PERIYAR UNIVERSITY

PERIYAR PALKALAI NAGAR

SALEM – 636011

DEGREE OF MASTER OF SCIENCE

CHOICE BASED CREDIT SYSTEM

(CBCS)

M.Sc. PHYSICS

SYLLABUS

For Candidates admitted in the Colleges affiliated to

Periyar University from the Academic Year 2023-2024 onwards

M.Sc. PHYSICS REGULATIONS

1. PROGRAMME OBJECTIVES AND OUTCOMES

PROGRAMME OBJECTIVES (POs)

PO1: The main aim of the M.Sc (Physics) programme is to have enriched syllabus prepared based on the recent scientific developments in physics and its interdisciplinary areas and to meet out the requirements of today's academic, research and industry requirements.

PO2: To impart comprehensive knowledge in theoretical, experimental and computational physics and a better understanding of the subject.

PO3: To teach core subjects of physics to students to acquire knowledge and to have in depth understanding about the laws of physics, concepts, principles and solve analytical problems.

PO4: To enrich knowledge through problem-solving skills, projects, seminars, participation in scientific events and study visits.

PO5: To prepare for careers in Teaching, Research laboratories and public/private sector units and to implant the entrepreneurship character.

PROGRAMME SPECIFIC OUTCOMES (PSOs)

On the successful completion of the M.Sc. Physics Programme, the students will

PSO1: Have a deep knowledge of the fundamental concepts of Physics and understand how the various phenomena in nature follow the laws of Physics.

PSO2: Identify, formulate and analyze the scientific problems using the basic principles.

PSO3: Develop problem-solving skills and have the ability to apply mathematical tools to understand and describe physical problems.

PSO4: Be able to handle the laboratory equipments, gain knowledge about advanced experimental techniques and can successfully interpret results required for research and industrial applications.

PSO5: Acquire effective computational skills to apply them to scientific and technological problems.

PSO6: Get familiarized with contemporary research within various fields of Physics.

2. ELIGIBILITY FOR ADMISSION

A candidate who has passed the B.Sc., Degree Examination with Physics as the main subject of this University or an examination of some other universities accepted by the Syndicate as equivalent

there to is eligible for admission to the Programme.

3. DURATION OF THE PROGRAMME

The course of study shall be on Semester System. The two year post graduate programme in M.Sc., Physics consists of four semesters under Choice Based Credit System (CBCS).

4. COURSE OF STUDY

The course of study for the Degree of Master of Science in Physics shall be under (Choice Based Credit System) semester system with internal assessment according to the syllabus prescribed from time to time. This Course consists of Core Subjects and Elective Subjects, Skill Enhancement Courses, Soft Skill Course, Internship and Extension Activity.

5. DISTRIBUTION OF CREDIT POINTS

A student must earn a minimum of 92 credits as mentioned in the Course Structure table. The break-up of credits for the programme is as follows:

Core Papers	:	44 credits
Core Practical	:	12 credits
Elective Courses	:	12 credits
Professional and Skill Enhancement Course	:	08 credits
Soft Skill and Internship	:	10 credits
Project with Viva Voice	:	04 credits
Extension Activity	:	01 credits
Human Rights	:	01 credits
Total	**:**	**92 credits**

M.Sc. DEGREE COURSE IN PHYSICS
COURSE STRUCTURE

FIRST SEMESTER							
COURSE COMPONENTS	**NAME OF THE COURSE**	IST. HOURS PER WEEK	CREDITS	EXAM HRS	MAX. MARKS		
					INT.	EXT.	TOTAL
Core	Paper 1 - Mathematical Physics	6	4	3	25	75	100
Core	Paper 2 - Classical Mechanics and Relativity	5	4	3	25	75	100
Core	Paper 3 - Linear and Digital ICs and Applications	5	4	3	25	75	100
Core Practical	Paper 4 - Practical – I General Physics Experiments	6	3	3	25	75	100
Elective - I	Choose any one from the list I	4	3	3	25	75	100
	Professional Competency Course - Semiconductor Devices	2	2	3	25	75	100
Soft Skill-I	Ability Enhancement Compulsory Course – Atmospheric Physics	2	2	3	25	75	100
SECOND SEMESTER							
Core	Paper 5 - Statistical Mechanics	5	4	3	25	75	100
Core	Paper 6 - Quantum Mechanics –I	5	4	3	25	75	100
Core Practical	Paper 7 - Practical – II Analog and Digital Experiments	6	3	3	25	75	100
Elective - II	Choose any one from the list II	4	3	3	25	75	100
Elective - III	Choose any one from the list III	4	3	3	25	75	100
	Skill Enhancement Course – I Electronics in daily life	2	2	3	25	75	100
Soft Skill-II	Ability Enhancement Compulsory Course – Laser Physics and Applications	2	2	3	25	75	100
Common Subject	Human Rights	2	1	3	25	75	100
	Internship * / Industrial Activity	-	-	-	-	-	-

*Internship will be carried out during the summer vacation of the first year and marks will be included in the Third Semester Marks Statement.

