SRI SANKARA ARTS AND SCIENCE COLLEGE

(AUTONOMOUS)

ENATHUR, KANCHIPURAM - 631561

M.Sc., PHYSICS

REGULATION & SYLLABUS

(Effective from the academic year 2022 – 2023)

Choice Based Credit System

SRI SANKARA ARTS AND SCIENCE COLLEGE (AUTONOMOUS)
M.Sc., PHYSICS
(Effective from the academic year 2022 – 2023)

REGULATIONS

1. DURATION OF THE PROGRAM

1.1. Two years (four semesters)

1.2. Each academic year shall be divided into two semesters. The odd semesters shall consist of the period from June to November of each year and the even semesters from December to April of each year.

1.3. There shall be not less than 90 working days for each semester.

2. ELIGIBILITY FOR ADMISSION

Pass in B.Sc. Physics

3. CREDIT REQUIREMENTS AND ELIGIBILITY FOR AWARD OFDEGREE

3.1. A Candidate shall be eligible for the award of the Degree only if he/she has undergone the prescribed course of study in a College affiliated to the University for a period of not less than two academic years and passed the examinations of all the four Semesters prescribed earning a minimum of **91 credits as per the distribution given in Regulation 4** and also fulfilled suchother conditions as have been prescribed thereof.

4. COURSEOFSTUDY, CREDITS AND SCHEME OFEXAMINATION

4.1 The Course Components and Credit Distribution shall consist of the following (Minimum Number of Credits to be obtained):

COURSE COMPONENTS/ NAME OF THE COURSE	NUMBER OF COURSES	CREDITS	CREDITS ALLOTTED
Core subject including Project	**15 Courses**	**4**	**60**
Elective	**5 Courses**	**3**	**15**
Extra Disciplinary	**2 Courses**	**3**	**6**
Soft Skill	**4 Courses**	**2**	**8**
Internship	**1 Course**	**2**	**2**
Total Credits			**91**

4.2. Scheme of Examination

FIRST SEMESTER

S.NO	Course Components	Name of the subject	Ins. Hours	Credit	Exam hours	External Mark	Internal mark	Total
1	Core – 1	Mathematical Physics – I	6	4	3	75	25	100
2	Core – 2	Classical Mechanics	6	4	3	75	25	100
3	Core – 3	Quantum Mechanics-I	6	4	3	75	25	100
4	Core – 4	Advanced Electronics	6	4	3	75	25	100
5	Core - 5	Advanced Physics Experiments Practical - I **	2		**			
6	Core – 6	Advanced Electronics Practical**	2		**			
7	Soft Skill - I	Language and Communication Advanced Level	2	2	3	60	40	100
		TOTAL	**30**	**18**	**3**	**360**	**140**	**500**

****Practical examination at the end of the even semester**

SECOND SEMESTER

S.NO	Course Components	Name of the subject	Ins. Hours	Credit	Exam hours	External Mark	Internal mark	Total
1	Core – 7	Statistical Mechanics	6	4	3	75	25	100
2	Core – 8	Electromagnetic Theory	6	4	3	75	25	100
3	Core	Advanced Physics Experiments Practical - I	2	4	3	60	40	100
4	Core	Advanced Electronics Practical	2	4	3	60	40	100
5	Elective - 1	Mathematical Physics – II	4	3	3	75	25	100
6	Elective - 2	Crystal Growth and Thin Film Physics	4	3	3	75	25	100
7	Extra Disciplinary - I	Nano sciences and Nanotechnology	4	3	3	75	25	100
8	Soft Skill – II	Spoken and Presentation Skills Advanced Level	2	2	3	60	40	100
		TOTAL	**30**	**27**	**3**	**555**	**245**	**800**

THIRD SEMESTER

S.NO	Course Components	Name of the subject	Ins. Hours	Credit	Exam hours	External Mark	Internal mark	Total
1	Core – 09	Quantum Mechanics - II	6	4	3	75	25	100
2	Core – 10	Condensed Matter Physics – I	6	4	3	75	25	100
3	Core – 11	Spectroscopy	6	4	3	75	25	100
4	Core – 12	Advanced Physics Experiments - II Practical**	2		**			
5	Core – 13	Microprocessor - 8085,8086 and Microcontroller 8051 Practical**	2		**			
6	Elective - 3	Microprocessor - 8085,8086 and Microcontroller 8051	3	3	3	75	25	100
7	Extra Disciplinary – II	Solar photovoltaic Cell	3	3	3	75	25	100
8	Soft Skill – III	Life and Managerial Skills Level -II	2	2	3	75	25	100
9		Internship***	-	2	-	80	20	100
		TOTAL	**30**	**22**	**3**	**530**	**170**	**700**

****Practical examination at the end of the even semester**

***** Internship will be carried out during the summer vacation of the first year and marks should be sent to the University by the College and the same will be included in the Third Semester Marks Statement.**

FOURTH SEMESTER

S.NO	Course Components	Name of the subject	Ins. Hours	Credit	Exam hours	External Mark	Internal mark	Total
1	Core – 14	Nuclear and Particle Physics	6	4	3	75	25	100
2	Core	Microprocessor - 8085,8086 and Microcontroller 8051 Practical	2	4	3	60	40	100
3	Core	Advanced Physics Experiments - II	2	4	3	60	40	100
4	Elective - 4	Condensed Matter Physics – II	4	3	3	75	25	100
5	Elective - 5	Laser Physics and Application	4	3	3	75	25	100
6	Core – 15	Project	10	4	3	80	20	100
7	Soft Skill – IV	Computing Skills Advanced	2	2	3	60	40	100
		TOTAL	**30**	**24**	**3**	**485**	**215**	**700**

4.2.1 The Chairperson, Board of Studies consider the available MOOCs and choose the courses to be included under Core, Elective and Soft Skill category and also the number of credits for such courses based on the content and duration of course. The credit for such courses shall be included as part of the Core, Elective and Soft Skill to award the Degree. The number of credits will be decided at the University level for such courses which are relevant to more than one department such as soft skills and elective courses.

4.3. Inclusion of the Massive Open Online Courses (MOOCs) available on SWAYAM, NPTEL and other such portals approved by the University Authorities.

5. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTERS

5.1. Eligibility: Students shall be eligible to go to subsequent semester only if they earn sufficient attendance as prescribed there for by the Syndicate of the University from time to time.

5.2. Attendance: All Students must earn 75% and above of attendance for appearing for the University Examination. (Theory/Practical)

5.3. Condonation of shortage of attendance: If a student fails to earn the minimum attendance (Percentage stipulated), the principal shall condone the shortage of attendance upto a maximum limit of 10% (i.e. between 65% and above and less than 75%) after collecting the prescribed fee of Rs.250/- each for Theory/Practical examination separately, (Theory Rs.250/- Per semester/Per Student: Practical Rs.250/- Per semester/Per Student) towards the condonation of shortage of attendance. Such fees are collected and should be remitted to the University.

5.4. Non-eligibility for condonation of shortage of attendance: Students who have secured less than 65 % but more than 50 %of attendance are NOT ELIGIBLE for condonation of shortage of attendance and such Students will not be permitted to appear for the regular examination, but will be allowed to proceed to the next year/next semester of the program and they may be permitted to take next University examination by paying the prescribed condonation fee of Rs.250/- each for Theory/Practical separately. Such fees shall be remitted to the University. Name of such Students should be forwarded to the University along with their attendance details in the prescribed format

mentioning the category (3 copies). Year wise/Branch wise/Semester wise together with the fees collected from them, so as to enable them to get permission from the University and to attend the Theory/Practical examination subsequently without any difficulty.

5.5. Detained students for want of attendance: Students who have earned less than 50% of attendance shall be permitted to proceed to the next semester and to complete the Program of study. Such Students shall have to repeat the semester, which they have missed by re-joining after completion of final semester of the course, by paying the fee for the break of study as prescribed by the University from time to time.

5.6. Condonation of shortage of attendance for married women students: In respect of married women students undergoing PG programs, the minimum attendance for condonation (Theory/Practical) shall be relaxed and prescribed as 55% instead of 65% if they conceive during their academic career**.** Medical certificate from the Doctor (D.G.O) attached to the Government Hospital and the prescribed fee of Rs.250/-therefor together with the attendance details shall be forwarded to the university to consider the condonation of attendance mentioning the category.

5.7. Zero Percentage(0%) Attendance: The Students, who have earned 0% of attendance, have to repeat the program (by rejoining) without proceeding to succeeding semester and they have to obtain prior permission from the

University immediately to rejoin the program.

5.8. Transfer of Students and Credits: The strength of the credits system is that it permits inter Institutional transfer of students. By providing mobility, it enables individual students to develop their capabilities fully by permitting them to move from one Institution to another in accordance with their aptitude and abilities.

5.8.1. Transfer of Students is permitted from one Institution to another Institution for the same program with same nomenclature.

Provided there is a vacancy in the respective program of Study in the Institution where the transfer is requested.

Provided the Student should have passed all the courses in the Institution from where the transferis requested.

5.8.2. The marks obtained in the courses will be convertedand grades will be assigned as per the University norms.

5.8.3. The transfer students are eligible for classification.

5.8.4. The transfer students are not eligible for Ranking, Prizes and Medals.

5.8.5. Students who want to go to foreign Universities upto two semesters or Project Work with the prior approval of the Departmental/College Committee are allowed to get transfer of credits and marks which will be converted into Grades as per the University norms and are eligible to get CGPA and Classification; they are not eligible for Ranking, Prizes and Medals.

5.9. Students are exempted from attendance requirements for online courses of the University and MOOCs.

6. EXAMINATION AND EVALUATION

6.1. Students shall register their names for the First Semester Examination after the admission in PG programs.

6.2. Students shall be permitted to proceed from the FirstSemester up to Final Semester irrespective of their failure in any of the Semester Examination and they should register for all the arrear courses of earlier semesters along with the current (subsequent)Semester courses.

6.3. Marks for Internal and End semester Examinations

Category	Theory	Practical
Internal Assessment	25	40
End semester (University) Examination	75	60

6.4 Procedure for Awarding Internal Marks

Course	Particulars	Marks
TheoryPapers	Tests (2 out of 3)	10
	Attendance	05
	Seminars	05
	Assignments	05
	TOTAL	**25**

PracticalPapers	Attendance	05
	Test best 2 out of 3	30
	Record	05
	TOTAL	**40**
Project	Internal Marks (Best 2 out of 3 presentations)	20
	Viva-Voce	
	Project Report	80
	TOTAL	**100**

6.5 : (i) Awarding Marks for Attendance (out of 5) Attendance
below 60%= 0 marks,
61 % to 75% = 3 marks,
76 % to 90% = 4 marks and
above 91%= 5marks

Conducting Practical and Project Viva-Voce Examination: By Internal and External Examiners.

Improvement of Internal Assessment Marks.

(a) Should have cleared end-semester University examination with more than 50% Marks in PG.
(b) Should have obtained less than 30% marks inthe Internal Assessment
(c) Should be permitted to improve internal assessment within N+2 years where N is denoted for number of years of the programme.
(d) Chances for reassessment will be open only for 25% of all core courses in Colleges and only one chance per course will be given.
(e) The Principal will decide based on the request for reassessment and designate a faculty member of the department to conduct the examination and evaluation.
(f) The reassessment may be based on a written test / assignment or any other for the entire internal assessment marks.
(g) The candidate must register for examination in the on-line system along with prescribed examination fee for that course.

6.6. Question Paper Pattern for End Semester (UniversityExamination)

PART A

(50 words): Answer 10 questions out of 12 Questions:
10 x 1 Marks = 10 marks

PART B

(200 words): Answer 5 questions out of 7 Questions:
5 x 5 Marks = 25 marks

PART C

(500 words): Answer 4 questions out of 6 Questions:
4 x 10 Marks = 40 marks

Total =75 Marks

6.7. PASSING MINIMUM:

6.7.1. There shall be no Passing Minimum for Internal.

6.7.2. A Student who secures not less than 50 percent marks in the External Written

Examination and the aggregate (i.e., Written Examination Marks and the Internal Assessment Marks put together) respectively of each paper shall be declared to have passed the examination in that subject.

6.7.3. A Student shall be declared to have passed Project Work and Viva-Voce respectively, if he/she secures a minimum 50 percent marks in the Project Work Evaluation and the Viva Voce each.

6.7.4. A Student failing in any subject will be permitted to appear for the examinations again on a subsequent occasion without putting in any additional attendance.

6.7.5. A Student who fails in either Project Work or Viva- Voce shall be permitted to redo the Project Work for evaluation and reappear for the Viva-Voce on a subsequent occasion, if so, recommended by the Examiners.

6.7.6. A Student who successfully completes the Programme and passes the examinations of all the FOUR Semesters prescribed as per the Scheme of Examinations earning 91 CREDITS shall be declared to have qualified for the Degree.

6.8. INSTANT EXAMINATION:

6.8.1. Instant Examinations is conducted for the students who appeared in the final semester examinations of the PG degree courses. Eligible criteria for appearing in the Instant Examinations are as follows:

6.8.2. Eligibility: A Student who is having arrear only in one theory paper in the final semester examination of the PG Degree program is eligible to appear for the Instant Examinations.

6.8.3. Non eligibility for one Arrear Paper: A Student who is having more than one arrear paper in the current appearance of Fourth Semester for PG Examinations is not eligible for appearing for the Instant Examinations.

6.8.4. Non eligibility for Arrear in other semester: Student having arrear in any other semester is not eligible and a candidate who is absent in the current appearance is also not eligible for appearing in the Instant Examinations and those Students who have arrear in Practical/Project are not eligible for the Instant Examinations.

6.8.5. Non eligibility for those completed the program: Students who have completed their Program duration but having arrears are not eligible to appear for Instant Examinations.

