski, An Introduction to General Relativity and Cosmology, Cambridge University Press 2006
5. R Adler, M Bazin& M Schiffer, Introduction to General Relativity

WEB SOURCES

1. http://www.fulviofrisone.com/attachments/article/486/A%20First%20Course%20In%20General%20Relativity%20-%20Bernard%20F.Schutz.pdf
2. https://link.springer.com/book/9780387406282
3. https://ocw.mit.edu/courses/8-962-general-relativity-spring-2020/resources/lecture-18-cosmology-i/
4. https://arxiv.org/abs/1806.10122
5. https://uwaterloo.ca/applied-mathematics/future-undergraduates/what-you-can-learn-applied-mathematics/relativity-and-cosmology

COURSE OUTCOMES (CO):

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

CO1	Skillfully handle tensors	K1
CO2	Understanding of the underlying theoretical aspects of general relativity and cosmology	**K2**
CO3	Gain knowledge on space time curvature	**K1**
CO4	Equipped to take up research in cosmology	**K3, K4**
CO5	Confidently solve problems using mathematical skills	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) and LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	1	3	2	3	2	2	2	2
CO2	3	3	1	3	2	3	2	2	2	2
CO3	3	2	1	2	1	2	1	1	3	2
CO4	3	2	1	2	1	2	1	1	3	2
CO5	3	2	1	2	1	2	1	1	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	1	3	2	3	2	2	2	2
CO2	3	3	1	3	2	3	2	2	2	2
CO3	3	2	1	2	1	2	1	1	3	2
CO4	3	2	1	2	1	2	1	1	3	2
CO5	3	2	1	2	1	2	1	1	3	2

Program:M.Sc.Physics

Elective	CourseCode:	Course Title: ADVANCED OPTICS		
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
I/II/III	4	60	4	100

Course Objectives

1. To know the concepts behind polarization and could pursue research work on application aspects of laser
2. To impart an extensive understanding of fiber and non-linear optics
3. To study the working of different types of LASERS
4. To differentiate first and second harmonic generation
5. Learn the principles of magneto-optic and electro-optic effects and its applications

UNIT 1:POLARIZATION AND DOUBLE REFRACTION

Classification of polarization – Transverse character of light waves – Polarizer and analyzer – Malu's law – Production of polarized light – Wire grid polarizer and the polaroid – Polarization by reflection – Polarization by double refraction – Polarization by scattering – The phenomenon of double refraction – Normal and oblique incidence – Interference of polarized light: Quarter and half wave plates – Analysis of polarized light – Optical activity

UNIT II:LASERS

Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO2 laser – Chemical lasers – HCl laser – Semiconductor laser

UNIT III:FIBER OPTICS

Introduction – Total internal reflection – The optical fiber – Glass fibers – The coherent bundle – The numerical aperture – Attenuation in optical fibers – Single and multi-mode fibers – Pulse dispersion in multimode optical fibers – Ray dispersion in multimode step index fibers – Parabolic-index fibers – Fiber-optic sensors: precision displacement sensor – Precision vibration sensor

UNIT IV:NON-LINEAR OPTICS

Basic principles – Harmonic generation – Second harmonic generation – Phase matching – Third harmonic generation – Optical mixing – Parametric generation of light – Self-focusing of light

UNIT V:MAGNETO-OPTICS AND ELECTRO-OPTICS

Magneto-optical effects – Zeeman effect – Inverse Zeeman effect – Faraday effect – Voigt effect – Cotton-mouton effect – Kerr magneto-optic effect – Electro-optical effects – Stark effect – Inverse stark effect – Electric double refraction – Kerr electro-optic effect – Pockels electro-optic effect

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. B. B. Laud, 2017, Lasers and Non – Linear Optics, 3rd Edition, New Age International (P) Ltd.
2. AjoyGhatak, 2017, Optics, 6th Edition, McGraw – Hill Education Pvt. Ltd.
3. William T. Silfvast, 1996, Laser Fundamentals Cambridge University Press, New York
4. J. Peatros, Physics of Light and Optics, a good (and free!) electronic book
5. B. Saleh, and M. Teich, Fundamentals of Photonics, Wiley-Interscience,

REFERENCE BOOKS

1. F. S. Jenkins and H. E. White, 1981, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition.
2. Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH.
3. Lipson, S. G. Lipson and H. Lipson, 2011, Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011.
4. Y. B. Band, Light and Matter, Wiley and Sons (2006)
5. R. Guenther, Modern Optics, Wiley and Sons (1990)

WEB SOURCES

1. https://www.youtube.com/watch?v=WgzynezPiyc
2. https://www.youtube.com/watch?v=ShQWwobpW60
3. https://www.ukessays.com/essays/physics/fiber–optics–and–it-applications.php
4. https://www.youtube.com/watch?v=0kEvr4DKGRI
5. http://optics.byu.edu/textbook.aspx

COURSE OUTCOMES(CO):