THIRD SEMESTER							
Core	Paper 8 - Quantum Mechanics-II	6	4	3	25	75	100
Core	Paper 9 - Condensed Matter Physics	5	4	3	25	75	100
Core	Paper 10 - Electromagnetic Theory	5	4	3	25	75	100
Core Practical	Paper 11- Practical -III Microprocessor 8085 and Microcontroller 8051	6	3	3	25	75	100
Elective -IV	Choose any one from the lists I, II & III	4	3	3	25	75	100
	Skill Enhancement Course – II Communication Electronics	2	2	3	25	75	100
Soft Skill - III	Ability Enhancement Compulsory Course - Sewage And Waste Water Treatment And Reuse	2	2	3	25	75	100
	Internship / Industrial Activity	-	2	-	-	-	-
FOURTH SEMESTER							
Core	Paper 12 - Nuclear and Particle Physics	5	4	3	25	75	100
Core	Paper 13 - Spectroscopy	5	4	3	25	75	100
Core	Paper 14 - Numerical Methods and Computer Programming	5	4	3	25	75	100
Core Practical	Paper 15 -Practical - IV Numerical Methods and Computer Programming (FORTRAN/C)	6	3	3	25	75	100
Core	Paper 16 - Project with Viva Voce	5	4	-	25	75	100
	Skill Enhancement Course – III Characterization of Materials	2	2	3	25	75	100
Soft Skill - IV	Ability Enhancement Compulsory Course - Solar Physics	2	2	3	25	75	100
	Extension Activity	-	1	-	-	-	-
	TOTAL		**92**				**2900**

SUMMARY OF STRUCTURE OF THE PROGRAMME

Part	Types of the Courses	No. of Courses	Credit Distribution	Total No. of Credits	Marks
A	Core Papers	11	4	44	1100
A	Core Practical	4	3	12	400
A	Elective	4	3	12	400
A	Project	1	4	4	100
B1	Skill Enhancement Course	4	2	8	400
B2	Soft Skill Course	4	2	8	400
B3	Internship	1	2	2	-
C	Extension Activity	1	1	1	-
D	Common Subject	1	1	1	100
	TOTAL	31	-	92	2900

6. EXAMINATION

For the purpose of uniformity, particularly for inter-departmental transfer of credits, there will be a uniform procedure credits, there will be a uniform procedure of examinations to be adopted by all teachers offering courses.

DISTRIBUTION OF MARKS:

(a)The following are the distribution of external and internal marks for Theory papers.

. i).External Exam. : 75 Marks

Passing Minimum : 38 Marks

ii). Internal Exam : 25 Marks

Passing Minimum : 12 Marks

(b) The following are the distribution of Internal marks for Theory papers.

1. Test (One best test out of 3 tests) : 05 Marks
2. End Semester Model Exam : 10 Marks
3. Assignments & Attendance : 05 Marks
4. Seminar : 05 Marks

TOTAL : 25 Marks

(c) The following are the distribution of Internal marks for Practical papers.

1. Record Submission : 10 Marks
   (Minimum 12 experiments)
2. Model Exam : 10 Marks
3. Attendance : 05 Marks

TOTAL : 25 Marks

SUBMISSION OF RECORD NOTEBOOKS FOR PRACTICAL EXAMINATIONS

Candidates taking the Practical Examinations should submit bonafide Record Note Books prescribed for the Practical Examinations with due certification by Staff in-charge and HOD is a must for External Practical Examination (for both Regular and Arrear Candidates). Otherwise, the candidates will not be permitted to take the Practical Examinations.

Allocation of Marks for University Practical Examinations:

Record	10 Marks
Formula and Formula Description	10 Marks
Circuit Diagrams / Diagrams	08 Marks
Observation-Tabulation and Readings	20 Marks
Calculations	15 Marks
Presentation	02 Marks
Result	05 Marks
Viva-Voce	05 Marks
TOTAL	**75 Marks**

PROJECT AND VIVA-VOCE EXAM

Students are required to submit a Project report at the end of Semester - IV and also required to make presentation of the project work during Viva- voce Examination. The Project work shall be based on research-oriented topics both in the fields of theoretical and experimental physics under the guidance of a faculty member of the Department as a Project Supervisor. In the course of the project, the student will refer books, Journals or collect literature/data by the way of visiting research institutes / industries. He/she may even do experimental /theoretical work in his/her college. After completion of the project work by the end of semester IV, each student should submit **THREE** copies of the project report with a minimum of 50 pages not exceeding 70 pages to the Department on or before the date notified for the same.