6.9. RETOTALLING, REVALUATION AND PHOTOCOPY OF THE ANSWER SCRIPT

6.9.1. Retotaling: PG Students not eligible for applying retotaling of their answer script.

6.9.2. Revaluation: All current batch students who have appeared for their Semester Examinations are alone eligible for Revaluation of their answer scripts; Passed out students are not eligible for Revaluation.

6.9.3. Photocopy of the answer scripts: Students who have applied for revaluation can download their answer scripts from the University Website after fifteen days from the date of publication of the results.

6.9.4. The examination and evaluation for MOOCs will be as per the requirements of the Courses and will be specified at the beginning of the Semester in which such courses are offered and will be notified by the University.

7. CLASSIFICATION OF SUCCESSFUL STUDENTS

7.1 Students who secured not less than 60 % of aggregate marks (Internal + External) in the whole examinationshall be declared to have passed the examination in the **First Class.** All other successful Students shall be declared to have passed in **Second Class**. Candidates who obtain 75% of the marks in the aggregate (Internal+ External) shall be deemed to have passed the examination in **First Class with Distinction**, provided they pass all the examinations (theory papers, practical, project and viva-voce) prescribed for the course in the First appearance.

GRADING SYSTEM

7.1. 1. Minimum Credits to be earned: For TWO-year Program: **Best 91 Credits**: 75 Credits (Core and Elective, 16 Credits (Soft skills and Internship, Non-major Electives and Extra Disciplinary).

7.2. Marks and Grades

7.2.1. The following table shows the marks, grade points, letter grades and classification to indicatethe performance of the student:

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	4.0-4.9	U	Re-appear
ABSENT	0.0	AAA	ABSENT

7.2.2. GPA (Grade Point Average) for a Semester: =

∑iCiGi ÷ ∑iCi

Sum of the multiplication of grade points by the credits of the courses ÷Sum of the credits of the courses in a semester.

7.2.3. CGPA (Cumulative Grade Point Average) For the entire program: = ∑n∑iCniGni ÷ ∑n∑iCni

CGPA =Sum of the multiplication of grade points by the credits of the entire programme ÷

Sum of the credits of the courses of the entire programme

Where,

Ci = Credits earned for course **i** in any semester Gi = Grade Point obtained for course **i** in any semester

n = Semester in which such courses were credited

7.3. Letter Grade and Class

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	
0.0 and above but below 5.0	C +	Re-appear

* The candidates who have passed in the first appearance and within the prescribed semester of the PG Programme are (Major, Allied and Elective courses alone) eligible.

8. RANKING

8.1. Students who pass all the examinations prescribed for the program in the first appearance itself are alone eligible for Ranking / Distinction, provided in the case of candidates who pass all the examinations prescribed for the program with a break in the First Appearance due to the reasons as furnished in the Regulations under **5** are only eligible for Classification.

9. CONCESSIONS FOR DIFFERENTLY-ABLED STUDENTS

9.1. Dyslexia students: For students who are mentally disabled, having disability and mental retardation, who are slow learners, who are mentally impaired having learning disorder and seizure disorder and students who are spastic and cerebral Palsy, the following concessions shall be granted, Provided the request is duly certified by the Medical Board of the Government Hospital/ General Hospital/ District headquarters Hospitals.:

a. One-third of the time of paper as extra time in the examination
b. Leniency in overlooking spelling
c. Amanuensis for all PG programme provided the request is duly certified by the Medical Board of the Government Hospital/ General Hospital/ District headquarters Hospitals and they shall be declared qualified for the degree if they pass the other examinations prescribed for the degree.

9.2. Visually Challenged Students

a. Exempted from paying examination fees.
b. A scribe shall be arranged by the college and the scribe be paid as per the college decision.

10. MAXIMUM PERIOD FOR COMPLETION OF THE ROGRAMS TO QUALIFY FOR A DEGREE

11.1. A Student who for whatever reasons is not able to complete the programme within the normal period (N) or the Minimum duration prescribed for the programme, may be allowed two years period beyond the normal period to clear the backlog to be qualified for the degree. (Time Span = N + 2 years for the completion of programme.)

11.2. In exceptional cases like major accidents and child birth, an extension of one year be considered beyond maximum span of time (Time Span = N + 2 +1 years for the completion of programme).

11.3. Students qualifying during the extended period, shall not be eligible for **RANKING.**

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UNIVERSITY OF MADRAS
SRI SANKARA ARTS AND SCIENCE COLLEGE (AUTONOMOUS)

M.Sc., PHYSICS
(Effective from the academic year 2022 – 2023)

SYLLABUS
FIRST SEMESTER

Core Paper Theory– 1				
Title of the paper	Mathematical Physics – I			
Category of the course	Year	Semester	Credits	L T P E
Core	I	I	4	60 15 - 15
Pre- requisites	Knowledge of Mathematics required			
Objectives of the course	To introduce the student to basics of Mathematical physics			

Course focusing on: Employability

Mathematical Physics-I Course Outcome

CO1: On the completion of this course, the students will acquire a sound knowledge in linear vector space which will be necessary to pursue other areas in physics.

CO2: Introducing concept of operator for vectors, operators for matrix, basic tensors, complex variables and special functions, in order to familiarizing the theorems and basic approach of problem solving from theoretical aspect.

CO3: On the completion of this course, the students will able to model real life phenomena in terms of complex differential equations, integration in the Complex plane, Cauchy's theorem, Cauchy's integral form.

CO4: Demonstrate the utility and limitations of a variety of calculation concepts such as functions in Physics especially in Electronics.

CO5: On completion of this course, students can formulate theoretical function which can model atomic system from different reducible/ irreducible representation of groups.

	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: VECTOR ANALYSIS AND VECTOR SPACES

Introduction to linear vector space in N-dimension-Concept of gradient, divergence and curl - Gauss's divergence theorem, Green's theorem and Stoke's theorem (statement and proof) - Orthogonal curvilinear coordinates - Expression for gradient, divergence, curl and Laplacian in cylindrical and spherical co-ordinates (Theory). Linearly dependent and independent sets of vectors - Inner product (problems)- Schmidt's orthogonalization process-orthonormal basis in vector space, Matrix representation of vector- operators in vector space.

UNIT-II: **MATRICES**

Types of Matrices and their properties, Rank of a Matrix, Characteristic equations of a matrix - Eigenvalue Equations and their solutions, Theorems on Matrices; Diagonalisation and Diagonalisation of different matrices; Cayley-Hamilton's theorem; Problems.

UNIT–III: TENSOR ANALYSIS

Definition of Tensors – Contravariant, covariant and mixed tensors – addition and subtraction of Tensors – Summation convention- Symmetry and Anti-symmetry Tensor – Contraction and direct product – Quotient rule- Pseudo tensors, Levi-Civita Symbol - Dual tensors, irreducible tensors-Metric tensors-Christoffel symbols – Geodesics - Kronecker delta – Application of Tensors in Elasticity and rigid bodies.

UNIT-IV: COMPLEX VARIABLE

Functions of complex variable-Analytic functions-Cauchy- Riemann equations-integration in the Complex plane-Cauchy's theorem- Cauchy's integral formula-Taylor and Laurent expansions- Singular Points- Cauchy's residue theorem - poles - evaluation of residues - evaluation of definite integrals.

UNIT-V: GROUP THEORY

Definition - Subgroups - Cyclic groups and abelian groups - Homomorphism and isomorphism of groups - Classes - Symmetry operations and symmetry elements - Representations of groups - Reducible and irreducible representations - Character tables for simple molecular types (C2v and C3v point group molecules).

BOOKS FOR STUDY

1. Mathematical Physics, B.D. Gupta, Vikas Publishing House Pvt. Ltd, 1995.
2. Mathematical Physics, B. S. Rajput, 20th Edition, Pragati Prakashan, 2008.
3. Mathematical Physics, H.K. Dass and Rama Verma, S. Chand and Company Ltd, 2010.
4. Mathematical physics, P.K. Chattopadhyay, Wiley Eastern Limited, 1990.
5. Introduction to Mathematical physics, Charlie Harper, Prentice Hall of India Pvt. Ltd, 1993.
6. Mathematical Physics, Satya Prakash Sultan Chand and Sons, 2017s.

BOOKS FOR REFERENCE

1. Applied Mathematics for Engineers and Physicists, L.A. Pipes and L.R. Havevill, McGraw Hill Publications Co., 3rd Edition, 1971.
2. Matrices and Tensors in Physics, A.W. Joshi, Wiley Eastern limited, 3rd Edition, 1995.
3. **F.A. Cotton**, 1990, *Chemical Application of Group Theory*, 3rd Edition, John Wiley and Sons, New York.
4. ***M.D.Greenberg,*** *1998, Advanced Engineering Mathematics,* 2nd *Edition*, International Ed., Prentice -Hall International, New Jersey.
5. Mathematical Physics the basics, (2007) S. D Joglekar, Taylor and Franics.
6. Mathematical methods Physicsts, (2012) Arfkan and Weber and Harris, 7th edition, academic press.

NPTEL LINK

1. https://nptel.ac.in/courses/111106148

2. https://nptel.ac.in/courses/111106152

Core Paper Theory– II				
Title of the paper	Classical Mechanics			
Category of the course	Year	Semester	Credits	L T P E
Core	I	I	4	60 15 - 15
Pre- requisites	Knowledge of Mechanics required			
Objectives of the course	To introduce the student to basics of Classical Mechanics			

Course focusing on: Employability

CLASSICAL MECHANICS COURSE OUTCOME

CO1: Understands Lagrangian and Hamiltonian formulation apply the mechanics to analysis the total energy of the dynamical system.

CO2: Gain the knowledge of motion in central force field Small oscillations, transformation to normal coordinates and frequencies of normal modes

CO3: Analyze and solve the theoretical concept of Euler angles, Euler's equations of motion, Torque - free motion, symmetrical top.

CO4: Learn to write Hamilton's principle of least action and Lagrangian and Hamiltonian equations of motion, Poisson brackets, Canonical transformations and their generators.

CO5: Learning of Relativity, Lorentz transformations on space-time, relativistic Lagrangian and Hamiltonian for a free particle and four vectors.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: LAGRANGIAN FORMULATION

Lagrangian formulation: System of particles-constraints and degrees of freedom- generalized coordinates, force and energy-conservation laws-conservations of linear and angular- momenta-symmetric properties-homogeneity and isotropy-D'Alemberts principle of virtual work-Lagrange's equation of motion- nonholonomic systems- applications of Lagrange equations of motion: free particle in space-Atwood's machine.

UNIT –II: HAMILTON'S EQUATION AND CANONICAL TRANSFORMATION

Calculus of variation--principle of least action-Hamilton's principle-Hamilton`s function-Lagrange's equation from Hamilton's principle-Hamilton's principle for nonholonomic system-variational principle- Hamilton's equations from variational principle-Legendre transformation and Hamilton's equation of motion. Cyclic coordinates and conservation theorem- Canonical transformations-Hamilton's canonical equations- Generating functions -examples-Poisson brackets and its properties.

UNIT-III: HAMILTON-JACOBI THEORY AND SMALL OSCILLATIONS

Hamilton-Jacobi equation for Hamilton's principle function-example: Harmonic oscillator problem-Hamilton's characteristic function-Action-angle variable-application to Kepler problem in action angle variables. Eigen value equation- Normal Coordinates-Normal frequencies of vibration-vibrations of linear triatomic molecule.

UNIT-IV: KINEMATICS OF RIGID BODY

Independent coordinates of rigid body-orthogonal transformation-properties of transformation matrix-Euler angle and Euler's theorem-infinitesimal rotation-Coriolis force-angular momentum and kinetic energy of motion about a point-moment of inertia tensor- non-inertial frames and pseudo forces-Euler's equations of motion-torque free motion of a rigid body-heavy symmetrical top.

UNIT-V: CENTRAL FORCE PROBLEM AND THEORY OF RELATIVITY

Reduction to the equivalent one body problem-Centre of mass-Equation of motion and first integral-classification of orbits - Kepler problem: Inverse-Square law of force-Scattering in a central force field - transformation of scattering to laboratory coordinates. Orbits of artificial satellites, Virial theorem – Lorentz transformation, Relativistic Mechanics, Relativistic Lagrangian and Hamiltonian for a particle, Space-time and energy – Momentum 4-vectors.

BOOKS FOR STUDY:

1. **H. Goldstein,** 2002, *Classical Mechanics.* 3rd Edition, C. Poole and J. Safko, Pearson Education, Asia, New Delhi.

2. **G. Aruldhas,** 2015, Classical Mechanics - PHI Learning Private Limited, New Delhi,

3. **S. N. Biswas,** 1998, *Classical Mechanics,* Books and Allied Ltd., Kolkata.

4. **Upadhyaya**, 1999, Classical *Mechanics*, Himalaya Publishing Co., New Delhi.

5. N.C.Rana and P.S.Joag, 2001,Classical *Mechanics*, McGraw Hill Education, New Delhi.

BOOKS FOR REFERENCE:

1. **L. D. Landau** and **E. M. Lifshitz,**1969, *Mechanics,* Pergomon Press, Oxford.

2. **K. R. Symon,** 1971, *Mechanics,* Addison Wesley, London.

3. **J. L. Synge** and **B. A. Griffith,** 1949, *Principles of Classical Mechanics*, McGraw-Hill, New York.

4. **C. R. Mondal**, *Classical Mechanics,* Prentice-Hall of India, New Delhi.

5. **R. Resnick,** 1968, *Introduction to Special Theory of Relativity,* Wiley Eastern, New Delhi.

6. N.C.Rana and P.S.Joag, 2001,Classical *Mechanics*, McGraw Hill Education, New Delhi.

NPTEL LINK:

1. https://nptel.ac.in/courses/115106123
2. https://nptel.ac.in/courses/122106027
3. https://nptel.ac.in/courses/115105098

Core Paper Theory– III				
Title of the paper	Quantum Mechanics-I			
Category of the course	Year	Semester	Credits	L T P E
Core	I	I	4	60 15 - 15
Pre- requisites	Knowledge of Mechanics required			
Objectives of the course	To introduce the student to basics of Quantum Mechanics			

Course focusing on: Employability

QUANTUM MECHANICS-I COURSE OUTCOME

CO1: Provide the knowledge of Interpretation and condition on the wave function and prove the Ehrenfest's theorem.