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

CO1	Discuss the transverse character of light waves and different polarization phenomenon	K1
CO2	Discriminate all the fundamental processes involved in laser devices and to analyze the design and operation of the devices	**K2**
CO3	Demonstrate the basic configuration of a fiber optic – communication system and advantages	**K3, K4**
CO4	Identify the properties of nonlinear interactions of light and matter	**K4**
CO5	Interpret the group of experiments which depend for their action on an applied magnetics and electric field	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	2	3	3	3	3	3	3
C02	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	2	3	3	3	3	3	3
CO3	3	3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3

Program:M.Sc.Physics				
Elective		**CourseCode:**21PPH3E01		**Course Title:** ADVANCED MATHEMATICAL PHYSICS
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

To educate and involve students in the higher level of mathematics and mathematical methods relevant and applicable to Physics.

UNIT I: DISCRETE GROUPS

Definition of a Group, Subgroup, Class, Lagrange's Theorem, Invariant Subgroup, Homomorphism and Isomorphism between Two Groups. Representation of a Group, Unitary Representations, Reducible and Irreducible Representations Schur's Lemmas, Orthogonality Theorem, Character Table, Reduction of Kronecker Product of Representations, Criterion for Irreducibility of a Representation.

UNIT II: CONTINUOUS GROUPS

Infinitesimal Generators, Lie Algebra; Rotation Group, Representations of theLie Algebra of the Rotation Group, Representation of the Rotation Group, D-Matrices and their Basic Properties. Addition of Two Angular Momenta and C.G. Coefficients, Wigner-Eckart Theorem.

UNIT III: SPECIAL UNITARY GROUPS

Definition of Unitary, Unimodular Groups SU (2) And SU(3). Lie Algebra Of SU(2). Relation Between SU(2) and Rotation Group. Lie Algebra of SU(3)-Gellmann'sMatrices. CartanForm Of The SU(3). Lie Algebra, Roots And Root Diagram for SU(3). Weights and their Properties, Weight Diagrams for the Irreducible Representations 3.3*-, 6,6 8, 10 And 10 Of SU(3). Direct Product of Two SU(3) Representations, Young Tableaux Method of Decomposition of Products Of IR's Illustrations with the Representations of Dim<10. C.G. Coefficients For ¬3 X 3* And 3 X 6 Representations. SU(3) Symmetry in Elementary Particle Physics, Quantum Numbers of Hadrons and SU(2) and SU(3) Classification of Hadrons.

UNIT IV:TENSORS

Cartesian Vectors and Tensors Illustration with Moment of Inertia, Conductivity, Dielectric Tensors. Four VectoriIn Special Relativitity, Vectors and Tensors under Lorentz Transformations, Illustration from Physics. Vectors and Tensors Under General Co-Ordinate Transformations, Contravariant and Covariant Vectors and Tensors, Mixed Tensors; Tensor Algebra, Addition, Subtraction, Direct Product of Tensors, Quotient Theorem, Symmetric and Antisymmetric Tensors.

UNIT V: TENSOR CALCULUS

Parallel Transport, Covariant Derivative, Affine Connection. Metric Tensor. Expression for Christoffel Symbols in terms of and its Derivatives (Assuming D G = 0. Curvature Tensor, Ricci Tensor and Einstein Tensor. Bianchi Identities, Schwarzschild Solution to The Einstein Equation G=0.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. A. W. Joshi, Group Theory for Physicists
2. D. B. Lichtenberg, Unitary Symmetry and Elementary Particles
3. E. Butkov, Mathematical Physics
4. J. V. Narlikar, General Relativity & Cosmology
5. R. Geroch, Mathematical Physics, The University of Chicago press (1985).

REFERENCE BOOKS

1. M. Hamermesh Group Theory
2. M. E. Rose: Elementary Theory of Angular Momentum
3. Georgi : Lie Groups for Physicists
4. E. A. Lord: Tensors, Relativity & Cosmology
5. P. Szekeres, A course in modern mathematical physics: Groups, Hilbert spaces and differential geometry, Cambridge University Press.

WEB SOURCES

1. https://vdoc.pub/documents/unitary-symmetry-and-elementary-particles-c4qsfejthkc0
2. https://physics.iith.ac.in/HEP_Physics/slides/poplawskitalk.pdf
3. https://www.hindawi.com/journals/amp/
4. https://projecteuclid.org/journals/advances-in-theoretical-and-mathematical-physics
5. https://www.springer.com/journal/11232

COURSE OUTCOMES (CO):

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

CO1	Gained knowledge of both discrete and continuous groups	**K1**
CO2	Apply various important theorems in group theory	**K3**
CO3	Construct group multiplication table, character table relevant to important branches of physics.	**K5**
CO4	Equipped to solve problems in tensors	**K4, K5**
CO5	Developed skills to apply group theory and tensors to peruse research	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	1	1	2	3	2
CO3	3	3	2	1	2	2	1	2	3	2
CO4	3	3	2	2	1	2	1	2	3	2
CO5	3	3	2	2	2	1	1	2	3	2