FORMAT FOR PREPARATION OF PROJECT REPORT

The sequence in which the project should be arranged and bound should be as follows

1. Cover Page and Title Page
2. Certificate
3. Declaration
4. Acknowledgement (not exceeding one page)
5. Contents (12 Font size, Times New Roman with 1.5 or double line spacing)
6. List of Figures / Exhibits / Charts
7. List of tables
8. Symbols and notations
9. Chapters
10. Result and Discussion
11. Conclusion
12. References
13. Xerox Copies of Publications/Certificates of Seminar, Conference Participation

The bifurcation of marks for project will be as follows:

1. Plan of the Project : 25 Marks
2. Evaluation of the Project Report : 75 Marks
3. Viva- Voce Examination : 25 Marks

DISTRIBUTION OF MARKS FOR EVAUATION OF PROJECT REPORT & VIVA-VOCE

(a) Execution of the Plan/Collection of Data/ Organisation of Materials / Presentation of the report /Novelty of the project : 40 Marks

(b) Presentation of project in state level/National level Seminar / Publication : 10 Marks

(c). Viva-Voce (Preparation, Presentation of work and Response to questions) : 25 Marks

7. QUESTION PAPER PATTERN

The following question paper pattern shall be followed for the candidates admitted from the academic year 2023–2024 onwards.

Time: 3 Hours Maximum: 75 Marks

Part – A (15 x 1 = 15 Marks)
Answer **ALL** the Questions
Three Questions from each unit
15 multiple choice questions with four options

Part - B (2 x 5 = 10 Marks)
Answer Any **TWO** Questions out of FIVE
One Question from each unit.
All Questions carry equal Marks.

Part - C (5 x 10 = 50 Marks)
Answer **ALL** the Questions.
One Question from each unit with Either or Type.
All Questions carry equal Marks.

8. PASSING MINIMUM

In order to pass a paper 50% minimum is compulsory both in the internal and external. A candidate who has secured a minimum 50 marks (Internal - 12 and External - 38) in all the courses prescribed in the programme and earned a minimum of 91 credits will be considered to have passed the Master's Programme.

9. COMMENCEMENT OF THIS REGULATION

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

10. GRADING

Once the marks of the cumulative internal assessment and end semester examinations are available, they will be added. The mark thus obtained will then be graded as per details given below:

Marks and Grades:

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

Conversion of Marks to Grade Points and Letter Grade:

Range of Marks	Grade Points	Letter Grade	Description
90-100	9.0-10.0	O	OUTSTANDING
80-89	8.0-8.9	D+	EXCELLENT
75-79	7.5- 7.9	D	DISTINCTION
70-74	7.0-7.4	A+	VERY GOOD
60-69	6.0-6.9	A	GOOD
50-59	5.0-5.9	B	AVERAGE
00-49	0.0	RA	RE-APPEAR
ABSENT	0.0	AAA	ABSENT

Ci = Credits earned for course i in any semester
Gi = Grade Point obtained for course i in any semester
n = refers to the semester in which such course was credited

For a Semester:

$$\text{GRADE POINT AVERAGE [GPA]} = \sum i\, Ci\, Gi \,/\, \sum i\, Ci$$

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

For the entire Programme*:*

$$\text{CUMULATIVE GRADE POINT AVERAGE [CGPA]} = \sum n \sum i\, Cni\, Gni \,/\, \sum n \sum i\, Cni$$

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

11. CLASSIFICATION OF SUCCESSFUL CANDIDATES

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

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.5 - 10.0	O+	First Class with 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	U	Re-appear

*****The Candidates who have passed in the first appearance and within the prescribed semester of the PG programme (Core, Elective, Professional Competency Course, Ability Enhancement Compulsory Course) are eligible.

12. RANKING

A candidate who qualifies for the M.Sc., Physics, passing all the Examinations in the first attempt, within the minimum period prescribed for the course from the date of admission to the course and secures first or second class shall be eligible for ranking and such ranking will be confined to 10% of the total number of candidates qualified in that particular subject to a maximum of 10 ranks. The improved marks shall not be taken into consideration for ranking.

13. CONFERMENT OF THE DEGREE

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

14. ELECTIVE COURSES

Elective courses will be chosen by the respective colleges from the list of Group Elective Papers.

ELECTIVE PAPERS

LIST 1

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

LIST 2

6. Plasma Physics
7. Bio Physics
8. Non-linear Dynamics
9. General Relativity and Cosmocology
10. Advanced Optics

LIST 3

INDUSTRY ORIENTED ELECTIVE (IOE)

11. Advanced Spectroscopy
12. Microprocessor 8086 and Microcontroller 8051
13. Medical Physics
14. Solid Waste Management (SWM)
15. Solar Energy Utilization

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

15. TRANSITORY PROVISION

Candidates who have undergone the Course of Study prior to the Academic Year 2023 - 2024 will be permitted to take the Examinations under those Regulations for a period of four years i.e., up to and inclusive of the Examination of April 2027 thereafter they will be permitted to take the Examination only under the Regulations in force at that time.