CO2: By apply the postulates of quantum mechanics to understand the commutation relations and about the uncertainty principle, symmetry and asymmetry wave functions.

CO3: Remember the Schrödinger equation to solve the solvable problem in one dimension like particle in a box, simple harmonic oscillator and barrier penetration.

CO4: Apply the technique of separation of variable to solve the problem in three dimensions such as spherical well, Hydrogen atom and reduction of two body problem for central force.

CO5: Understand the concept of spin; Pauli spin matrices evaluate the addition of angular moment and C.G coefficient.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: FOUNDATIONS OF WAVE MECHANICS

Postulates of wave mechanics -adjoint and self-adjoint operators-degeneracy-eigen value, eigen functions-Hermitian operator- parity - observables - Physical interpretation-expansion coefficients-momentum eigen functions-Uncertainty principle-states with minimum value-commuting observables. Matter waves- Equation of motion- Schrodinger equation for the free particle – physical interpretation of wave function-normalized and orthogonal wave functions-expansion theorem- admissibility conditions- stationary state solution of Schrodinger wave equation - expectation values-probability current density- Ehrenfest theorem.

UNIT-II: STATIONARY STATE AND EIGEN SPECTRUM

Time independent Schrodinger equation - Particle in a square well potential – Bound states – eigen values, eigen functions –Potential barrier – quantum mechanical tunnelling- alpha emission. **Identical Particles and Spin:** Identical Particles – symmetry and antisymmetric wave functions – exchange degeneracy – Spin and statistics: Pauli's exclusion principle-Slater determinant-spin and Pauli's matrices.

UNIT-III: EXACTLY SOLUBLE EIGENVALUE PROBLEMS

One dimensional linear harmonic oscillator – properties of stationary states- abstract operator method - Angular momentum operators- commutation relation- spherical symmetry systems -Particle in a central potential – radial wave function – Hydrogen atom: solution of the radial equation – stationary state wave functions – bound states-the rigid rotator: with free axis-in a fixed plane-3-Dimentional harmonic oscillator.

UNIT-IV: MATRIX FORMULATION OF QUANTUM THEORY, EQUATION OF MOTION & ANGULAR MOMENTUM

Quantum state vectors and functions- Hilbert space-Dirac's Bra-Ket notation-matrix theory of Harmonic oscillator –Equation of motions-Schrodinger, Heisenberg and Interaction representation. **Angular Momentum:** Angular momentum -commutation relation of J_Z, J_+, J_- - Eigen values and matrix representation of J^2, J_Z, J_+, J_- – Spin angular momentum – spin ½, spin-1- addition of angular momenta- Clebsch-Gordan coefficients.

UNIT-V: SCATTERING THEORY

Kinematics of scattering process - wave mechanical picture- Green's functions – Born approximation and its validity –Born series – screend coulombic potential scattering from Born approximation. **Partial wave analysis:** Asymptotic behavior – phase shift – scattering amplitude in terms of phase shifts – differential and total cross sections – optical theorem – low energy scattering – resonant scattering – non-resonant scattering-scattering length and effective range– Ramsauer-Townsend effect – scattering by square well potential.

BOOKS FOR STUDY:

1. A Text book of Quantum Mechanics – G. Aruldhas, Prentice Hall of India Pvt., Ltd., 2002

2. Quantum Mechanics - Satya Prakash, Kedar Nath Ram Nath and Co. Publications, 2018.

3. Quantum Mechanics - Pauling & Wilson, Dover Publications, New Edition, 1985.

4. Principle of Quantum Mechanics - R. Shankar, Plenum US Publication, Second Edition, 1994.
5. Zettili,2016, Quantum Mechanics: Concepts and Applications, 2nd edition, Willey India PVt. Ltd, New Delhi.
6. Introduction to Quantum Mechanics, (2016), David J. Griffiths, 2nd edition, Cambridge India.

BOOKS FOR REFERENCE:

1. Quantum Mechanics – Theory and applications - A. K. Ghatak and Lokanathan, Macmillan India Ltd Publication, Fifth Edition, 2015.
2. Quantum Mechanics - Leonard I. Schiff, McGraw-Hill International Publication, Third Edition, 1968.
3. Quantum Mechanics - V. K. Thankappan, New Age International (P) Ltd. Publication, Second Edition, 2003.
4. Quantum Mechanics - E. Merzbacher, John Wiley Interscience Publications, Third Edition, 2011.
5. Quantum Mechanics (Vol .I) - Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë, John Wiley Interscience Publications, First Edition, 1991.

NPTEL LINK

1. https://nptel.ac.in/courses/115106066
2. https://nptel.ac.in/courses/115101107
3. https://nptel.ac.in/courses/122106034
4. https://nptel.ac.in/courses/115104096
5. https://nptel.ac.in/courses/115103104
6. https://nptel.ac.in/courses/115102023

Core Paper Theory– IV				
Title of the paper	Advanced Electronic			
Category of the course	Year	Semester	Credits	L T P E
Core	I	I	4	60 15 - 15
Pre- requisites	Knowledge of Semiconductor and circuits required			
Objectives of the course	To introduce the student to basics of Advanced Electronic experiments			

Course focusing on: Employability

ADVANCED ELECTRONIC COURSE OUTCOME

CO1: Create electronic systems, from 'building block' to timing in circuits, interfacing in mixed-signal electronic systems, power, and filters.

CO2: Analyze the simple circuits containing active elements such as bipolar and MOS transistors, and Op-amps

CO3: Appreciate the practical limitations of such devices

CO4: Apply links between mathematical concepts to a range of electrical problems

CO5: Student can realize the communications of 8085 with different peripheral devices and its utilizations.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: OPERATIONAL AMPLIFIER

Operational Amplifier- CMRR-Slew rate -Instrumentation amplifier – V to I and I to V converter – Op-amp stages- Equivalent circuits - Sample and Hold circuits. Applications of Op-Amp: Inverting, Non- inverting Amplifiers- circuits – Adder- Subtractor- Differentiator-Integrator.

UNIT-II: APPLICATIONS OF OPERATIONAL AMPLIFIER

Electronic analog Computation solving simultaneous and differential equation –. Schmitt Trigger – Triangular wave generator – Sine wave generator – Active filters: Low, High and Band pass first and second order Butterworth filters – wide and narrow band reject filters

UNIT-III: TIMER CIRCUIT AND DATA COUNTERS

Timer 555: Internal architecture and working – Schmitt trigger – Astable and monostable multivibrators – Phase Locked loop. Binary weighted and R/2R ladder DAC – Accuracy and resolution – Dual slope DAC – ADC – Simultaneous conversion – Counter method – Successive approximation.

UNIT-IV: SEMICONDUCTOR MEMORIES

Classification of memories and sequential memory – Static Shift Register and Dynamic Shift Register, ROM, PROM and EPROM principle and operation Read & Write memory - Static RAM, dynamic RAM, Content Addressable Memory - principle, block diagram and operation. Programmable Logic Array (PLA) - Operation, Internal Architecture. Charge Couple Device (CCD) - Principle, Construction, Working and Data transfer mechanism.

UNIT-V: A/D AND D/A CONVERTER

Sampling theorem-Time division multiplexing – Quantization – DAC- Weighted resistor method – Binary Ladder network – ADC – successive approximation, Dual slope and Counter method – Voltage to Frequency conversion and Voltage to Time conversion.

BOOKS FOR STUDY:

1. Modern Digital Electronics – R.P. Jain – Tata McGraw Hill, 2007.
2. Op-Amp and linear integrated circuits - R.F. Coughlin and F.F, Driscol, Prentice Hall of India, New Delhi, 1996.
3. Op-Amps and Linear Integrated Circits -Ramakant A. Gayakwad, Pearson Education: Fourth Edition, 2015.
4. Electronic Principles- Albert Malvino, David J Bates, 7 th Edition, McGraw Hill, 2007.
5. Principles of Electronics- V.K.Mehta, 6th Revised Edition, S.Chand and Company, 2001.

BOOKS FOR REFERENCE:

1. Electronic Devices and Circuits- David A. Bell, 4th Edition, Prentice Hall. 2007.
2. B.Ram, *2012, Fundamentals of Microprocessors and Microcontrollers*, Dhanpat Rai Publications, New Delhi.
3. V.Vijayendran, 2009, *Fundamentals of Microprocessor8085–Architecture, Programming and Interfacing*, Viswanathan, S. Printers & Publishers Pvt Ltd, Chennai.
4. D. Roy Choudhury Shail B. Jain, 2011, *Linear Integrated Circuits*, New Age international publishers, New Delhi.
5. **R. L. Boylestad** and **L. Nashelsky**, 2012, *Electronic Devices and Circuit Theory*, 8th Edition, Pearson Education, India

NPTEL LINK:

1. https://nptel.ac.in/courses/118104008

2. https://nptel.ac.in/courses/118102003

Core Paper (Practical)– I				
Title of the paper	**ADVANCED PHYSICS EXPERIMENTS – I**			
Category of the course	Year	Semester	Credits	L T P E
Core	I	I	4	- - 45 15

Course focusing on: Skill Development

ADVANCED PHYSICS EXPERIMENTS – I COURSE OUTCOME

CO-1. A student will study about in practical on Advanced Physics experiments

CO-2. Will come to know practically about the Semiconductor, Hydrogen spectrum and diffraction pattern

CO-3. Students study in detail about the laser light sources.

LIST OF EXPERIMENTS

01. Cornu's Method – Young's modulus and Poisson's ratio by Elliptic fringes.
02. Stefan's constant.
03. Bang gap energy – Thermistor / Semiconductor.
04. Hydrogen spectrum – Rydberg's constant.
05. Thickness of the enamel coating on a wire – by diffraction.
06. Coefficient of linear expansion – Air wedge method.
07. Permittivity of a liquid using an RFO.
08. L-G plate.
09. Lasers: Study of laser beam parameters.
10. Arc spectrum: Copper
11. Cornu's Method – Young's modulus and Poisson's ratio by Hyperbolic fringes.
12. Determination of strain hardening coefficient.
13. Viscosity of liquid – Meyer's disc.
14. F. P. Etalon using spectrometer.
15. Solar constant.
16. Solar spectrum – Hartmann's formula.
17. Arc spectrum – Iron.
18. Edser and Butler fringes – Thickness of air film.
19. B-H loop using Anchor ring.
20. Specific charge of an electron – Thomson's method

BOOKS FOR REFERENCE:

D. Chattopadhyay, **P. C. Rakshit**, and **B. Saha**, 2002, *An Advanced Course in Practical Physics,* 6th Edition Books and Allied, Kolkata.

Core Paper (Practical)– II				
Title of the paper	**ADVANCED ELECTRONIC EXPERIMENTS-I**			
Category of the course	Year	Semester	Credits	L T P E
Core	I	I	4	- - 45 15

Course focusing on: Skill Development

ADVANCED ELECTRONIC EXPERIMENTS-I COURSE OUTCOME

CO-1. A student will study about in practical on Advanced Electronic experiments

CO-2. Will come to know practically about the Semiconductor, IC 741 and IC 555

CO-3. Students study in detail about the UJT, FET and counters, Flip flops and Multivibrator.

LIST OF EXPERIMENTS

01. Design of UJT relaxation oscillator for a frequency – Generation of positive and negative triggering pulses.
02. Solving simultaneous equations - IC 741 / IC LM324.
03. Op-Amp. – Active filters: Low pass, High pass and Band pass filters (Second Order).
04. Construction of square wave generator using IC 555 – study of VCO.
05. Design of Schmitt trigger circuit using IC 555 for a given hysteresis – Application as squarer.
06. Construction of pulse generator using the IC 555 – Application as frequency divider.
07. IC 7476 / IC 7473 – Study of binary up / down counters
08. IC 7476 – Shift register, ring counter and Johnson counter (twisted ring counter).
09. FET CS amplifier – Design, Frequency response, input impedance, output impedance
10. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
11. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
12. Design of a Schmitt trigger circuit using IC 741 for a given hysteresis – application of squarer.
13. Design of a square wave oscillator using IC 741 – Triangular wave oscillator.
14. Construction of pulse generator using the IC 741 – application as frequency divider.
15. OP-Amp. – 4 bit Digital to Analog converter [R / 2R ladder network].
16. Study of R-S, clocked R-S and D-flip flops using NAND / NOR gates.
17. Study of J-K, D and T flip flops using IC 7476 / 7473.
18. Arithmetic operations using IC 7483 – 4 bit binary addition and subtraction.

19. IC 7490 as a scalar and display using IC 7447.
20. OP-Amp Astable multivibrator using IC-741 (Square wave generator).

BOOKS FOR REFERENCE:

D. Chattopadhyay, **P. C. Rakshit**, and **B. Saha**, 2002, *An Advanced Course in Practical Physics*, 6th Edition Books and Allied, Kolkata

Core Paper Theory– V				
Title of the paper	Statistical Mechanics			
Category of the course	Year	Semester	Credits	L T P E
Core	I	II	4	60 15 - 15
Pre- requisites	Knowledge of heat and thermodynamics			
Objectives of the course	To introduce the student to basics of Statistical Mechanics			

Course focusing on: Employability

STATISTICAL MECHANICS COURSE OUTCOME

CO1: This course explains the concept of phase transformation.

CO2: This course established the concepts of statistical mechanics and thermodynamics.

CO3: This course gives the basic knowledge of canonical and gran canonical ensembles.

CO4: After this course the students can able to implement concepts of classical and quantum statistics.