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	1	1	2	1	2	3	3
CO2	3	3	2	1	1	1	1	2	3	2
CO3	3	3	2	1	2	2	1	2	3	2
CO4	3	3	2	2	1	2	1	2	3	2

CO5	3	3	2	2	2	1	1	2	3	2

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** ADVANCED SPECTROSCOPY	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. Helps students understand and appreciate spectroscopy as a sufficiently broad field in which many sub disciplines exist.
2. Make them appreciate each of these specific techniques with numerous implementations.
3. To realize the progress in this field that is rapid, resulting in improved instrument capabilities and an ever-widening range of applications.
4. To apply group theory in spectroscopy to shed light on molecular symmetry and determine important physical parameters.

UNIT I:MOLECULAR SPECTROSCOPY AND GROUP THEORY

Group axioms –subgroup, simple group, Abelian group, cyclic group, order of a group, class- Lagrange's theorem statement and proof - Symmetry operations and symmetry elements - Application: construction of group multiplication table (not character table) for groups of order 2, 3, cyclic group of order 4, noncyclic group of order 4 – reducible and irreducible representations- Unitary representations – Schur's lemmas – Great orthogonality theorem - point group -Simple applications : Symmetry operations of water and ammonia- Construction of character table for C2v (water) and C3v (ammonia) molecules

UNIT II:LASER SPECTROSCOPY

Lasers as Spectroscopy Light sources – Special Characteristics of Laser emission- ultra short pulses- laser cooling -Single and multi-mode lasers- Laser tenability- Fluorescence spectroscopy with lasers- Laser Raman Spectroscopy – Non-linear Spectroscopy – Applications of Laser Spectroscopy in medical fields, materials science research

UNIT III:MOSSBAUER SPECTROSCOPY

Basic idea of Mossbauer spectroscopy - Principle- Mossbauer effect- Recoilless emission and absorption- Chemical shift -Effect of electric and magnetic fields – Hyperfine Interactions- instrumentation-Applications: understanding molecular and electronic structures

UNIT IV:XRAY PHOTOELECTRON SPECTROSCOPY

Principle – XPS spectra and its interpretation- ECSA-EDAX- other forms of XPS – Chemical Shift - Applications : - Stoichiometric Analysis- Electronic Structure- XPES techniques used in astronomy, glass industries, paints and in biological research

UNIT V:MOLECULAR MODELLING

Determination of Force Constants- Force Field From Spectroscopic Data-Normal Coordinate Analysis of A Simple Molecule (H_2O) – Analyzing Thermodynamic Functions, Partition Functions, Enthalpy, Specific Heat And Related Parameters From Spectroscopic Data- Molecular Modelling Using Data From Various Spectroscopic Studies

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. William Kemp, 2019, Organic Spectroscopy (2nd Edition) MacMillan, Indian Edition.
2. C N Banwell and McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
3. D.N. Satyanarayana, 2001, Vibrational Spectroscopy and Applications, New Age International Publication.
4. B.K. Sharma , 2015, Spectroscopy, Goel Publishing House Meerut.
5. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.

REFERENCE BOOKS

1. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, SpringerLink.
2. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol.I., Chapman and Hall, New York.
3. J L McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
4. David. L. Andrews, Introduction to Laser Spectroscopy, Springer, 2020

5. Kalsi.P.S, 2016, Spectroscopy of Organic Compounds (7th Edition) New Age International Publishers.

WEB SOURCES

1. Fundamentals of Spectroscopy - Course (nptel.ac.in)
2. http://mpbou.edu.in/slm/mscche1p4.pdf
3. https://onlinecourses.nptel.ac.in/noc20_cy08/preview
4. https://www.coursera.org/lecture/spectroscopy/nmr-spectroscopy-introduction-XCWRu
5. https://serc.carleton.edu/research_education/geochemsheets/techniques/mossbauer.html

COURSE OUTCOMES(CO):

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

CO1	Comprehend set of operations associated with symmetry elements of a molecule, apply mathematical theory while working with symmetry operations. Apply mathematical theory while working with symmetry operations. To use group theory as a tool to characterize molecules.	**K1, K2**
CO2	Align with the recent advances in semiconductor laser technology combined sensitive spectroscopic detection techniques.	**K3**
CO3	Understand principle behind Mossbauer spectroscopy and apply the concepts of isomer shift and quadrupole splitting to analyse molecules.	**K2, K3**
CO4	Assimilate this XPES quantitative technique and the instrumentation associated with this, as applied in understanding surface of materials.	**K3, K4**
CO5	Employ IR and Raman spectroscopic data along with other data for structural investigation of molecules. Analyze thermodynamic functions and other parameters to evolve molecular models.	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	2	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	2	3	3	2
CO3	2	2	3	3	3	3	3	2	3	3