Core Paper-1 MATHEMATICAL PHYSICS I YEAR - FIRST SEMESTER

UNIT I: LINEAR VECTOR SPACE

Basic concepts – Definitions– examples of vector space – Linear independence – Scalar product- Orthogonality – Gram-Schmidt orthogonalization procedure – linear operators – Dual space – ket and bra notation – orthogonal basis – change of basis – Isomorphism of vector space – projection operator – Eigen values and Eigen functions – Direct sum and invariant subspace – orthogonal transformations and rotation.

UNIT II: COMPLEX ANALYSIS

Review of Complex Numbers – de Moivre's theorem – Functions of a Complex Variable – Differentiability – Analytic functions- Harmonic Functions – Complex Integration – Contour Integration, Cauchy – Riemann conditions – Singular points – Cauchy's Integral Theorem and integral Formula – Taylor's Series – Laurent's Expansion – Zeros and poles – Residue theorem and its Application: Potential theory – (1) Electrostatic fields and complex potentials – Parallel plates, coaxial cylinders and an annular region (2) Heat problems – Parallel plates and coaxial cylinders.

UNIT III: MATRICES

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

UNIT IV: FOURIER TRANSFORMS & LAPLACE TRANSFORMS

Definitions **–** Fourier transform and its inverse **–** Transform of Gaussian function and Dirac delta function **–** Fourier transform of derivatives **–** Cosine and sine transforms - Convolution theorem. Application: Diffusion equation: Flow of heat in an infinite and in a semi - infinite medium **–** Wave equation: Vibration of an infinite string and of a semi - infinite string.

Laplace transform and its inverse – Transforms of derivatives and integrals – Differentiation and integration of transforms – Dirac delta functions – Application – Laplace equation: Potential problem in a semi - infinite strip.

UNIT V: DIFFERENTIAL EQUATIONS

Second order differential equation – Sturm – Liouville's theory – Series solution with simple examples – Hermite polynomials – Generating function – Orthogonality properties – Recurrence relations – Legendre polynomials – Generating function – Rodrigue formula – Orthogonality properties – Dirac delta function – One dimensional Green's function and Reciprocity theorem – Sturm - Liouville's type equation in one dimension & their Green's function.

TEXT BOOKS

1. George Arfken and Hans J Weber, 2012, Mathematical Methods for Physicists – A Comprehensive Guide (7th edition), Academic press.
2. P.K. Chattopadhyay, 2013, *Mathematical Physics* (2^{nd} edition), New Age, New Delhi.
3. A. W. Joshi, 2017, Matrices and Tensors in Physics, 4th Edition (Paperback), New Age International Pvt. Ltd., India.
4. B.D.Gupta, 2009, *Mathematical Physics*(4^{th}edition), Vikas Publishing House, New Delhi.
5. H. K. Dass and Dr. Rama Verma, 2014, Mathematical Physics, Seventh Revised Edition, S. Chand & Company Pvt. Ltd., New Delhi.

REFERENCE BOOKS

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

WEB SOURCES

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

Core Paper-2 CLASSICAL MECHANICS AND RELATIVITY

I YEAR- FIRST SEMESTER

UNIT I: PRINCIPLES OF CLASSICAL MECHANICS

Mechanics of a single particle – mechanics of a system of particles – conservation laws for a system of particles – constraints – holonomic & non-holonomic constraints – generalized coordinates – configuration space – transformation equations – principle of virtual work.

UNIT II: LAGRANGIAN FORMULATION

D'Alembert's principle – Lagrangian equations of motion for conservative systems – applications: (i) simple pendulum (ii) Atwood's machine (iii) projectile motion.

UNIT III: HAMILTONIAN FORMULATION

Phase space – cyclic coordinates – conjugate momentum – Hamiltonian function – Hamilton's canonical equations of motion – applications: (i) simple pendulum (ii) one dimensional simple harmonic oscillator (iii) motion of particle in a central force field.

UNIT IV: SMALL OSCILLATIONS

Formulation of the problem – transformation to normal coordinates – frequencies of normal modes – linear triatomic molecule.

UNIT V: RELATIVITY

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

TEXT BOOKS

1. H. Goldstein, *Classical Mechanics*, 3rd Edition, Pearson Edu., 2002.
2. J. C. Upadhyaya, *Classical Mechanics*, Himalaya Publshing. Co. New Delhi, 2016.
3. R. Resnick, *Introduction to Special Theory of Relativity*, Wiley Eastern, New Delhi, 1968.
4. R. G. Takwala and P.S. Puranik, Introduction to Classical Mechanics – Tata – McGraw Hill, New Delhi, 1980.
5. N. C. Rana and P.S. Joag, Classical Mechanics - Tata McGraw Hill, 2001.