CO5: This course gives the analytical idea of real gas Ising model and fluctuation.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT- I: THERMODYNAMICS, MICROSTATES AND MACROSTATES

Basic postulates of thermodynamics – Phase space and ensembles – Fundamental relations and definition of intensive variables – Intensive variables in the entropic formulation – Equations of state – Euler relation, densities - Gibbs-Duhem relation for entropy - Thermodynamic potentials– Maxwell relations – Thermodynamic relations – Microstates and macrostates – Ideal gas – Microstate and macrostate in classical systems – Microstate and macrostate in quantum systems – Density of states and volume occupied by a quantum state

UNIT-II: TYPES OF ENSEMBLES

Microcanonical distribution function – Two level system in microcanonical ensemble – Gibbs paradox and correct formula for entropy – The canonical distribution function – Contact with thermodynamics - Partition function and free energy of an ideal gas –The grand partition function – Relation between grand canonical and canonical partition functions – One-orbital partition function

UNIT-III: BOSE-EINSTEIN, FERMI-DIRAC AND MAXWELL-BOLTZMANN DISTRIBUTIONS

Bose-Einstein and Fermi-Dirac distributions – Thermodynamic quantities – Non-interacting Bose gas and thermodynamic relations – Chemical potential of bosons – The principle of detailed balance – Number density of photons and Bose condensation - Thermodynamic relations for non-interacting Fermi gas – Fermi gas at zero and low temperature – Fermi energy and Fermi momentum - Maxwell-Boltzmann distribution law for microstates in a classical gas - Physical interpretation of the classical limit – Fluctuations in different ensembles

UNIT-IV: TRANSPORT AND NON-EQUILIBRIUM PROCESSES

Derivation of Boltzmann transport equation for change of states without and with collisions – Boltzmann equation for quantum statistics – Equilibrium distribution in Boltzmann equation – Transport processes; One speed and one dimension - All speeds and all directions - Conserved properties - Distribution of molecular velocities – Equipartition and Virial theorems – Random walk - Brownian motion - Non-equilibrium process; Joule-Thompson process - Free expansion and mixing - Thermal conduction - The heat equation.

UNIT-V: HEAT CAPACITIES, ISING MODEL AND PHASE TRANSITIONS

Heat capacities of heteronuclear diatomic gas – Heat capacities of homonuclear diatomic gas – Heat capacity of Bose gas –One-dimensional Ising model and its solution by variational method – Exact solution for one-dimensional Ising model - Phase transitions and criterion for phase transitions – Classification of phase transitions by order and by symmetry – Phase diagrams for pure systems – Clausius-Clapeyron equation – Gibbs phase rule

BOOKS FOR STUDY:

1. Fundamentals of Statistical and Thermal Physics Paperback, Reif, Sarat Book Distributors (2010).
2. Fundamentals of Statistical Mechanics Paperback, B.B. Laud , New Age International Private Limited, Jan 2012.
3. Elementary Statistical Physics, C.Kittel, John Wiley & Sons, 2004.
4. Statistical and Thermal Physics, F.Reif, McGraw Hill, Fifth Edition, 2010.
5. Statistical Mechanics, Gupta & Kumar, 20th Edition, Pragati Prakashan, Meerut, 2003.

BOOKS FOR REFERENCE:

1. Statistical Mechanics, B.K.Agarwal and M.Eisner, Second Edition, New Age International Private Limited, Delhi, 2016.
2. Statistical Mechanics and Properties of Matter (Theory and Applications), E.S.R.Gopal, Ellis Horwood Ltd, 1974.
3. **K. Huang,** 2009, *StatisticalMechanics,2nd Edition,* Taylor and Francis, London.
4. **L. D. Landau and E. M. Lifshitz**, 1996, *Statistical Physics*, *3rd Edition,* Butterworth-Heinemann, UK.
5. R.K.Pathria, 2011, *Statistical Mechanics*,3rd edition, Academic Press, USA.

NPTEL LINK

1. https://nptel.ac.in/courses/115106126
2. https://nptel.ac.in/courses/115103113
3. https://nptel.ac.in/courses/104101125
4. https://nptel.ac.in/courses/115103028

Core Paper Theory– VI				
Title of the paper	Electromagnetic Theory			
Category of the course	Year	Semester	Credits	L T P E
Core	I	II	4	60 15 - 15
Pre- requisites	Knowledge of Electricity and magnetism			
Objectives of the course	To introduce the student to basics of Maxwell's equations and Electromagnetic theory			

Course focusing on: Employability

ELECTROMAGNETIC THEORY COURSE OUTCOME

CO1: On the completion of this course, the students can establish fundamental of electrostatics or manipulate electrostatic forces based on technological advancement.

CO2: On completion of this course, student can demonstrate effect of magnetic field on the electric charges from theoretical point of view.

CO3: The course provides the complete knowledge of electromagnetic forces demonstrated from theoretical view point.

CO4: On completion of the course, the student can validate the wave propagation applies in communication technologies or radio wave technology.

CO5: Up on completing the course, student understands the concept of plasma and can manipulate the dipole on different conditions based on technology required.

	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT -I: ELECTROSTATICS

Coulomb's law; the electric field – line, flux and Gauss's Law in differential form - the electrostatic potential; conductors and insulators; Gauss's law - application of Gauss's law – curl of E - Poisson's equation; Laplace's equation – work and energy in electrostatics – energy of a point charge distribution – energy of continuous charge distribution – induced charges – capacitors. Potentials: Multipole Expansion – solution to Laplace equation in one dimension and two dimensions and three dimensions using boundary conditions-Dielectrics – induced dipoles – Gauss's Law in the presence of dielectrics.

UNIT- II: MAGNETOSTATICS

Lorentz force – magnetic fields – magnetic forces – currents – Biot-Savart Law – divergence and curl of B – Ampere's Law – Electromagnetic induction - comparison of magnetostatics and electrostatics – Magnetic vector potential. Magnetization: effect of magnetic field on atomic orbit – Ampere's Law in magnetized materials – ferromagnetism.

UNIT-III: **ELECTROMOTIVE FORCE**

Ohm's Law – electromotive force – motional emf – Faraday's Law – induced electric field – inductance – energy in magnetic field – Maxwell's equation in free space and linear isotropic media – continuity equation – Poynting theorem-Maxwell's equations in relativistic form.

Electromagnetic waves in vacuum: Waves in one dimension – wave equation – sinusoidal waves – reflection and transmission – Polarization.

UNIT-IV: ELECTROMAGNETIC WAVES

The wave equation for E and B – Monochromatic Plan waves – energy and momentum in electromagnetic waves – electromagnetic waves in matters –TE waves in rectangular wave guides – the co-axial transmission line. Potentials: potentials and fields – scalar and vector potentials – Gauge transformation – Coulomb Gauge and Lorentz Gauge – Lorentz force law in potential form.

UNIT-V: APPLICATION OF ELECTROMAGNETIC WAVES

Boundary conditions at the surface of discontinuity – Reflection and refraction of E.M waves at the interface of non – Conducting media – Kinematic and dynamic properties – Fresnel's equation – Electric field vector 'E' parallel to the plane of incidence and perpendicular to the plane of incidence – Reflection and transmission co-efficient at the interface between two non–Conducting media – Brewster's law and degree of polarization – Total internal reflection - Oscillating electric dipole - Radiation from an oscillating electric dipole.

BOOK FOR STUDY:

1. Introduction to Electrodynamics – David J. Griffiths, 4th Edition, Pearson, 2016.
2. Electromagnetic Theory and Electrodynamics, Sathya Prakash, Kedar Nath Ram Nath and Co, 2017.
3. Electromagnetics, B.B Laud, Wiley Eastern Company, 2000.
4. Fundamentals of Electromagnetic, Wazed Miah, Tata Mc Graw Hill, 1980.
5. Basic Electromagnetics with Application, Narayana Rao, (EEE) Prentice Hall, 1997.

BOOKS FOR REFERENCE:

1. Fundamentals of Electromagnetic Theory, Third edition, Narosa Publishing House, New Delhi – John R. Reitz, Frederick J Milford and Robert W. Christy, 1998.
2. Classical Electrodynamics – J.D. Jackson, II Edition, Wiley Eastern Limited, 1993.
3. Electromagnetic – B B Laud, New age international Pvt Ltd Publishers.
4. J. D. Kraus and D. A. Fleisch, 2010, *Electromagnetics with Applications,* 5th Edition, WCB Mc Graw-Hill, New York.
5. B.Chakraborty,2002,*Principles of Electrodynamics*, Books and Allied, Kolkata

NPTEL LINK

1. https://nptel.ac.in/courses/115104088

2. https://nptel.ac.in/courses/108104087

Elective Paper– I				
Title of the paper	Mathematical Physics-II			
Category of the course	Year	Semester	Credits	L T P E
Elective	I	II	3	45 - - 15
Pre- requisites	Knowledge of Mathematics required			
Objectives of the course	To introduce the student to basics of Mathematical physics			

Course focusing on: Entrepreneurship

Mathematical Physics-II Course Outcome

CO1: On the completion of this course, the students will acquire a sound knowledge in linear vector space which will be necessary to pursue other areas in physics.

CO2: Introducing concept of operator for vectors, operators for matrix, basic tensors, complex variables and special functions, in order to familiarizing the theorems and basic approach of problem solving from theoretical aspect.

CO3: On the completion of this course, the students will able to model real life phenomena in terms of differential equations.

CO4: Demonstrate the utility and limitations of a variety of calculation concepts such as Fourier series, differential equation and Laplace transformation to periodic functions in Physics especially in Electronics.

CO5: On completion of this course, students can formulate theoretical function which can integral transformation.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: DIFFERENTIAL EQUATIONS

Homogeneous linear equations of second order with constant coefficients and their solutions – ordinary second order differential with variable coefficients and their solution by power series and Frobenius methods – extended power series method for indicial equations.

UNIT-II: SPECIAL FUNCTIONS – I

Gamma and Beta function- Legendre's differential equation: Legendre polynomials - Generating functions - Recurrence relation - Rodrigue's formula - Orthogonality; Bessel's differential equation: Bessel polynomials - Generating functions - Recurrence relation - Rodrigue's formula – Orthogonality.

UNIT-III: SPECIAL FUNCTIONS – II

Hermite differential equation – Generating functions – Hermite polynomials - Recurrence relations – Rodrigue's formula - Orthogonality: Laguerre differential equations – Generating functions - Laguerre polynomials - Recurrence relation - Rodrigue's formula – Orthogonality.

UNIT-IV: PARTIAL DIFFERENTIAL EQUATIONS

Solution of Laplace Differential Equation – Two-dimensional flow of heat in cartesian and cylindrical co-ordinates. Solution of heat flow equation in one dimension - Solution of wave equation - Transvers e vibrations of a stretched string (Theory).

UNIT - V: INTEGRAL TRANSFORMS

Fourier transforms - cosine and sine transforms - Linearity theorem - Parseval's theorem - solution of differential equation. Laplace transforms - Definition - Linearity, shifting and change of scale properties. Inverse Laplace transforms – Definition - Problems - Solution of differential equation (problems using the above methods).

BOOKS FOR STUDY:

1. Mathematical Physics, B.D. Gupta, Vikas Publishing, 1995.

2. Mathematical Physics, B.S. Rajput, 20th Edition, Pragati Prakashan, 2008.

3. Mathematical Physics, H.K. Dass and Rama Verma, Chand and Company Ltd, 2010.

4. Mathematical physics, P.K. Chattopadhyay, Wiley Eastern Limited, 1990.

5. Introduction to Mathematical Physics, Charlie Harper, Prentice Hall of India Pvt. Ltd, 1993.

6. Mathematical methods in classical and Quantum Physics, (1998), Tulsai and Satish K Sharma, Universities Press.

7. Mathematical Physics the basics, (2007) S. D Joglekar, Taylor and Franics.

8. Mathematical methods Physicsts, (2012) Arfkan and Weber and Harris, 7th edition, academic press.

BOOKS FOR REFERENCE

1. Applied Mathematics for Engineers and Physicists, L.A. Pipes and L.R. Havevill, 3rd Edition, McGraw Hill, 1971.

2. Theory and problems of Laplace Transforms, Murray R. Spigel, International edition, McGraw Hill, 1986.

3. C.R. Wylieand L.C.Barrett,1995,*Advanced Engineering Mathematics*, 6th Edition, International Edition, McGraw-Hill, New York.

4. W.W.Bell, 2004, *Special Functions for Scientists and Engineers*, Dover Publications, New York.

5. M. A. Abramowitzand I.Stegun (Editors),1972, *Handbook of Mathematical Functions* Dover Publications, New York.

NPTEL LINK

1. https://nptel.ac.in/courses/111106148

2. https://nptel.ac.in/courses/111106152

Elective Paper– II				
Title of the paper	Crystal Growth and Thin Film Physics			
Category of the course	Year	Semester	Credits	L T P E
Elective	I	II	3	45 - - 15
Pre- requisites	Knowledge of crystal system			
Objectives of the course	To introduce the student to basics of Crystal growth and thin film at research level.			

Course focusing on: Entrepreneurship

CRYSTAL GROWTH AND THIN FILM PHYSICS COURSE OUTCOME

CO1: From this course students can able to establish the nucleation kinetic parameters

CO2: This course provides the completeness of theory and concepts of crystal growth.

CO3: This course can help to grow single crystals from solution

CO4: This course can help to growth single crystal from melt growth and vapour growth.

CO5: This course can help to growth single crystal from flux and gel growth.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT I: 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 vapor phase, solutions and melts – Epitaxial growth – Growth mechanism and classification – Kinetics of growth of epitaxial films – Mechanisms and controls for nanostructures in 0 and 1 dimensions.

UNIT II: CRYSTALLIZATION PRINCIPLES AND SOLUTION GROWTH TECHNIQUES

Classes of crystal system – Crystal symmetry – Solvents and solutions – Solubility diagram – Super solubility – Expression for super saturation – Metastable zone and induction 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 VAPOR GROWTH TECHNIQUES

Principle of gel technique – Various types of gel -- Structure and importance of gel – Methods of gel growth and advantages -- Melt technique – Czochralski growth – Floating zone – Bridgeman method – Horizontal gradient freeze – Flux growth – Hydrothermal growth – Vapor-phase growth – Physical vapor deposition – Chemical vapor deposition – Stoichiometry.