CO4	3	2	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	2	2	3	3	3	3	3	2
CO2	2	2	2	3	3	3	2	3	3	2
CO3	2	2	3	3	3	3	3	2	3	3
CO4	3	2	3	3	2	3	3	3	3	2
CO5	3	2	3	3	3	3	3	3	3	3

Program:M.Sc.Physics				
Elective	**CourseCode**		**Course Title:** MICROPROCESSOR 8085 AND MICROCONTROLLER 8051	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To provide an understanding of the architecture and functioning of microprocessor 8085A and to the methods of interfacing I/O devices and memory to microprocessor
2. To introduce 8085A programming and applications and the architecture and instruction sets of microcontroller 8051

UNIT I: 8085 PROGRAMMING, PERIPHERAL DEVICES AND THEIR INTERFACING

Instruction set - Addressing modes - Programming techniques - Memory mapped I/O scheme- I/O mapped I/O scheme - Memory and I/O interfacing- Data transfer schemes - Interrupts of 8085 - Programmable peripheral interface (PPI) - Control group and control word- Programmable DMA controller - Programmable interrupt controller – Programmable communication interface - Programmable counter /interval timer.

UNIT II:8085 INTERFACING APPLICATIONS

Seven segment display interface - Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities –Voltage and current) Measurement of physical quantities (Temperature an strain).

UNIT III:8051 MICROCONTROLLER HARDWARE

Introduction – Features of 8051 – 8051 Microcontroller Hardware: Pin-out 8051, Central Processing Unit (CPU), internal RAM, Internal ROM, Register set of 8051 – Memory organization of 8051 – Input/ Output pins, Ports and Circuits – External data memory and program memory: External program memory, External data memory.

UNIT IV: 8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING

Addressing modes – Data moving (Data transfer) instructions: Instructions to Access external data memory, external ROM / program memory, PUSH and POP instructions, Data exchange instructions – Logical instructions: byte and bit level logical operations, Rotate and swap operations – Arithmetic instructions: Flags, Incrementing and decrementing, Addition, Subtraction, Multiplication and division, Decimal arithmetic – Jump and CALL instructions: Jump and Call program range, Jump, Call and subroutines – Programming.

UNIT V:INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD

8051 Interrupts – Interrupt vector table – Enabling and disabling an interrupt – Timer interrupts and programming – Programming external hardware interrupts – Serial communication interrupts and programming – Interrupt priority in the 8051 : Nested interrupts , Software triggering of interrupt. LED Interface Seven segment display interface- Interfacing of Digital to Analog converter and Analog to Digital converter - Stepper motor interface - Measurement of electrical quantities – Voltage and current) Measurement of physical quantities(Temperature an strain).

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. A. NagoorKani, Microprocessors & Microcontrollers, RBA Publications (2009).
2. A. P. Godse and D. A. Godse, Microprocessors, Technical Publications, Pune (2009).
3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing (2013).
4. B. Ram, Fundamentals of Microprocessors & Microcontrollers, DhanpatRai publications New Delhi (2016).
5. V. Vijayendran, 2005, Fundamentals of Microprocessor-8085”, 3rd Edition S.Visvanathan Pvt, Ltd.

REFERENCE BOOKS

1. Douglas V. Hall, Microprocessors and Interfacing programming and Hardware, Tata Mc Graw Hill Publications (2008)

2. Muhammad Ali Mazidi, Janice GillispieMazidi, Rolin D. Mckinlay, The 8051 Microcontroller and Embedded Systems, Pearson Education (2008).
3. Barry B. Brey, 1995, The Intel Microprocessors 8086/8088, 80186, 80286, 80386 and 80486, 3rd Edition, Prentice- Hall of India, New Delhi.
4. J. Uffrenbeck, "The 8086/8088 Family-Design, Programming and Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.
5. W. A. Tribel, Avtar Singh, "The 8086/8088 Microprocessors: Programming, Interfacing, Software, Hardware and Applications", Prentice-Hall of India, New Delhi.

WEB SOURCES

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.html
2. http://www.electronicsengineering.nbcafe.in/peripheral-mapped-io-interfacing/
3. https://www.geeksforgeeks.org/programmable-peripheral-interface-8255/
4. http://www.circuitstoday.com/8051-microcontroller
5. https://www.elprocus.com/8051-assembly-language-programming/

COURSE OUTCOMES:

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

CO1	Gain knowledge of architecture and working of 8085 microprocessor.	K1
CO2	Get knowledge of architecture and working of 8051 Microcontroller.	**K1**
CO3	Be able to write simple assembly language programs for 8085A microprocessor.	**K2, K3**
CO4	Able to write simple assembly language programs for 8051 Microcontroller.	**K3, K4**
CO5	Understand the different applications of microprocessor and microcontroller.	**K3, K 5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1

CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	3	3	1	1	1	1	1
CO2	2	1	1	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1
CO5	3	3	3	3	3	1	1	1	1	1

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** CHARACTERIZATON OF MATERIALS	
Semester	**Hours/Week**	**TotalHours**	**Credits**	**TotalMarks**
I/II/III	4	60	4	100

Course Objectives

1. To make the students learn some important thermal analysis techniques namely TGA, DTA, DSC and TMA.
2. To make the students understand the theory of image formation in an optical microscope and to introduce other specialized microscopic techniques.
3. To make the students learn and understand the principle of working of electron microscopes and scanning probe microscopes.
4. To make the students understand some important electrical and optical characterization techniques for semiconducting materials.
5. To introduce the students the basics of x-ray diffraction techniques and some important spectroscopic techniques.