REFERENCE BOOKS

1. K. R. Symon, *Mechanics*, Addison Wesley, London, 1971.
2. S. N. Biswas, *Classical Mechanics*, Books & Allied, Kolkata,1999.
3. Gupta, Kumar and Sharma, *Classical Mechanics*, Pragathi Prakashan, 2017.
4. T.W.B. Kibble, *Classical Mechanics*, McGraw-Hill, New York, 2004.
5. Greenwood, *Classical Dynamics*, Dover Publication, New York, 1985.

WEB SOURCES

1. http://poincare.matf.bg.ac.rs/~zarkom/Book_Mechanics_Goldstein_Classical_Mechanics_optimized.pdf
2. https://pdfcoffee.com/classical-mechanics-j-c-upadhyay-2014-editionpdf-pdf-free.html
3. https://nptel.ac.in/courses/122/106/122106027/
4. https://ocw.mit.edu/courses/physics/8-09-classical-mechanics-iii-fall-2014/lecture-notes/
5. https://www.britannica.com/science/relativistic-mechanics

Core Paper - 3 LINEAR AND DIGITAL ICs & APPLICATIONS

I YEAR - FIRST SEMESTER

UNIT I: INTEGRATED CIRCUITS AND OPERATIONAL AMPLIFIER

Introduction, Classification of IC's, basic information of Op-Amp 741 and its features, the ideal Operational amplifier, Op-Amp internal circuit and Op-Amp Characteristics.

UNIT II: APPLICATIONS OF OP-AMP

LINEAR APPLICATIONS OF OP-AMP: Solution to simultaneous equations and differential equations, Instrumentation amplifiers, V to I and I to V converters.
NON-LINEAR APPLICATIONS OF OP-AMP: Sample and Hold circuit, Log and Antilog amplifier, multiplier and divider, Comparators, Schmitt trigger, Multivibrators, Triangular and Square waveform generators.

UNIT III: ACTIVE FILTERS & TIMER AND PHASE LOCKED LOOPS

ACTIVE FILTERS: Introduction, Butterworth filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters.
TIMER AND PHASE LOCKED LOOPS: Introduction to IC 555 timer, description of functional diagram, monostable and astable operations and applications, Schmitt trigger, PLL - introduction, basic principle, phase detector/comparator, voltage controlled oscillator (IC 566), low pass filter, monolithic PLL and applications of PLL.

UNIT IV: VOLTAGE REGULATOR & D to A AND A to D CONVERTERS

VOLTAGE REGULATOR: Introduction, Series Op-Amp regulator, IC Voltage Regulators, IC 723 general purpose regulators, Switching Regulator.
D to A AND A to D CONVERTERS: Introduction, basic DAC techniques -weighted resistor DAC, R-2R ladder DAC, inverted R-2R DAC, A to D converters -parallel comparator type ADC, counter type ADC, successive approximation ADC and dual slope ADC, DAC and ADC Specifications.

UNIT V: CMOS LOGIC, COMBINATIONAL CIRCUITS USING TTL 74XX ICs & SEQUENTIAL CIRCUITS USING TTL 74XX ICs

CMOS LOGIC: CMOS logic levels, MOS transistors, Basic CMOS Inverter, NAND and NOR gates, CMOS AND-OR-INVERT and OR-AND-INVERT gates, implementation of any function using CMOS logic. COMBINATIONAL CIRCUITS USING TTL 74XX ICs: Study of logic gates using 74XX ICs, Four-bit parallel adder (IC 7483), Comparator (IC 7485), Decoder (IC 74138, IC74154), BCD to 7-segment decoder (IC7447), Encoder (IC74147), Multiplexer (IC74151), Demultiplexer (IC 74154).
SEQUENTIAL CIRCUITS USING TTL 74XX ICs: Flip Flops (IC 7474, IC 7473), Shift Registers, Universal Shift Register (IC 74194), 4- bit asynchronous binary counter (IC 7493).

TEXT BOOKS

1. D. Roy Choudhury, Shail B. Jain (2012), Linear Integrated Circuit, 4th edition, New Age International Pvt. Ltd., New Delhi, India.
2. Ramakant A. Gayakwad, (2012), OP-AMP and Linear Integrated Circuits, 4th edition, Prentice Hall / Pearson Education, New Delhi.
3. B.L. Theraja and A.K. Theraja,(2004), A Textbook of Electrical technology, S. Chand & Co.
4. V.K. Mehta and Rohit Mehta, (2008), Principles of Electronics, S. Chand & Co, 12th Edition.
5. V. Vijayendran, (2008), Introduction to Integrated electronics (Digital & Analog), S. Viswanathan Printers & Publishers Private Ltd, Reprint. V.