UNIT IV: THIN FILM DEPOSITION TECHNIQUES

Vacuum evaporation -- Hertz-Knudsen equation -- Evaporation from a source and film thickness uniformity -- E-beam, Pulsed laser and ion beam deposition- implantation- Glow discharge and plasmas - Mechanisms and yield of sputtering processes – DC, rf, magnetically enhanced, reactive sputtering – Spray pyrolysis – Electro deposition – Sol-gel technique.

UNIT V: CHARACTERIZATION TECHNIQUES

X–ray diffraction – Powder and single crystal – Fourier transform infrared analysis – Elemental dispersive X-ray analysis – Transmission and scanning electron microscopy – UV-vis-NIR spectrometer – Chemical etching – Vickers micro hardness – Basic principles and operations of AFM and STM - X-ray photoelectron spectroscopy for chemical analysis – Ultraviolet Photo emission spectroscopy analysis for work function of the material - Photoluminescence – Thermoluminescence.

BOOKS FOR STUDY:

1. I.V. Markov, Crystal Growth for Beginners: Fundamentals of Nucleation, Crystal Growth and Epitaxy (2004) 2nd edition.
2. P. Santhanaragavan and P. Ramasamy, Crystal Growth Process and Methods (KRU Publications, Kumbakonam, 2001).
3. A. Goswami, Thin Film Fundamentals (New Age, New Delhi, 2008).
4. H.H. Willard, L.L. Meritt, J.A. Dean, F.A. Sette, Instrumental Methods of Analysis (CBS Publishers, New Delhi, 1986).
5. S. Zhang, L. Li and A. Kumar, Materials Characterization Techniques (CRC Press, Bota Racon, 2009).

BOOKS FOR REFERENCE:

1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986).
2. M. Ohring, Materials Science of Thin Films (Academic Press, Boston, 2002) 2nd edition.
3. E. N. Kaufmann, Characterization of Materials, Volume-I (John Wiley, New Jersey, 2012).

4. **P.Ramasamy**and**F.D.Gnanam**, 1983, *UGC Summer School Notes*, Anna University, Chennai.
5. .**J.C.Brice**, 1965, *The Growth of Crystals from Melt*, North Holland Publishing Company, Holland.

EXTRA DISCIPLINARY - I				
Title of the paper	**Nano sciences and Nanotechnology**			
Category of the course	Year	Semester	Credits	L T P E
Extra Disciplinary	I	II	3	45 - - 15
Pre- requisites	Knowledge of materials			
Objectives of the course	To introduce the student to basics of nano materials at research level.			

Course focusing on: Entrepreneurship

NANO SCIENCES AND NANOTECHNOLOGY COURSE OUTCOME

CO1: Students will learn about the fundamentals of NANO scale systems and its physical, chemical and electrical properties

CO2: Students may gain knowledge on the synthesis of NANO materials and their merits

CO3: Provide instrumental skills to study the structure of crystalline materials and phase purity.

CO4: Students would gain perception of characterization techniques, optical and electron transport properties of NANO materials

CO5: provides the broad knowledge of application from energy conversion system like solar cell, fuel cell to energy storage system like battery, capacitors. They would able to expand their knowledge on applications of NANO materials and design of new materials for next generation applications.

	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT – I: INTRODUCTION

Introduction – History of nanotechnology - Classification of nanomaterials: Definition of – Zero, one and two dimension nano structures – Examples - Classification of synthesis methods. Surface energy – Chemical potential as a function of surface curvature – Electrostatic stabilization - Steric stabilization – DLVO theory.

UNIT – II: NANOMATERIALS

Carbon Fullerenes and Nanotubes: Carbon fullerenes, Fullerene derived crystals, Carbon nanotubes. Micro and Mesoporous Materials: Ordered mesoporous structures, Random mesoporous structures, crystalline microporous materials. Core-shell structures: Metal-oxide structures, Metal-polymer structures, Oxide-polymer structures. Organic- Inorganic Hybrids. Intercalation Compounds – Nanocomposites.

UNIT – III: PROPERTIES OF NANOMATERIALS

Physical properties of nanomaterials: Melting points, Specific heat capacity and lattice constants – Mechanical properties – Optical properties:-Surface Plasmon Resonance – Quantum size effects – Electrical property: Surface scattering, charge of electronic structure, Quantum transport, effect of microstructure: Ferroelectrics and dielectrics – Variation of magnetism with size-Super para magnetism-Diluted magnetic semiconductor.

UNIT – IV: SYNTHESIS METHODS

Synthesis of nano materials: Physical vapour deposition - Chemical vapour deposition plasma arching - Sol gel - Ball milling technique - Reverse miceller technique - Electro deposition. Synthesis of Semiconductors: Nanostructures fabrication by physical techniques – Nano lithography – Nanomanipulator.

UNIT – V: CHARACTERIZATION AND APPLICATIONS

In-situ and ex-situ method of characterization-Structural Characterization: X-Ray diffraction – Scanning tunneling Microscopy –SEM- TEM – Chemical Characterization: Optical spectroscopy. Applications: Molecular electronics and MEMS-NEMS Nano electromechanical systems- Colorants and pigments –DNA chips – DNA array devices – Drug delivery systems.

BOOKS FOR REFERENCE:

1. Nanoscale Materials in Chemistry, Kenneth F. Klablunde, John wiley and sons, Inc., 2001.
2. The Essentials, Pradeep T, Nano: Tata MC Graw-Hill publishing company limited, 2007.
3. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer, Chad A. Mirkin, 2004.
4. Nanotechnology, Wilson M, K Kannangara, G. Smilt, M. Simmons and B. Boguse-Overseas Press, 2005.
5. Nanomedicine, Freitas R A, Landes., TX publication, 1996.

BOOKS FOR REFERENCE:

1. Nano Materials, Viswanathan B, Narosa publishing house, 2010.
2. Nanotechnology Principles and Practices by Sulabha K.Kulkarni, Capital publishing company (2007).
3. Introduction to nanotechnology by Charles P.Poole, Frank J. Owens, John Wiley & Sons publication (2003).
4. Structure and properties of solid state materials by B. Viswanathan, 2nd Edition, Alpha Science International,(2006).
5. Nano–The Essentials by T. Pradeep, Tata Mc Graw-Hill publishing company limited (2007).

NPTEL LINK

1. https://nptel.ac.in/courses/118104008

2. https://nptel.ac.in/courses/118102003

Core Paper Theory– VII				
Title of the paper	Quantum Mechanics-II			
Category of the course	Year	Semester	Credits	L T P E
Core	II	III	4	60 15 - 15
Pre- requisites	Knowledge of Different kinds of mechanics			
Objectives of the course	To introduce the student to basics of WKB Approximations and variational methods			

Course focusing on: Employability

QUANTUM MECHANICS –II COURSE OUTCOME

CO1: Gain the knowledge of Hilbert space, Dirac notation, different types of pictures and conservation laws.

CO2: To predict approximation methods (WKB), variational methods and connection formula by applying the principle of quantum mechanics.

CO3: Analysis and predict the properties of system through equation of wave function in time dependent perturbation theory and harmonic perturbation.

CO4: Calculate scattering amplitude, cross section, born approximation and effective range theory for S wave by learning and imply the quantum scattering theory.

CO5: Acquire an extended knowledge about relativistic wave equation like Klein Gordon equation, Dirac equation, gamma matrices and their properties

	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: APPROXIMATION METHODS FOR TIME INDEPENDENT PROBLEMS

Time independent perturbation theory – stationary theory- non-degenerate case: first and second order-Normal Helium atom– Zeeman effect without electron spin – Stark effect in hydrogen molecule - Degenerate case: Energy correction- Stark effect in hydrogen atom.

UNIT-II: APPROXIMATION METHODS FOR TIME DEPENDENT PERTURBATION THEORY

Time dependent Perturbation theory - first order transitions – constant perturbation- transition probability: Fermi Golden Rule –Periodic perturbation –harmonic perturbation – adiabatic and sudden approximation. Semi-classical theory of radiation: Application of the time dependent perturbation theory to semi-classical theory of radiation – Einstein's coefficients – absorption - induced emission- spontaneous emission – Einstein's transition probabilities- dipole transition - selection rules – forbidden transitions.

UNIT-III: THE VARIATIONAL METHOD AND THE WKB METHOD

Variational method: Variational Principle – upper bound states- Application to the ground state of Helium atom and Application to the Hydrogen molecule-WKB approximation - Schrodinger equation-Asymptotic solution-validity of WKB approximation-solution near a turning point – connection formula for penetration barrier – Bohr-Summer field quantization condition- tunneling through a potential barrier.

UNIT–IV: QUANTUM THEORY OF ATOMIC AND MOLECULAR STRUCTURE

Atoms-Central field approximation: Residual electrostatic interaction-spin-orbit interaction- Determination of central field: Thomas Fermi statistical method-Hartree and Hartree - Fock approximations (self-consistent fields) – Atomic structure and Hund's rule. **Molecules** - Born-Oppenheimer approximation – An application: the hydrogen molecule Ion (H_2^+) – Molecular orbital theory: LCAO- Hydrogen molecule.

UNIT-V: RELATIVISTIC QUANTUM MECHANICS & QUANTIZATION OF FIELDS

Schrodinger relativistic equation- Klein-Gordon equation- problems of Klein –Gordon equation-charge and current densities – interaction with electromagnetic field- Hydrogen like atom – non-relativistic limit- Dirac relativistic equation: Dirac Hamiltonian –Dirac matrices-probability density-plane wave solution – Energy eigen value spectrum – spin of Dirac particle – significance of negative eigen states – electron in a magnetic field – spin magnetic moment. **Quantization of the Field:** Definition of a field - Classical Hamiltonian equations for Fields - Field quantization of the non-relativistic Schrodinger equation- Number operators and creation, destruction/ annihilation operators-Commutation and Anticommutation relations- Quantization of Electromagnetic field- Energy and Momentum.

BOOKS FOR STUDY:

1. A Text book of Quantum Mechanics - P. M. Mathews and K. Venkatesan, Tata McGraw – Hill Publications, Second Edition, 2010.
2. Quantum Mechanics - Satya Prakash, Kedar Nath Ram Nath and Co. Publications, 2018.
3. Claude Cohen-Tannoudji, Bernard Diu, Franck Laloë, Quantum Mechanics (Vol. II), Quantum Mechanics (Vol. II), John Wiley Publications, 2008.
4. Quantum Mechanics - E. Merzbacher, John Wiley Interscience Publications, Third Edition, 2011.
5. Fundamental principles of Quantum mechanics with elementary applications - Edwin C. Kemble, Dover Publications, Re Issue Edition, 2005.
6. Principle of Quantum Mechanics - R. Shankar, Plenum US Publication, Second Edition, 1994
7. Introduction to Quantum Mechanics,(2020), David J. Griffiths and Darrell F.Schroeter, Cambridge University press.
8. Relativistic Quantum mechanics, Wave equation (2000) by Walter Greiner and D.A. Bromley, Springer.

BOOKS FOR REFERENCE:

1. Quantum Mechanics V. K. Thankappan, New Age International (P) Ltd. Publication, Second Edition, 2003.
2. Quantum mechanics - Franz Schwabl, Narosa Publications, Fourth Edition, 2007.
3. Molecular Quantum mechanics - P.W.Atkins and R.S. Friedman,), Oxford University Press publication, Fifth Edition, 2010.
4. Quantum Mechanics – Theory and Applications, A. K. Ghatak and Lokanathan, Macmillan India Ltd Publication, Fifth Edition, 2015.
5. Quantum Mechanics - Leonard I. Schiff, McGraw-Hill International Publication, Third Edition, 1968.

NPTEL LINK

1. https://nptel.ac.in/courses/115106066
2. https://nptel.ac.in/courses/115101107
3. https://nptel.ac.in/courses/122106034
4. https://nptel.ac.in/courses/115104096
5. https://nptel.ac.in/courses/115103104
6. https://nptel.ac.in/courses/115102023

Core Paper Theory– VIII				
Title of the paper	Condensed Matter Physics – I			
Category of the course	Year	Semester	Credits	L T P E
Core	II	III	4	60 15 - 15
Pre- requisites	Knowledge of Crystal structure			
Objectives of the course	To introduce the student to basics of Matter and super conductivity			

Course focusing on: Employability

CONDENSED MATTER PHYSICS-I COURSE OUTCOME

CO1: Offer extensive ideas in arrangement of atoms in solids and dynamics of atoms from basic knowledge of crystal systems and symmetries

CO2: course offers skills like to distinguish the concepts of regular lattice to reciprocal lattice and Brillouin zones from band structure point of view.

CO3: student can understand the phonons; estimate the thermal properties, and electrical properties using the free-electron model. Students could know Bloch's theorem and what energy bands are and know the fundamental principles of semiconductors.

CO4: know the fundamentals of dielectric and ferroelectric properties of materials and also can distinguish the basic difference of magnetic materials from Dia, Para, Ferro and Anti-Ferro magnetism.

CO5: Student can understand superconductivity using BCS theory

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-1: CRYSTAL PHYSICS: CRYSTAL STRUCTURE

Lattice representation - Simple symmetry operations - Bravais Lattices, Unit cell, Wigner -Seitz cell - Miller planes and spacing - Characteristics of cubic cells - Structural features of NaCl, CsCl, Diamond, ZnS – Close packing.

Crystal Binding*:* Interactions in inert gas crystals and cohesive energy – Lennard – Jones potential - Interactions in ionic crystals and Madelung energy - Covalent bonding – Heitler – London Theory – Hydrogen bonding – metallic bonding.