UNITI:THERMALANALYSIS

Introduction – Thermogravimetric Analysis (TGA) – Instrumentation – Determination of Weight Loss and Decomposition Products – Differential Thermal Analysis (DTA)- Cooling Curves – Differential Scanning Calorimetry (DSC) – Instrumentation – Specific Heat Capacity Measurements – Determination of Thermomechanical Parameters.

UNIT II : MICROSCOPIC METHODS

Optical Microscopy: Optical Microscopy Techniques – Bright Field Optical Microscopy – Dark Field Optical Microscopy – Dispersion Staining Microscopy - Phase Contrast Microscopy – Differential Interference Contrast Microscopy - Fluorescence Microscopy - Confocal Microscopy - - Digital Holographic Microscopy - Oil Immersion Objectives - Quantitative Metallography - Image Analyzer.

UNIT III : ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY

SEM, EDAX, EPMA, TEM: working principle and Instrumentation – Sample Preparation –Data Collection, Processing and Analysis- Scanning tunneling microscopy (STEM) - Atomic force microscopy (AFM) - Scanning New Field Optical Microscopy.

UNIT IV : ELECTRICAL METHODS AND OPTICAL CHARACTERISATION

Two Probe And Four Probe Methods- Van Der PauwMethod – Hall Probe and Measurement – Scattering Mechanism – C-V Characteristics – Schottky Barrier Capacitance – Impurity Concentration – Electrochemical C-V Profiling – Limitations. Photoluminescence – Light – Matter Interaction – Instrumentation – Electroluminescence – Instrumentation – Applications.

UNIT V :X-RAY AND SPECTROSCOPIC METHODS

Principles and Instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) – Rutherford Back Scattering (RBS) analysis-application - Powder diffraction - Powder diffractometer -Interpretation of Diffraction Patterns - Indexing - Phase Identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990.
2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979.
3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991

4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002.
5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).

REFERENCE BOOKS

1. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001).
2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).Volumes 49 – 51, (2009).
4. Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, (1986).
5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993)

WEB SOURCES

1. https://cac.annauniv.edu/uddetails/udpg_2015/77.%20Mat%20Sci(AC).pdf
2. http://www.digimat.in/nptel/courses/video/113106034/L11.html
3. https://nptel.ac.in/courses/104106122
4. https://nptel.ac.in/courses/118104008
5. https://www.sciencedirect.com/journal/materials-characterization

COURSE OUTCOMES (CO):

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

CO1	Describe the TGA, DTA, DSC and TMA thermal analysis techniques and make interpretation of the results.	**K1, K3**
CO2	The concept of image formation in Optical microscope, developments in other specialized microscopes and their applications.	**K2**
CO3	The working principle and operation of SEM, TEM, STM and AFM.	**K2, K3**
CO4	Understood Hall measurement, four –probe resistivity measurement, C-V, I-V, Electrochemical, Photoluminescence and electroluminescence experimental techniques with necessary theory.	**K3, K4**
CO5	The theory and experimental procedure for x- ray diffraction and some important spectroscopic techniques and their applications.	**K4,K5**

K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	2	2	2	3
CO2	3	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	2	3	2	2	2	2
CO4	2	2	2	3	2	3	2	2	2	2
CO5	2	2	2	2	2	2	3	2	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	2	2	2	2	2	3
CO2	3	3	3	2	2	2	2	2	2	2
CO3	3	3	2	2	2	3	2	2	2	2
CO4	2	2	2	3	2	3	2	2	2	2
CO5	2	2	2	2	2	2	3	2	2	2

Program:M.Sc.Physics				
Elective		**CourseCode:**21PPH3E01		**Course Title:** MEDICAL PHYSICS
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To understand the major applications of Physics to Medicine
2. To study the aid of different medical devices such as X-ray machines, gamma camera, accelerator and nuclear magnetic resonance.
3. To outline the principles of Physics of different medical radiation devices and their modern advances, especially in medical radiation therapy and different applications in medical physics.
4. To introduce the ideas of Radiography.
5. To form a good base for further studies like research.

UNIT I: X-RAYS AND TRANSDUCERS

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – Photo Electric Transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– Piezoelectric Transducer

UNIT II:BLOOD PRESSURE MEASUREMENTS

Introduction –sphygmomanometer – Measurement of heart rate – Basic principles of Electrocardiogram (ECG) –Basic principles of electro-neurography (ENG) – Basic principles of magnetic resonance imaging (MRI).