REFERENCE BOOKS

1. Sergio Franco (1997), Design with operational amplifiers and analog integrated circuits, McGraw Hill, New Delhi.
2. Gray, Meyer (1995), Analysis and Design of Analog Integrated Circuits, Wiley International, New Delhi.
3. Malvino and Leach (2005), Digital Principles and Applications 5th Edition, Tata McGraw Hill, New Delhi.
4. Floyd, Jain (2009), Digital Fundamentals, 8th edition, Pearson Education, New Delhi.
5. Millman & Halkias (2000), Integrated Electronics, Tata McGraw Hill, 17th Reprint.

WEB SOURCES

1. https://nptel.ac.in/course.html/digital circuits/
2. https://nptel.ac.in/course.html/electronics/operational amplifier/
3. https://www.allaboutcircuits.com/textbook/semiconductors/chpt-7/field-effect-controlled-thyristors/
4. https://www.electrical4u.com/applications-of-op-amp/
5. https://www.geeksforgeeks.org/digital-electronics-logic-design-tutorials/

Core Practical **PRACTICAL I - GENERAL PHYSICS EXPERIMENTS**

I YEAR - FIRST SEMESTER

(ANY TWELVE EXPERIMENTS)

1. Determination of Young's modulus and Poisson's ratio by Elliptical fringes - Cornu's Method.
2. Determination of Young's modulus and Poisson's ratio by Hyperbolic fringes - Cornu's Method.
3. Charge of an Electron by Spectrometer.
4. Determination of Viscosity of the given liquid – Meyer's disc.
5. Measurement of Coefficient of linear expansion- Air wedge Method.
6. B-H loop using Anchor ring.
7. Determination of Thickness of the enamel coating on a wire by diffraction.
8. Determination of Rydberg's Constant - Hydrogen Spectrum.
9. F. P. Etalon-Spectrometer- Determination of Thickness.
10. Determination of Thickness of air film - Solar spectrum – Hartmann's formula- Edser and Butler fringes.
11. Measurement of Band gap energy – Thermistor.
12. Determination of Planck's Constant – LED Method.
13. Determination of Specific charge of an electron – Thomson's method.
14. Determination of Compressibility of a liquid using Ultrasonics Interferrometer.
15. Determination of Wavelength, Separation of wavelengths – Michelson Interferometer.
16. GM counter - Characteristics, inverse square law and absorption coefficient.
17. Measurement of Resistivity of semiconductor - Four probe method.
18. Arc spectrum - Iron/Copper.
19. Molecular spectra - AlO band.
20. Measurement of wavelength of Diode Laser / He – Ne Laser using Diffraction grating.
21. Determination of Diffraction pattern of light with circular aperture using Diode/ He-Ne laser.
22. Study the beam divergence, spot size and intensity profile of Diode/He-Ne laser.
23. Measurements of Standing wave and standing wave co-efficient, Law of Inverse square, Receiver end transmitter behavior, Radiation Pattern - Microwave test bench.
24. Susceptibility measurement by Quinke's method.
25. Susceptibility determination of solid by Gouy's method
26. Determination of Stefan's constant.
27. Study the temperature characteristics and determine the band gap of given thermistor.
28. Determination of band gap in a semiconductor.

29. Study the spectrum of hydrogen atom.
30. I-V Characteristics of Solar cell and determine its maximum efficiency.
31. Determination of Hall Effect in a semiconductor and measurement of Hall Coefficient.
32. Characterization of LVDT.
33. e/m-Zeeman effect.
34. Characteristics of laser and tunnel diode.
35. Determination of Solar constant.

TEXT BOOKS

1. Practical Physics, Gupta and Kumar, Pragati Prakasan, 2020.
2. An Advanced Course in Practical Physics, D.Chattopadhyay, P,C.Rakshit, New Central Book Agency(P) Ltd., 2007.
3. Kit Developed for doing experiments in Physics-Instruction manual, R. Srinivasan K.R Priolkar, Indian Academy of Sciences.
4. A Textbook of Advanced Practical Physics, S.K.Ghosh, New Central, Fourth Edition, 2000.

REFERENCE BOOKS

1. Advanced Practical Physics, S.P Singh, PragatiPrakasan.
2. An advanced course in Practical Physics, D. Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd.
3. A course on experiment with He-Ne Laser, R.S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd.

Professional Competency Course – SEMICONDUCTOR DEVICES

I YEAR- FIRST SEMESTER

UNIT I : SEMICONDUCTOR DIODE

Semiconductors – characteristics and applications of PN Junction diode – Zener diode – Gunn diode – Varactor diode – Schottky diode – LED.

UNIT II : METAL - SEMICONDUCTOR DEVICES

JFET - Structure and Characteristics – MOSFET –- Depletion and Enhancement typeMOSFFT.