UNIT-2: DIFFRACTION OF WAVES AND PARTICLES BY CRYSTALS

X-rays and their generation - Moseley's law – Absorption of X-rays (Classical theory) – Absorption Edge – X-ray diffraction – The Laue equations – Equivalence of Bragg and Laue equations – Interpretation of Bragg equation – Ewald construction - Reciprocal lattice – Reciprocal lattice to SC, BCC and FCC crystals- Importance properties of the Reciprocal lattice – Diffraction Intensity - The Powder method – Powder Diffractometer - The Laue method -The Rotating Crystal method - Neutron Diffraction - Electron diffraction.

UNIT-3: CRYSTAL DEFECTS

Point imperfections – Concentrations of Vacancy, Frenkel and Schottky imperfections – Line Imperfections – Burgers Vector – Presence of dislocation – surface imperfections- Polorans – Excitons. Ordered phases of matter: Translational and orientation order - Kinds of liquid crystalline order - Quasi crystals - Superfluidity.

UNIT-4: LATTICE DYNAMICS

Theory of elastic vibrations in mono and diatomic lattices - Phonons – Dispersion relations - Phonon momentum- phonon confinements.

Heat Capacity - Specific heat capacity of solids – Dulong and Petit's law - Vibrational modes - Einstein model - Density of modes in one and three dimensions - Debye Model of heat capacity.

Anharmonic Effects - Explanation for Thermal expansion, Conductivity and resistivity – Umklapp process.

UNIT-5: THEORY OF ELECTRONS

Energy levels and Fermi-Darac distribution for a free electron gas – Periodic boundary condition and free electron gas in three dimensions – Heat capacity of the electron gas – Ohm's law, Matthiessen's rule – Hall effect and magnetoresistance – Wiedemann – Franz law.

Nearly free electron model and the origin and magnitude of energy gap – Bloch functions - Bloch theorem - Motion of an electron in a periodic potential – Kronig – Penney model - Approximate solution near a zone boundary –Metals, semiconductors and insulators – effective mass – Limitations of K-P model – Tight binding approach - Construction of Fermi surfaces: Reduced and periodic zone schemes of construction- de Haas – van Alphen effect.

BOOKS FOR STUDY:

1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, Wiley India Pvt. Ltd. , New Delhi, 2004.
2. Rita John, Solid State Physics, Tata Mc Graw Hill Publications, 2014.
3. M. A. Wahab, Solid State Physics – Structure and Properties of Materials. Narosa, New Delhi, 1999.
4. J.D. Patterson, B.C. Bailey Solid-State Physics: Introduction to the Theory, Springer Publications, 2007.
5. M. Ali Omar, Elementary Solid-State Physics – Principles and Applications, Pearson, 1999.

BOOKS FOR REFERENCE:

1. J. Blakemore, Solid State Physics, 2nd Edition, W. B. Saunders Co, Philadelphia, 1974.
2. C. M. Kachhava, Solid State Physics, Tata Mcgraw Hill, New Delhi, 1990.
3. N. W. Aschroft and N. D., Mermin, Solid State Physics, Rhinehart and Winton, New York. 1976.
4. M. Tinkham, Introduction to Superconductivity, Tata Mcgraw Hill, New Delhi, 1996.
5. K.K.Chattopadhyay, A.N.Banerjee, Introduction to Nanoscience and Nanotechnolog, PHI Learning private Ltd., Delhi 2014.
6. A. J. Dekker, Electrical Engineering Materials, Prentice Hall of India, 1975.
7. S.O. Pillai, Problems and Solutions in Solid State Physics, New Age international Publishers, New Delhi, 1994.
8. A.K. Bain, P. Chand, Ferroelectrics, Wiley, 2017.
9. Kwan Chi Kao, Dielectric phenomena in solids with emphasis on physical concepts of electronic processes, Elsevier Academic Press, 2004
10. Alexander O. E. Animalu, Intermediate Quantum Theory of Crystalline solids, Prentice Hall of India, New Delhi, 1978.
11. Eleftherios N. Economou, The Physics of Solids – Essentials and Beyond, Springer, 2010.

NPTEL LINK

1. https://nptel.ac.in/courses/115106061

2. https://nptel.ac.in/courses/115103102

3. https://nptel.ac.in/courses/115104109

Core Paper Theory– IX				
Title of the paper	Spectroscopy			
Category of the course	Year	Semester	Credits	L T P E
Core	II	III	4	60 15 - 15
Pre- requisites	Knowledge of Atoms and molecules			
Objectives of the course	To introduce the student to basics of Microwave, IR and Raman spectroscopy			

Course focusing on: Employability

SPECTROSCOPY COURSE OUTCOME

On completion of this course the students can able to

CO1: Utilize the microwave spectroscopy.

CO2: gain the knowledge of normal co-ordinate analysis.

CO3: able to handling the infrared spectroscopy.

CO4: able to handling the instruments of Infra-Red & Raman Spectroscopy.

CO5: Able to handling the instruments NMR and ESR spectroscopy.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: MICROWAVE SPECTROSCOPY

Rotation of Molecules – Rigid Rotor (Diatomic Molecules) – Expression for the Rotational Constant - Intensity of Spectral Lines – Effect of Isotopic Substitution - Molecular Parameters (Bond Length, Bond Angle, Dipole Moment) from Rotation Spectra – Stark effect - Applications to chemical analysis - Techniques and Instrumentation.

UNIT II: INFRARED SPECTROSCOPY

Vibrational energy of a diatomic molecule- Infrared selection rules-Vibrating diatomic molecule-Diatomic vibrating rotator- Vibrations of polyatomic molecules-Fermi resonance-Rotation vibration spectra of polyatomic molecules-Normal modes of vibration in crystal-Interpretation of vibrational spectra-Group frequencies-IR spectrophotometer-Instrumentation-Sample handling techniques-Fourier Transform Infrared spectroscopy-Applications

UNIT III: RAMAN SPECTROSCOPY

Introduction-Theory of Raman Scattering-Rotational Raman spectra-Vibrational Raman spectra-Mutual Exclusion principle-Raman spectrometer-Sample handling techniques-Polarization of Raman scattered light-Structure determination using IR and Raman spectroscopy-Raman investigation of phase transitions-Resonance Raman scattering-Nonlinear Raman phenomena-Preliminaries-Hyper Raman effect-Stimulated Raman scattering-Inverse Raman effect-Coherent Anti-Stokes Raman scattering.

UNIT IV: NUCLEAR MAGNETIC AND ELECTRON SPIN RESONANCE SPECTROSCOPY

Basic principles – Quantum theory of NMR - magnetic resonance – relaxation processes – chemical shifts – spin-spin coupling - Spectra and molecular structure – Fourier Transform NMR –Instrumentation – Applications. Basic principles – Quantum theory - g-factor – Nuclear Interaction and Hyperfine structure – Relaxation effects - Hyperfine interaction – line widths – ESR spectrometer – Instrumentation – applications.

UNIT V: NUCLEAR QUADRUPOLE RESONANCE AND MOSSBAUER SPECTROSCOPY

Basic theory - Nuclear Electric quadrupole interaction – Energy levels – Transition frequency – Excitation and Detection – Effect of magnetic field – Instrumentation – applications. Mossbauer effect - recoilless emission and absorption - hyperfine interaction - chemical isomer shift - magnetic hyperfine and electric quadruple interactions – ` Instrumentation – applications.

BOOKS FOR STUDY

1. Colin N. Banwell, Elaine M. McCash, Fundamentals of Molecular Spectroscopy (Fourth Edition), Tata McGraw-Hill Publishing Company Ltd, 1995.
2. J. D. Graybeal, Molecular Spectroscopy, McGraw-Hill, New York, 1988.
3. Hollas, Michael, Modern Spectroscopy (Fourth Edition) John Wiley, New York, 2004.
4. R. P Straughen, S. Walker, Spectroscopy Vols. I, II and III, Chapman & Hall, London, 1976.
5. **G.Aruldas**, 2007, *Molecular Structure and Spectroscopy,* Prentice Hall of India Pvt. Ltd. NewDelhi.

BOOKS FOR REFERENCE:

1. G. Aruldas, 2001, Molecular Structure and Spectroscopy, Prentice - Hall of India Pvt. Ltd., New Delhi.

2. D.N. Satyanarayana, 2004, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi.
3. **Atta-ur-Rahman,**2012,*Nuclear Magnetic Resonance*, Springer Verlag, Chennai
4. **D. A. Lang, 1977,** *Raman Spectroscopy*, McGraw-Hill International, USA.
5. **RaymondChang,** 1970, *Basic Principles of Spectroscopy,* McGraw-Hill Kogakusha, Tokyo.

NPTEL LINK

1. https://nptel.ac.in/courses/104101099

2. https://nptel.ac.in/courses/104106122

Core Paper (Practical)– III				
Title of the paper	Advanced Electronic Experiments-II			
Category of the course	Year	Semester	Credits	**L T P E**
Core	II	III	3	- - 45 15

Course focusing on: Skill Development

ADVANCED ELECTRONIC EXPERIMENTS-II COURSE OUTCOME

CO-1. A student will study about in practical on Advanced Electronic experiments

CO-2. Will come to know practically about the Michelson interferometer, ultrasonic

CO-3. Students study in detail about the Dielectric measurement and Hall Effect, Fiber optics.

LIST OF EXPERIMENTS

1. Michelson Interferometer – Wavelength, separation of wavelengths.
2. Michelson Interferometer – Thickness of mica sheet.
3. Susceptibility by Guoy's method.
4. Ultrasonics – Compressibility of a liquid.
5. Miscibility measurements using ultrasonic diffraction method.
6. Dielectric measurements in Microwave test bench.
7. Iodine absorption spectra
8. Molecular spectra – AlO band
9. Molecular spectra – CN bands
10. UV-visible spectroscopy – Verification of Beer-Lambert's law and identification of wave-length maxima – Extinction coefficient.
11. GM counter – Characteristics, inverse square law, absorption coefficient.
12. GM counter – Feather's analysis: Range of Beta rays.
13. Hall Effect.
14. Susceptibility by Quincke's method.
15. B-H curve using CRO.

16. Thermal diffusivity of brass.

17. Thermal relaxation of bulb.

18. Conductivity measurement using four probe method.

19. Laser Experiments : (i) Diffraction at straight edge, (ii) Interference of laser beams – Llyods single mirror method, (iii) Interference using an optically plane glass plate, (iv) Diffraction at a straight wire and (v) Diffraction at a circular aperture.
20. Experiments on optical fibres.

BOOKS FOR REFERENCE:

D. Chattopadhyay, **P. C. Rakshit**, and **B. Saha**, 2002, *An Advanced Course in Practical Physics*, 6thEditionBooks and Allied, Kolkata.

Core Paper (Practical)– IV				
Title of the paper	Microprocessor 8085, 8086 and Microcontroller 8051			
Category of the course	Year	Semester	Credits	L T P E
Core	II	III	4	- 15 60 15

Course focusing on: Skill Development

MICROPROCESSOR 8085, 8086 AND MICROCONTROLLER 8051

COURSE OUTCOME

CO-1. A student will study about in practical on Microprocessor 8085
CO-2. Will come to know practically about the Microprocessor 8086
CO-3. Students study in detail about the Microcontroller 8051.

LIST OF EXPERIMENTS

Microprocessor 8085

1. Addition, Subtraction, Multiplication and Division (8 bit numbers)
2. Square and square root of 8 bit number
3. Sum of a set of N data (8 – bit numbers), average of N numbers.
4. Sorting in ascending and descending order. Picking up the smallest and largest number in an array.
5. Clock program – 12 / 24 hours.
6. LED interface – single LED on / off, binary, BCD, ring and Johnson counters.
7. Interfacing of seven segment display.
8. Interfacing R / 2R ladder DAC (IC 741) – Wave form generation.
9. DAC 0800 interface and wave form generation.
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

Microprocessor 8086 Programs using MASM

1. Addition, Subtraction, Multiplication and Division (8 bit numbers)
2. Multibyte addition and subtraction (64 and 128 bit numbers)
3. Square and square root of 8 bit number
4. Sum of a set of N data (8 – bit numbers), average of N numbers.
5. Sorting in ascending and descending order. Picking up the smallest and largest number in an array.
6. Generation of Fibonacci series.

Micro controller 8051

1. Addition, subtraction, multiplication and division of two 8-bit numbers.
2. Sum of a series of 8-bit numbers, average of N numbers.
3. Factorial of number, Fibonacci series of N terms.
4. Sorting in ascending and descending order – Picking up smallest and largest number.
5. LED interface – Binary up/down counter, BCD up/down counter, Ring and twisted ring counter.
6. Interfacing seven segment display.
7. DAC 0800 / 1408 interface and wave form generation.
8. ADC interfacing. Stepper motor interfacing

BOOKS FOR REFERENCE:

D. Chattopadhyay, **P. C. Rakshit**, and **B. Saha**, 2002, *An Advanced Course in Practical Physics*, 6thEditionBooks and Allied, Kolkata.

Elective Paper– III				
Title of the paper	Micrprocessor-8085, 8086 and Microcontroller 8051			
Category of the course	Year	Semester	Credits	L T P E
Elective	II	III	3	45 - - 15
Pre- requisites	Knowledge of Digital Electronic			
Objectives of the course	To introduce the student to basics of Microprocessor and Microcontroller			

Course focusing on: Entrepreneurship

MICRPROCESSOR-8085, 8086 AND MICROCONTROLLER 8051

COURSE OUTCOME

On completion of this course, the students can

CO1: Study the internal architecture and organization of the Microprocessor 8086, and Microcontroller 8051.

CO2: learn assembly language programming for arithmetic operations.

CO3: Acquire the knowledge of Memory interfacing, and different Data transfer schemes, mainly for interfacing peripheral I/O devices.

CO4: Design the microprocessor and microcontroller-based systems particularly for the Analog to Digital convert, and 7 segment LED displays.

CO5: Apply the interfacing system in applications. Plan the internal organization of microprocessor and microcontroller.