UNIT III:RADIATION PHYSICS

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness –Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with

Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter

UNIT IV:MEDICAL IMAGING PHYSICS

Radiological Imaging – Radiography – Filters – Grids – Cassette – X-Ray Film – Film processing – Fluoroscopy – Computed Tomography Scanner – Principal Function – Display – Mammography – Ultrasound Imaging – Magnetic Resonance Imaging – Thyroid Uptake System – Gamma Camera (Only Principle, Function and display)

UNIT V:RADIATION PROTECTION

Principles of Radiation Protection – Protective Materials – Radiation Effects – Somatic – Genetic Stochastic and Deterministic Effect – Personal Monitoring Devices – TLD Film Badge – Pocket Dosimeter

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Dr. K. Thayalan , Basic Radiological Physics, Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi, 2003.
2. Curry, Dowdey and Murry, Christensen's Physics of Diagnostic Radiology: - LippincotWilliams and Wilkins, 1990.
3. FM Khan, Physics of Radiation Therapy, William and Wilkins, 3rd ed, 2003.
4. D. J. Dewhurst, An Introduction to Biomedical Instrumentation, 1st ed, Elsevier Science, 2014.
5. R.S. Khandpur, Hand Book of Biomedical Instrumentations, 1st ed, TMG, New Delhi, 2005.

REFERENCE BOOKS

1. Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
2. Daniel Jirák, FrantišekVítek, Basics of Medical Physics, 1st ed, Charles University, Karolinum Press, 2018

3. Anders Brahme, Comprehensive Biomedical Physics, Volume 1, 1st ed, Elsevier Science, 2014.
4. K. Venkata Ram, Bio-Medical Electronics and Instrumentation, 1st ed, Galgotia Publications, New Delhi, 2001.
5. John R. Cameron and James G. Skofronick, 2009, Medical Physics, John Wiley Interscience Publication, Canada, 2nd edition.

WEB SOURCES

1. https:nptel.ac.in/courses/108/103/108103157/
2. https://www.studocu.com/en/course/university-of-technology-sydney/medical-devices-and-diagnostics/225692
3. https://www.technicalsymposium.com/alllecturenotes_biomed.html
4. https://lecturenotes.in/notes/17929-note-for-biomedical-instrumentation-bi-by-deepraj-adhikary/78
5. https://www.modulight.com/applications-medical/

COURSE OUTCOMES(CO):

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

CO1	Learn the fundamentals, production and applications of X-rays.	**K1**
CO2	Understand the basics of blood pressure measurements. Learn about sphygmomanometer, EGC, ENG and basic principles of MRI.	**K2**
CO3	Apply knowledge on Radiation Physics	**K3**
CO4	Analyze Radiological imaging and filters	**K4**
CO5	Assess the principles of radiation protection	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) **and** LOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	3	3	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3

CO5	3	3	3	1	1	2	3	3	1	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	1	2	3	3	1	3
CO2	3	3	3	2	1	2	3	3	1	3
CO3	3	3	3	2	1	2	3	3	1	3
CO4	3	3	3	2	1	2	3	3	1	3
CO5	3	3	3	1	1	2	3	3	1	3

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** SOLID WASTE MANAGEMENT	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To gain basic knowledge in solid waste management procedures
2. To gain industry exposure and be equipped to take up a job.
3. To harness entrepreneurial skills.
4. To analyze the status of solid waste management in the nearby areas.
5. To sensitize the importance of healthy practices in waste managements

UNIT I:SOLID WASTE MANAGEMENT

Introduction - Definition of solid waste - Types – Hazardous Waste: Resource conservation and Renewal act – Hazardous Waste: Municipal Solid waste and non-municipal solid waste.

UNIT II:SOLID WASTE CHARACTERISTICS

Solid Waste Characteristics: Physical and chemical characteristics - SWM hierarchy - factors affecting SW generation

UNIT III:TOOLS AND EQUIPMENT

Tools and equipment - Transportation - Disposal techniques - Composting and land filling technique

UNIT IV:ECONOMIC DEVELOPMENT

SWM for economic development and environmental protectionLinking SWM and climate change and marine litter.