UNIT III : POWER CONTROL DEVICES

Construction, V-I characteristics and applications of UJT, SCR , DIAC, TRIAC.

UNIT IV : MICROWAVE DEVICES

Tunnel diode – I-V characteristics of Tunnel diode – IMPATT diode – MISS diode.

UNIT V : PHOTONIC DEVICES

Photoconductor, Photodiode, quantum efficiency, PIN photodiode, heterojunction photodiode, avalanche photodiode - Photo transistors.

TEXT BOOKS

1. Principles of Electronics, V.K.Mehta, S.Chand and Company, New Delhi (2015).
2. A text book of Applied Electronics, R.S.Sedha, S.Chand & Company, New Delhi (2017).
3. Modern Digital Electronics, R.P.Jain, Tata McGraw-Hill Edn., Publishing Company Ltd., New Delhi (2010).
4. Solid State Electronic Devices, B.G. Streetman, S. Banerjee, Prentice Hall (2009).
5. Physics of Semiconductor Devices, S.M.Sze, Kwok K.Ng, John Wiley & Sons,New Delhi (2011).

REFERENCE BOOKS

1. Semiconductor Physics and Devices: Basic Principles, D.A. Neamen, McGraw-Hill(2003).
2. Physics of Semiconductor Devices, Dilip K. Roy, Universitys Press (India) Private Limited, Hyderabad (2004).
3. Principles of Electronics, ParthaKumar and Ganguly, PHI Learning (P) Ltd., New Delhi (2015).
4. Physics of Photonic Devices, Shun Lien Chuang, John Wiley & Sons, 2nd Edition (2009).

5. Photonic Devices, Jia-Ming Liu, Cambridge University Press (2005).

WEB RESOURCES

1. https://open.umn.edu/opentextbooks/textbooks/573
2. https://www.khanacademy.org/science/electrical-engineering/ee-semiconductor-devices
3. https://www.cambridge.org/core/books/abs/computational-electromagnetics-for-rf-and-microwave-engineering/web-resources/5DFE109913C5411D2E60C828A4F96F77
4. https://technav.ieee.org/topic/microwave-devices
5. https://www.nature.com/subjects/photonic-devices

Ability Enhancement Compulsory Course - ATMOSPHERIC PHYSICS

I YEAR – FIRST SEMESTER

UNIT I INTRODUCTION

The atmosphere as a physical system - Atmospheric models - Two simple atmospheric models - Some atmospheric observations - Weather and climate.

UNIT II ATMOSPHERIC THERMODYNAMICS

The ideal gas law - Atmospheric composition - Hydrostatic balance - Entropy and potential temperature - Parcel concepts - tephigram - Cloud formation.

UNIT III ATMOSPHERIC RADIATION

Atmospheric radiation - Basic physical concepts – Plank's and Boltzmann - Basic spectroscopy of molecules – vibrational and rotational states – Line shapes – Transmittance.

UNIT IV BASIC FLUID DYNAMICS

Mass conservation - The material derivative - An alternative form of the continuity equation - The Navier – Stokes equation - Equations of motion in coordinate form – Spherical - thermodynamic energy equation.

UNIT V ATMOSPHERIC REMOTE SOUNDING

Atmospheric remote sounding from space - Thermal emission measurements - Backscatter measurements - Atmospheric remote sounding from the ground - The Dobson ozone spectrophotometer – Radars – Lidars.

TEXT BOOKS

1. David G. Anderws, 2000, An Introduction to Atmospheric Physics Second Edition, Cambridge University Press.
2. Murry L. Salby, 1995, Fundamentals of Atmospheric Physics, Academic Press.
3. R. M. Goody and Y. L. Yung, 1989, Atmospheric Radiation Theoretical Basis Second Edition, Library of Congress Cataloging-in-Publication.
4. D. G. Andrews, 2000, *An Introduction to Atmospheric Physics,* Cambridge University Press.
5. C. F. Bohren and B. A. Albrecht 1998, *Atmospheric Thermodynamics,* Oxford University Press, New York,

REFERENCE BOOKS

1. Shaun Lovejoy 2019, Weather, Macroweather, and the Climate: Our Random Yet Predictable Atmosphere, Oxford University Press Inc.
2. Neil C. Wells, 2011, The Atmosphere and Ocean: A Physical Introduction, John Wiley and Sons Inc.

3. John E Frederick**,** 2007, Principles of Atmospheric Science, Jones & Bartlett Publishers.
4. J.V.Iribarne, H.R.Cho, 1980, Atmospheric Physics, D.Reidel Publishing Company, London,
4. Blundell, S.J. and Blundell,K.M, 2009, Concepts in Thermal Physics, Oxford University Press, 2nd edition.