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT -1: ARCHITECTURE

Architecture of 8085 – registers, flags, ALU, address and data bus, de multiplexing address/data bus – control and status signals – control bus, Programmer's model of 8085 – Pin out diagram – Functions of different pins. Instruction set of 8085 – data transfer, arithmetic, logic, branching and machine control group of instructions – addressing modes – register indirect, direct, immediate and implied addressing modes.

UNIT-2 INTERFACING MEMORY AND INTERRUPTS TO 8085

Memory interfacing – Interfacing 2kx8 ROM and RAM, Timing diagram of 8085 (MOV R_d, R_s). Interfacing input port and output port to 8085 – Programmable peripheral interface 8255 – flashing LEDs. Interrupts in 8085 - hardware and software interrupts -RIM, SIM instructions.

UNIT - 3 8086 ARCHITECTURE

8086 Architecture – Min.Mode, Max.Mode –Addressing Modes – Instruction Set-Constructing Machine Code – Instruction Templates for MOV Instruction– Data Transfer Instructions– Arithmetic, Logic, Shift, rotate instructions-Flag Control instructions- Compare, Jump Instructions– Loop and String instructions

UNIT - 4 8051 MICROCONTROLLER HARDWARE

Introduction – Features of 8051 – 8051 Microcontroller Hardware : Pin-out of 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 - 5 8051 INSTRUCTION SET

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.

BOOKS FOR STUDY

1. A. P. Godse and D. A. Godse, "Microprocessors & its Applications",Technical Publications, Pune,
2. Kenneth Ayala, "The 8051 Microcontroller", Third Edition, Delmar Cengage Learning, 2005.
3. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Second Edition, Pearson Education
4. W.A. Triebel and Avatar Singh, The 8086 /8088 Microprocessors- Programming, Software, Hardware and application, Prentice Hall of India, New Delhi. (Unit 1)

BOOKS FOR REFERENCE

1. Douglas V. Hall : - Microprocessors and Interfacing programming and Hardware (Tata McGraw Hill) (Unit 1)

2. B. Brey, 1995, Intel Microprocessors 8085, 8086/8088, 80186, 80286,80486, 80486, Architecture, Programming and Interfacing

3. Yu – Cheng and Glenn A. Gibson, The 8086 / 8088 family Architecture, Programmingand Design, Prentice-Hall of India.

4. Muhammed Ali Mazidi and Janice Gillespie Mazidi, 2004, The 8051 Microcontrollerand Embedded Systems, Fourth Indian Reprint, Pearson Education.

5. V.Vijayendran, 2002, Fundamentals of Microprocessor–8085, 8086 Architecture, Programming (MASM)&interfacing,Viswanathan, chennai.

EXTRA DISCIPLINARY - II				
Title of the paper	**Solar Photovoltaic Cell**			
Category of the course	Year	Semester	Credits	L T P E
Extra Disciplinary	II	III	3	45 - - 15
Pre- requisites	Knowledge of photovoltaic cell			
Objectives of the course	To introduce the student to basics of nano materials at research level.			

Course focusing on: Entrepreneurship

SOLAR PHOTOVOLTAIC CELL COURSE OUTCOME

CO1: Students will learn about the fundamentals of Solar cell and its physical, chemical and electrical properties

CO2: Students may gain knowledge on the basics of crystal structure and orientations.

CO3: Provide instrumental skills to study the structure of solar cell materials and phase purity.

CO4: Students would gain the junction properties of solar cell materials

CO5: provides the broad knowledge of application from energy conversion system like solar cell, fuel cell to energy storage system like battery, capacitors. They would able to expand their knowledge on applications of fourth generation solar cells materials and design of new materials for next generation applications.

	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT I: INTRODUCTION TO SOLAR CELLS

Outline of solar cell developments – Physical sources of sunlight – solar intensity at the Earth's Surface – direct and diffused radiation – apparent motion of the sun – solar insolation data – Types of solar energy converter – Photons in, electrons out – Basic principles of Photo-voltaic.

UNIT II: SEMICONDUCTOR MATERIALS, PROPERTIES AND ITS CHARACTERISTICS

Basics of crystal structure and orientations - Basic concepts – electron states in semiconductors – semiconductor in equilibrium – impurities and doping - semiconductor under bias- drift and diffusion – semiconductor transport equations – photo-generation – recombination – formulation of the transport problem

UNIT III: JUNCTION PROPERTIES

Origin of photovoltaic action – work function and types of junctions –Homo-junctions – metal semiconductor junction – semiconductor-semiconductor junctions – electrochemical junction – organic material junctions – surface and interface states – p-n junction – dark and illuminated current — effect of temperature – efficiency loss - short circuit current-open circuit voltage – introduction to various resistance.

UNIT IV: DESIGN, FABRICATION AND CHARACTERIZATION OF SOLAR PHOTOVALTIC CELLS

Basic silicon Solar cells - Basic theoretical performance – Major considerations for solar cell fabrication – doping of the substrate – Back surface fields – top layer limitations – top contact design – optical design – spectral response – cell fabrication process – surface treatment – etching – doping and diffusion – contact formation – solar cell measurement (IV) – analysis of the output- future direction in silicon cell design.

UNIT V: TOWARDS THIRD AND FOURTH GENERATION SOLAR CELLS

Introduction to nanoparticles – concepts of quantum dot solar cells – dye sensitized solar cell – organic solar cells - hybrid solar cell-other types of advanced solar materials and solar cell devices.

BOOKS FOR STUDY:

1. Solar Cells (operating Principles, Technology and System applications by Martin A.Green (Published by The University of New South Wales).
2. The Physics of Solar cells by Jenny Nelson (Published by Imperial college press)
3. Light-Induced Redox Reactions in Nanocrystalline Systems, Anders Hagfeldtt and Michael Gratzel, Chem, Rev.1995,95, 49-68.

BOOKS FOR REFERENCE:

1. Silicon solar cells: Advanced principles and Practice by M. Green, Centre for Photovoltatic Devices and system. 1995
2. Solar cell Physics,(2010), 2nd edition Elsevier.
3. Solar Cells: operating system and Principles, Technology and system Application by M. Green (1982), Prentice-Hall, Inc., Engiewood chiffs, New Jersey.,

NPTEL LINK

1. https://onlinecourses.nptel.ac.in/noc21_ph25/preview
2. https://nptel.ac.in/courses/115103123

Core Paper Theory– X				
Title of the paper	Nuclear and Particle Physics			
Category of the course	Year	Semester	Credits	L T P E
Core	II	IV	4	60 15 - 15
Pre- requisites	Knowledge of Atoms and Nucleus			
Objectives of the course	To introduce the student to basics of nuclear structure and elementary particle.			

Course focusing on: Employability

NUCLEAR AND PARTICLE PHYSICS COURSE OUTCOME

CO1: Understand the various nuclear models like liquid drop mode, shell model and evaluate magnetic moments and Schmidt lines.

CO2: Develop the Understanding of Nuclear interactions, Meson theory of nuclear forces, nucleon – nucleon scattering.

CO3: Acquire the knowledge on types of Nuclear reaction, Q value equation, compound and direct nucleus reactions and solve Breit – Wigner one level formula.

CO4: Study the different types of decay (Beta decay, Gamma decay) Neutrino physics, internal conversion and Nuclear Isomerism.

CO5: Learn about the concept of elementary particle, classification of hadrons – SU(2) and SU(3) multiples, Quark model.

	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT-I: NUCLEAR FORCES

Characteristics of Nucleus Forces – Exchange forces and tensor forces – charge independence-Spin dependence of Nucleus Forces - Meson theory of nuclear forces- Ground state of deuteron- Nucleon-nucleon scattering singlet and triplet parameters – Nucleon-Nucleon scattering: Cross-section, Differential Cross-section, Scattering Cross-sections – magnetic moment- Quadrupole moment –S and D state admixtures - Effective range theory of n-p scattering at low energies.

UNIT-II: NUCLEAR MODELS

Binding energy & mass defect – Weizacker's formula – mass parabola - Liquid drop model - Bohr -Wheeler theory of fission- Activation energy for fission- Shell model- Spin –Orbit Coupling-Spins of nuclei- Magnetic moments – Schmidt lines- Electric quadrupole moments - Collective model of Bohr and Mottelson: Nuclear vibration – Nuclear rotation –Nelson model.

UNIT-III: NUCLEAR REACTIONS

Nuclear reaction - Q- value – Nuclear reaction cross section – Direct Nuclear Reactions: Knock out reaction, Pick-up reaction, Stripping reaction – Compound nucleus theory – Formation – Disintegration energy levels – Partial wave analysis of Nuclear reaction cross-section - Resonance Scattering and Reaction cross-section (Breit-Wigner dispersion formula) – Scattering matrix - Reciprocity theorem – Breit -Wigner one level formula – Resonance scattering – Absorption cross section at high energy.

UNIT-IV: RADIOACTIVE DECAYS

Alpha decay - Beta decay –Energy release in beta decay – Fermi theory of beta decay – Shape of the beta spectrum – decay rate Fermi-Curie plot – Fermi & G.T Selection rules - Comparative's half - lives and forbidden decays- Gama decay - Multipole radation – Angular momentum and parity selection rules – Internal conversion – Nuclear isomerism.

UNIT-V: ELEMENTRY PARTICLE PHYSICS

Classification of elementary particles - Types of interaction between elementary particles – Hadrons and leptons – Symmetry and conservation laws – Strangeness and associate production - CPT theorem – classification of hadrons – Quark model – Isospin multiples - SU(2)- SU(3) multiplets- Gell-Mann - Okubo mass formula for octet and decuplet hadrons – Phenomenology of weak interaction hadrons and leptons - Universal Fermi interaction – Elementary concepts of weak interactions.

BOOKS FOR STUDY:

1. Concepts of Nuclear Physics, B. B. Cohen, TMGH, Bombay, 1971.
2. Introductory Nuclear Physics, K. Krane, Wiley, New York, 1987.
3. Nuclear Physics, V. Devanathan, Narosa Publishing house.
4. Introduction to Elementary Particles, D. Griffiths, 2nd Ed., Wiley-Vch, 2008
5. Nuclear Physics, S.N. Ghoshal, S. Chand and Co., II edition, 1994.
6. Nuclear Physics, D.C. Tayal, Himalaya Publishing House Pvt., Ltd., V edition, 2018.
7. Nuclear Physics, Irving Kaplan, Narosa Publishing House, 2012.
8. Basic Nuclear Physics and Cosmic Rays, B.N. Srivatsava, Pragati Prakashan publications, Meerut, Edition: XVII, 2016.
9. Elements of Nuclear Physics, M.L. Pandya and P.R.S Yadav, Kedar Nath Ram Nath publications, Meerut, 2016.

BOOKS FOR REFERENCE:

1. R. D. Evans, "Atomic Nucleus", Mcgraw-Hill NY.1955.
2. J. M. Blatt and V. F. Weisskopf, "Theoretical Nuclear Physics". Berlin 1979.
3. H. Enge, "Introduction to Nuclear Physics Addision-Wesley" .Reading MA. 1975
4. R. R. Roy and B. P. Nigam, "Nuclear Physics", Wiley Eastern, Madras1993.
5. D.C. Tayal „Nuclear Physics"
6. A. Bohr and B. R. Mottelson, "Nuclear Structure" Vol. I (1969) and Vol.II(1975), Benjamin Reading.

NPTEL LINK

1. https://nptel.ac.in/courses/115103101

2. https://nptel.ac.in/courses/115104043

Elective Paper– IV				
Title of the paper	Condensed Matter Physics – II			
Category of the course	Year	Semester	Credits	L T P E
Elective	II	IV	3	45 - - 15
Pre- requisites	Knowledge of Crystal System			
Objectives of the course	To introduce the student to Dielectrics, Ferroelectrics and Piezo Electrics			

Course focusing on: Entrepreneurship

CONDENSED MATTER PHYSICS – II COURSE OUTCOME

CO1: Offer extensive ideas in arrangement of atoms in solids and polarization, theory of dielectric

CO2: course offers skills like to distinguish the concepts of ferroelectrics and piezo electrics

CO3: student can understand the fundamental principles of magnetic materials.

CO4: know the fundamentals of dielectric and ferroelectric properties of materials and also can distinguish the basic difference of magnetic materials from Dia, Para, Ferro and Anti-Ferro magnetism.

CO5: Student can understand superconductivity using BCS theory

	CO-1	**CO-2**	**CO-3**	**CO-4**	**CO-5**
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT – I: THEORY OF DIELECTRICS

Dipole moment – Polarization – The electric field of a dipole – Local electric field at an atom – Clausius –Mosotti equation - Dielectric constants and its measurements - Polarizability – The Classical theory of electronic polarizability – Ionic polarizabilities - Orientational polarizabilities - The polarizability catastrophe - Dipole orientation in solids - Dipole relaxation and dielectric losses – Debye Relaxation time - Relaxation in solids - Complex dielectric constants and the loss angle - Frequency and temperature effects on Polarization – Dielectric breakdown and dielectric loss

UNIT – II: THEORY OF FERROELECTRICS AND PIEZO ELECTRICS

Ferroelectric Crystals – Classifications of Ferroelectric crystals - Dipole theory of ferroelectricity – Landau Theory of the phase transition – Second order Transition – First Order Transition - Ferroelectric Transition - One-Dimensional Model of the Soft Mode of Ferroelectric Transitions – Antiferroelectricity - Ferroelectric domains – Ferroelectric domain wall motion – Piezoelectricity - Phenomenological Approach to Piezoelectric Effects - Piezoelectric Parameters and Their Measurements - Piezoelectric Materials

UNIT – III: MAGNETIC PROPERTIES OF MATERIALS

Terms and definitions used in magnetism – Classification of magnetic materials – Atomic theory of magnetism – The quantum numbers- The origin of permanent magnetic moments – Langevin's classical theory of diamagnetism – Sources of paramagnetism – Langevin's classical theory of paramagnetism – Quantum theory of paramagnetism – Paramagnetism of free electrons - Ferromagnetism – The Weiss molecular field – Temperature dependence of Spontaneous magnetization – The physical origin of Weiss Molecular field - Ferromagnetic domains - Domain theory – Antiferromagnetism – Ferrimagnetism – Structure of Ferrite.