UNIT V:INDUSTRIAL VISIT

SWM Industrial visit – Data Collection and Analysis - Presentation

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Handbook of Solid Waste Management /Second Edition, George Tchobanoglous, McGraw Hill (2002).
2. Prospects and Perspectives of Solid Waste Management, Prof. B BHosett, New Age International (P) Ltd (2006).
3. Solid and Hazardous Waste Management, Second Edition, M.N Rao, BS Publications / BSP Books (2020).
4. Integrated Solid Waste Management Engineering Principles and Management, Tchobanoglous, McGraw Hill (2014).
5. Solid Waste Management (SWM), Vasudevan Rajaram, PHI learning private limited, 2016

REFERENCE BOOKS

1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012
2. Solid Waste Management Bhide A. D Indian National Scientific Documentation Centre, New Delhi Edition 1983 ASIN: B0018MZ0C2
3. Solid Waste Techobanoglous George; Kreith, Frank McGraw Hill Publication, New Delhi 2002, ISBN 9780071356237
4. Environmental Studies Manjunath D. L. Pearson Education Publication, New Delhi, 20061SBN-I3: 978-8131709122
5. Solid Waste Management Sasikumar K. PHI learning, New Delhi, 2009 ISBN 8120338693

WEB SOURCES

1. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648
2. https://testbook.com/learn/environmental-engineering-solid-waste-management/
3. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsA-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJ_jxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. https://images.app.goo.gl/tYiW2gUPfS2cxdD28
5. https://amzn.eu/d/5VUSTDI

COURSE OUTCOMES(CO):

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

CO1	Gained knowledge in solid waste management	**K1**
CO2	Equipped to take up related job by gaining industry exposure	**K5**
CO3	Develop entrepreneurial skills	**K3**
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	**K4**
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	2	3	3	3	2	2	2	2	2	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2
CO5	2	3	3	2	2	2	3	3	2	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	2	3	3	3	2	2	2	2	2	3
CO2	2	3	3	2	2	2	3	3	3	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	3	2	2	2	2	3	3	3	3	2

CO5	2	3	3	2	2	2	3	3	2	3

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** SEWAGE AND WASTE WATER TREATMENT AND REUSE	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To gain basic knowledge in sewage and waste water Treatment procedures
2. To gain industry exposure and be equipped to take up job.
3. To harness entrepreneurial skills.
4. To analyze the status of sewage and waste water management in the nearby areas.
5. To sensitize the importance of healthy practices in waste water management.

UNIT I: RECOVERY & REUSE OF WATER

Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - Sedimentation with coagulation - Filtration - Sand Filters - Pressure Filters - horizontal filters - vector control measures in industries - Chemical and Biological methods of vector eradication

UNIT II: DISINFECTION

Disinfection: Introduction to disinfection and sterilization: Disinfectant - UV radiation - Chlorination - Antisepsis - Sterilant - Aseptic and sterile -Bacteriostatic and Bactericidal - factors affecting disinfection.

UNIT III: CHEMICAL DISINFECTION

Chemical Disinfection: Introduction - Theory of Chemical Disinfection - Chlorination Other Chemical Methods - Chemical Disinfection Treatments Requiring - Electricity - Coagulation/Flocculation Agents as Pretreatment - Disinfection By-Products(DBPs)

UNIT IV: PHYSICAL DISINFECTION

Physical Disinfection: Introduction - Ultraviolet Radiation - Solar Disinfection - Heat Treatment - Filtration Methods - Distillation - Electrochemical Oxidation Water Disinfection by Microwave Heating.

UNIT V: INDUSTRIAL VISIT

Industrial visit – data collection and analysis - presentation

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Drinking water and disinfection technique, Anirudhha Balachandra. CRC press (2013)
2. Design of Water and Wastewater Treatment Systems (CV-424/434), Shashi Bushan, Jain Bros (2015)
3. Integrated Water Resources Management, Sarbhukan M M, CBS PUBLICATION (2013)
4. C.S. Rao, Environmental Pollution Control Engineering, New Age International, 2007
5. S.P. Mahajan, Pollution control in process industries, 27th Ed. Tata McGraw Hill Publishing Company Ltd., 2012.

REFERENCE BOOKS

1. Handbook of Water and Wastewater Treatment Plant Operations, Frank. R Spellman, CRC Press, 2020
2. Wastewater Treatment Technologies, MritunjayChaubey, Wiley, 2021.
3. Metcalf and Eddy, Wastewater Engineering, 4th ed., McGraw Hill Higher Edu., 2002.
4. W. Wesley Eckenfelder, Jr., Industrial Water Pollution Control, 2nd Edn., McGraw Hill Inc., 1989
5. Lancaster, Green Chemistry: An Introductory Text, 2nd edition, RSC publishing, 2010.

WEB SOURCES

1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en
2. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648?
3. .https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-gM0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
5. https://www.amazon.in/Design-Wastewater-Treatment-Systems-CV-424/dp/B00IG2PI6K/ref=asc_df_B00IG2PI6K/?tag=googleshopmob-21&linkCode=df0&hvadid=397013004690&hvpos=&hvnetw=g&hvrand=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi

COURSE OUTCOMES(CO):

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

CO1	Gained knowledge in solid waste management	K1
CO2	Equipped to take up related job by gaining industry exposure	**K5**
CO3	Develop entrepreneurial skills	**K3**
CO4	Will be able to analyze and manage the status of the solid wastes in the nearby areas	**K4**
CO5	Adequately sensitized in managing solid wastes in and around his/her locality	**K5**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	3	2	3	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	2	2	2	2	3	3	3	3	2
CO4	3	2	3	3	2	3	3	3	3	2
CO5	2	2	2	2	3	3	2	2	2	2

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	3	3	2	3	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	2	2	2	2	3	3	3	3	2
CO4	3	2	3	3	2	3	3	3	3	2
CO5	2	2	2	2	3	3	2	2	2	2

Program:M.Sc.Physics				
Elective	**CourseCode:**		**Course Title:** SOLAR ENERGY UTILIZATION	
Semester I/II/III	**Hours/Week** 4	**TotalHours** 60	**Credits** 4	**TotalMarks** 100

Course Objectives

1. To impart fundamental aspects of solar energy utilization.
2. To give adequate exposure to solar energy related industries
3. To harness entrepreneurship skills
4. To understand the different types of solar cells and channelizing them to the different sectors of society
5. To develop an industrialist mindset by utilizing renewable source of energy

UNIT I:HEAT TRANSFER & RADIATION ANALYSIS

Conduction, Convection and Radiation – Solar Radiation at the earth's surface - Determination of solar time – Solar energy measuring instruments.

UNIT II:SOLAR COLLECTORS

Physical principles of conversion of solar radiation into heat flat plate collectors - General characteristics – Focusing collector systems – Thermal performance evaluation of optical loss.

UNIT III:SOLAR HEATERS

Types of solar water heater - Solar heating system – Collectors and storage tanks – Solar ponds – Solar cooling systems.

UNIT IV:SOLAR ENERGY CONVERSION

Photo Voltaic principles – Types of solar cells – Crystalline silicon/amorphous silicon and Thermo - electric conversion - process flow of silicon solar cells- different approaches on the process- texturization, diffusion, Antireflective coatings, metallization.

UNIT V:NANOMATERIALS IN FUEL CELL APPLICATIONS

Use of Nanostructures and Nanomaterials in Fuel Cell Technology - High and Low Temperature Fuel Cells, Cathode and Anode Reactions, Fuel Cell Catalysts, Electrolytes, Ceramic Catalysts. Use of Nano Technology in Hydrogen Production AndStorage.Industrial visit – data collection and analysis - presentation

UNIT VI:PROFESSIONAL COMPONENTS

Expert Lectures, Online Seminars - Webinars on Industrial Interactions/Visits, Competitive Examinations, Employable and Communication Skill Enhancement, Social Accountability and Patriotism

TEXT BOOKS

1. Solar energy utilization -G.D. Rai –Khanna publishers – Delhi 1987.
2. Maheshwar Sharon, Madhuri Sharon, Carbon “Nano forms and Applications”, Mc Graw-Hill, 2010.
3. Soteris A. Kalogirou, „Solar Energy Engineering: Processes and Systems“, Academic Press, London, 2009
4. Tiwari G.N, “Solar Energy – Fundamentals Design, Modelling and applications, Narosa Publishing House, New Delhi, 2002
5. Sukhatme S.P. Solar Energy, Tata McGraw Hill Publishing Company Ltd., New Delhi, 1997.

REFERENCE BOOKS

1. Energy – An Introduction to Physics – R.H.Romer, W.H.Freeman.(1976)
2. Solar energy thermal processes – John A.Drife and William. (1974)
3. John W. Twidell& Anthony D.Weir, 'Renewable Energy Resources,2005
4. John A. Duffie, William A. Beckman, Solar Energy: Thermal Processes, 4th Edition, john Wiley and Sons, 2013
5. Duffie, J.A., Beckman, W.A. , "Solar Energy Thermal Process", John Wiley and Sons,2007.

WEB SOURCES

1. https://pdfs.semanticscholar.org/63a5/a69421b69d2ce9f359bbfc86c63556f9a4fb
2. https://books.google.vg/books?id=l-XHcwZo9XwC&sitesec=buy&source=gbs_vpt_read
3. www.nptel.ac.in/courses/112105051
4. www.freevideolectures.com
5. http://www.e-booksdirectory.com

COURSE OUTCOMES:

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

CO1	Gained knowledge in fundamental aspects of solar energy utilization	K1
CO2	Equipped to take up related job by gaining industry exposure	**K3**
CO3	Develop entrepreneurial skills	**K5**
CO4	Skilled to approach the needy society with different types of solar cells	**K4**
CO5	Gained industrialist mindset by utilizing renewable source of energy	**K2, K3**
K1 - Remember; K2 – Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate;		

MappingofCOswithPOs

Map course outcomes **(CO)** for each course with program outcomes **(PO)** and program specific outcomes **(PSO)** in the 3-point scale of STRONG (3), MEDIUM (2) andLOW (1)**.**

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2
CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	2	3	3	3	2	2	2	3	2
CO2	2	3	2	2	3	3	2	3	2	2

CO3	2	3	2	2	2	2	3	3	3	2
CO4	2	2	2	3	2	3	2	3	3	2
CO5	2	2	3	2	3	3	3	3	3	3