UNIT – IV: SUPERCONDUCTIVITY

Occurrence of super conductivity - Destruction of super conductivity by magnetic fields - Meissner Effect – Type I and Type II Super conductors - Heat Capacity - Energy gap - Microwave and infrared properties - Isotope effect - Thermodynamics of the superconducting transition - London equation - Coherence Length - BCS theory of superconductivity, BCS ground state - Flux quantization in a super conduction ring - Duration of persistence currents - Single particle tunnelling - DC Josephson effect - AC Josephson effect - Macroscopic quantum interference – High temperature super conductors – Applications.

UNIT – V: PHYSICS OF NANOSOLIDS

Definition of nanoscience and nanotechnology – Preparation of nanomaterials – Surface to volume ratio – Quantum confinement – Qualitative and Quantitative description – Density of states of nanostructures – Excitons in Nano semiconductors – Carbon in nanotechnology – Buckminsterfullerene – Carbon nanotubes – Nano diamond – BN nano tubes – Nanoelectronics – Single electron transistor – Molecular machine – nano biometrics.

BOOKS FOR STUDY:

1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, Wiley India Pvt. Ltd. , New Delhi, 2004.
2. Rita John, Solid State Physics, Tata Mc Graw Hill Publications, 2014.
3. M. A. Wahab, Solid State Physics – Structure and Properties of Materials. Narosa, New Delhi, 1999.
4. J.D. Patterson, B.C. Bailey Solid-State Physics: Introduction to the Theory, Springer Publications, 2007.
5. M. Ali Omar, Elementary Solid State Physics – Principles and Applications, Pearson, 1999.
6. Eleftherios N. Economou, The Physics of Solids – Essentials and Beyond, Springer, 2010.

BOOKS FOR REFERENCE:

1. J. Blakemore, Solid State Physics, 2nd Edition, W. B. Saunders Co, Philadelphia, 1974.
2. C. M. Kachhava, Solid State Physics, Tata Mcgraw Hill, New Delhi, 1990.
3. N. W. Aschroft and N. D., Mermin, Solid State Physics, Rhinehart and Winton, New York. 1976.
4. M. Tinkham, Introduction to Superconductivity, Tata Mcgraw Hill, New Delhi, 1996.
5. K.K.Chattopadhyay, A.N.Banerjee, Introduction to Nanoscience and Nanotechnolog, PHI learning private Ltd., Delhi 2014.
6. A. J. Dekker, Electrical Engineering Materials, Prentice Hall of India, 1975.
7. S.O. Pillai, Problems and Solutions in Solid State Physics, New Age international Publishers, New Delhi, 1994.
8. A.K. Bain, P. Chand, Ferroelectrics, Wiley, 2017.
9. Kwan Chi Kao, Dielectric phenomena in solids with emphasis on physical concepts of electronic processes, Elsevier Academic Press, 2004
10. Alexander O. E. Animalu, Intermediate Quantum Theory of Crystalline solids, Prentice Hall of India, New Delhi, 1978.

NPTEL LINK

1. https://nptel.ac.in/courses/115106061

2. https://nptel.ac.in/courses/115103102

3. https://nptel.ac.in/courses/115104109

Elective Paper– V				
Title of the paper	**Laser Physics and Nonlinear Optics**			
Category of the course	Year	Semester	Credits	L T P E
Elective	II	IV	3	45 - - 15
Pre- requisites	Knowledge of laser in lower level			
Objectives of the course	To introduce the student to basics of nonlinear optics			

Course focusing on: Entrepreneurship

LASER PHYSICS AND NONLINEAR OPTICS COURSE OUTCOME

On gone through the course the students can

CO1: Acquire knowledge on laser.

CO2: Analyze the physical properties of laser and its operations

CO3: Get basic understanding of laser characteristics

CO4: Understand the knowledge of laser beam and phase matching.

CO5: Understand the knowledge of nonlinear optics.

	CO-1	CO-2	CO-3	CO-4	CO-5
Unit-1	✓				
Unit-2		✓			
Unit-3			✓		
Unit-4				✓	
Unit-5					✓

UNIT I: LASERS-FUNDAMENTALS AND TYPES

Basic Construction and Principle of Lasing-Einstein Relations and Gain Coefficient - Creation of a Population Inversion- Three-Level System - Four-Level System - Threshold Gain Coefficient for Lasing- Laser types-He-Ne Laser-CO2 Laser- Nd:YAG Laser- Semiconductor Laser.

UNIT II: LASER OPERATION

Optical Resonator-Laser Modes-Axial modes- Transverse Modes-Modification in Basic Laser Structure- Basic Principle of Mode Locking- Active Mode Locking -Passive Mode Locking-Q-Switching- Pulse Shaping.

UNIT III: LASER BEAM CHARACTERISTICS

Wavelength-Coherence-Mode and Beam Diameter-Polarizations-Introduction to Gaussian Beam Width-Divergence-Radius of Curvature-Rayleigh Range-Guoy Phase Shift-3-D Gaussian Beams -ABCD Law for Gaussian Beam-The Complex Radius of Curvature- Tensorial ABCD Law.

UNIT IV: FOCUSING OF LASER BEAM

Diffraction- Limited spot size-M2Concept of Beam Quality-Spherical Aberration-Thermal Lensing Effects-Depth of Focus-Tight focusing of laser beam - Angular Spectrum Representation of Optical Near Field-Aplanatic Lens-Focusing of Higher- order laser modes-Radially Polarized Doughnut Mode-Azimuthally Polarized Doughnut mode.

UNIT V: NON-LINEAR OPTICS

Introduction-Nonlinear Optical Media-The Nonlinear Wave Equation-Scattering Theory Born Approximation-Second-order Nonlinear Optics-Second-Harmonic Generation (SHG) and Rectification-The Electro-Optic Effect-Three-Wave Mixing- Frequency and Phase Matching-Third Harmonic Generation-Optical Kerr Effect- Self-Focusing- Four-Wave Mixing (FWM) - Optical Phase Conjugation (OPC)- Use of Phase Conjugators in Wave Restoration.

BOOKS FOR STUDY:

1. Nonlinear Optics - D.L. Mills - Basic Concepts, Springer, Berlin 1998.
2. Lasers and Nonlinear Optics -B.B. Laud-2nd Edn. New Age International (P) Ltd., New Delhi, 1991
3. Fundamentals of Photonics - Bahaa E. A. Saleh, Malvin Carl Teich-John Wiley Sons, Inc.

BOOKS FOR REFERENCE:

1. Nanomaterials: Processing and Characterization with Lasers-Subhash Chandra Singh, HaiboZeng, ChunleiGuo, and WeipingCai -Wiley-VCH Verlag GmbH & Co. (2012).
2. Walter Koechner-Solid state Laser Engineering-6th edition-Springer
3. Principles of Nano optics -L. Novotny and B. Hecht-Cambridge University Press (2006)
4. Encyclopedia of Optical Engineering- R.G.Driggers,C.Hoffman- Marcel Dekker(2003)
5. Laser Material Processing- M. Steen, J.Mazumder- Springer (2010)

NPTEL LINK

1. https://nptel.ac.in/courses/104104085

2. https://onlinecourses.nptel.ac.in/noc21_ph01/preview

SRI SANKARA ARTS AND SCIENCE COLLEGE (AUTONOMOUS)

DEPARTMENT OF PHYSICS

PROGRAM OUTCOMES

PROGRAM OUTCOMES FOR POST-GRADUATE DEGREE

1. Enriching the knowledge in theoretical and practical aspects.
2. Developing research aptitude among the students and encouraging them to take up research projects and publish research papers.
3. Enabling the students to come out successfully in competitive examinations.
4. Developing students' skills, based on current trends by offering Job oriented, Entrepreneurial, certificate courses and Value-added courses.

PROGRAMME SPECIFIC OUTCOME

(M.Sc., Physics)

Programme specific outcome

1. PSO-1. This course provides the students to develop proficiency in various mathematical concepts for the proper understanding of application in all physical systems especially in Classical and Quantum mechanics, Electromagnetic theory, Statistical Mechanics and Integrated Electronics etc.

2. PSO-2. Ability to apply the classical and quantum principle in the Condensed matter physics, nuclear and particle physics, Materials science, Energy physics, Crystal growth and Nano science for various technological applications.

3. PSO-3. Learn the operation of the different electronic and physical devices such as microprocessor, microcontroller, laser and optical instruments. Learn to minimize contributing variables and recognize the limitations of equipment. Develop the following experimental tools: Numerical model simple physical systems using Euler's method, curve fitting, and error analysis.

4. PSO-4. Learning of laboratory skills, enabling measurements in a physics and electronics laboratory, analysis of the measurements and also expected to have an understanding of the analytical methods required to interpret and analyze results and draw conclusions as supported by their data.

5. PSO-5. The outcome of the course would enlighten the students with the in-depth Knowledge of Classical and quantum physics, Electromagnetic theory, Statistical Mechanics and Integrated Electronics to grow as a Physicist and also prepare them for the competitive exam such as CSIR, GATE related to physics for their higher and research studies

PSO - PO MATRIX

Program Outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
PO-1	✓	✓			
PO-2			✓		
PO-3				✓	
PO-4					✓

PSO –CO MATRIX

Course	Course outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
MATHEMATICAL PHYSICS-I	CO-1	✓		√		
	CO-2		✓			
	CO-3			✓		√
	CO-4				✓	
	CO-5					✓
CLASSICAL MECHANICS	CO-1	✓				√
	CO-2		✓			
	CO-3	√		✓		
	CO-4				✓	
	CO-5		√			✓
QUANTUM MECHANICS-I	CO-1	✓				
	CO-2		✓			√
	CO-3	√		✓		
	CO-4				✓	
	CO-5				√	✓
ADVANCED ELECTRONIC	CO-1	✓		√		
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5	√				✓
ADVANCED PHYSICS EXPERIMENTS-I	CO-1	√				√
	CO-2		√	√		
	CO-3	√			√	
ADVANCED ELECTRONIC EXPERIMENTS	CO-1	√				√
	CO-2		√	√		
	CO-3	√			√	
STATISTICAL MECHANICS	CO-1	✓		√		
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5				√	✓
ELECTROMAGNETIC THEORY	CO-1	✓				√
	CO-2		✓			
	CO-3	√		✓		
	CO-4				✓	
	CO-5					✓

Course	Course outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
MATHEMATICAL PHYSICS-II	CO-1		✓	√		
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5				✓	
CRYSTAL GROWTH AND THIN FILM PHYSICS	CO-1		✓			
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5		√		✓	
NANO SCIENCES AND NANO TECHNOLOGY	CO-1		✓			
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5				✓	
QUANTUM MECHANICS-II	CO-1	✓				√
	CO-2		✓			
	CO-3			✓		
	CO-4	√			✓	
	CO-5			√		✓
CONDENSED MATTER PHYSICS -I	CO-1	√	✓		√	
	CO-2		✓			
	CO-3			✓		
	CO-4				√	
	CO-5					✓
SPECTROSCOPY	CO-1		✓		✓	
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5			√	✓	
ADVANCED PHYSICS EXPERIMENTS-II	CO-1	√				√
	CO-2		√	√		
	CO-3	√			√	
MICROPROCESSOR 8085, 8086 AND 8051	CO-1	√				√
	CO-2		√	√		
	CO-3	√			√	
MICROPROCESSOR 8085, 8086 AND MICROCONTROLLER 8051	CO-1		✓			
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5				✓	

Course	Course outcome	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
SOLAR PHOTOVOLTAIC CELL	CO-1		✓			
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5			√	✓	
NUCLEAR AND PARTICLE PHYSICS	CO-1	✓				√
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5	√				✓
CONDENSED MATTER PHYSICS	CO-1		✓		√	
	CO-2		✓			
	CO-3			✓		
	CO-4			√	✓	
	CO-5				✓	
LASER PHYSICS AND APPLICATION	CO-1		✓			
	CO-2		✓			
	CO-3			✓		
	CO-4				✓	
	CO-5		√		✓	

SRI SANKARA ARTS AND SCIENCE COLLEGE (AUTONOMOUS)

EANTHUR, KANCHIPURAM

PROGRAM WISE LIST OF COURSES HAVING FOCUS ON EMPLOYABILITY/ENTREPRENEURSHIP/ SKILL DEVELOPMENT IN POST GRADUATES CURRICULUM

M.Sc., Physics

S. No	Name of the Course	Focus on Employability/Entrepreneurship/ Skill Development
1	Mathematical Physics-I	Employability
2	Classical Mechanics	Employability
3	Quantum mechanics-I	Employability
4	Advanced Electronic	Employability
5	Statistical Mechanics	Employability
6	Electromagnetic theory	Employability
7	Mathematical Physics-II	Entrepreneurship
8	Crystal Growth and Thin Film Physics	Entrepreneurship
9	Nano sciences and Nanotechnology	Entrepreneurship
10	Quantum mechanics-II	Employability
11	Condensed Matter Physics-I	Employability
12	Spectroscopy	Employability
13	Microprocessor-8085, 8086 and Microcontroller-8051	Entrepreneurship
14	Solar photovoltaic cell	Entrepreneurship
15	Internship	Skill Development
16	Nuclear and Particle Physics	Employability
17	Condensed Matter Physics-II	Entrepreneurship
18	Laser Physics and application	Entrepreneurship
19	Advanced Physics experiments-I	Skill Development

20	Advanced Electronic Experiments	Skill Development
21	Advanced Physics experiments-II	Skill Development
22	Microprocessor 8085,8086 and Microcontroller 8051 Practical	Skill Development
23	Project	Skill Development

Total paper = 23 (Employability = 10, Entrepreneurship = 07 and Skill Development - 06)