WEB RESOURCES

1. http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/home.rxml
2. https://www.britannica.com/science/atmospheric-pressure
3. http://site.ebrary.com/lib/berkeley/Doc?id=10378944
4. http://www.sciencedirect.com/science/book/9780127329512
5. https://www.embibe.com/exams/atmospheric-pressure/

Core Paper-5 STATISTICAL MECHANICS I YEAR - SECOND SEMESTER

UNIT I: PHASE TRANSITIONS

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

UNIT II: STATISTICAL MECHANICS AND THERMODYNAMICS

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

UNIT III: CANONICAL AND GRAND CANONICAL ENSEMBLES

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

UNIT IV: CLASSICAL AND QUANTUM STATISTICS

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

UNIT V: REAL GAS,ISING MODEL AND FLUCTUATIONS

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

TEXT BOOKS

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

5. M. K. Zemansky, 1968, *Heat and Thermodynamics,* 5th edition, McGraw-Hill New York.

REFERENCE BOOKS

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

WEB SOURCES

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

Core Paper - 6 QUANTUM MECHANICS – I I YEAR - SECOND SEMESTER

UNIT I: BASIC FORMALISM

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

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

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

UNIT III:GENERAL FORMALISM

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

UNIT IV:APPROXIMATION METHODS

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

UNIT V:ANGULAR MOMENTUM

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

TEXT BOOKS

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

REFERENCE BOOKS

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

WEB SOURCES

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

Core Practical PRACTICAL - II ANALOG AND DIGITAL EXPERIMENTS

I YEAR - SECOND SEMESTER

1. Construction of relaxation oscillator using UJT
2. FET CS amplifier- Frequency response, input impedance, output impedance
3. Study of important electrical characteristics of IC741.
4. V- I Characteristics of different colours of LED.
5. Study of attenuation characteristics of Wien's bridge network and design of Wien's bridge oscillator using Op-Amp.
6. Study of attenuation characteristics of Phase shift network and design of Phase shift oscillator using Op-Amp.
7. Design of monostable multivibrator using IC 741 and 555 timer.
8. Construction of Schmidt trigger circuit using IC 741.
9. Construction of square wave and Triangular wave generator using IC 741.
10. Construction of a quadrature wave using IC 324.
11. Construction of pulse generator using the IC 741.
12. Construction of half adder and full adder circuits using NAND gates.
13. Construction of half subtractor and full subtractor circuits using NAND gates.
14. Construction of Op-Amp - 4 bit Digital to Analog converter (Binary Weighted and R/2R ladder type)
15. Study of R-S, clocked R-S and D-Flip flop using NAND gates
16. Study of J-K, D and T flip flops using IC 7476/7473
17. Arithmetic operations using IC 7483- 4-bit binary addition and subtraction.
18. Study of Arithmetic logic unit using IC 74181.
19. Construction of Encoder and Decoder circuits using ICs.
20. IC 7490 as scalar and seven segment display using IC7447
21. Solving simultaneous equations – IC 741 / IC LM324
22. Op-Amp –Active filters: Low pass, High pass and Band pass filters (Second Order) Batter worth filter
23. Construction of Current to Voltage and Voltage to Current Conversion using IC 741.
24. Construction of second order butter worth multiple feedback narrow band pass filter
25. Realization of analog to digital converter (ADC) using 4-bit DAC and synchronous counter IC74193
26. Construction of square wave generator using IC 555.
27. Construction of Schmidt trigger circuit using IC555.

28. Construction of pulse generator using the IC 555.
29. BCD to Excess- 3 and Excess 3 to BCD code conversion.
30. Study of binary up / down counters - IC 7476 / IC7473.
31. Shift register and Ring counter and Johnson counter- IC 7476/IC 7474.
32. Study of synchronous parallel 4-bit binary up/down counter using IC 74193.
33. Study of asynchronous parallel 4-bit binary up/down counter using IC 7493.
34. Study of Modulus Counter.
35. Construction of Multiplexer and Demultiplexer using ICs.

TEXT BOOKS

1. Practical Physics, Gupta and Kumar, Pragati Prakasan.
2. Kit Developed for doing experiments in Physics- Instruction manual, R. Srinivasan, K.R Priolkar, Indian Academy of Sciences.
3. Op-Amp and linear integrated circuit, Ramakanth A Gaykwad, Eastern Economy Edition.
4. Electronic lab manual Vol I, K ANavas, Rajath Publishing.
5. Electronic lab manual Vol II, K ANavas, PHI eastern Economy Edition.

REFERENCE BOOKS

1. An advanced course in Practical Physics, D. Chattopadhayay, C.R Rakshit, New Central Book Agency Pvt. Ltd.
2. Advanced Practical Physics, S.P Singh, PragatiPrakasan.
3. A course on experiment with He-Ne Laser, R. S. Sirohi, John Wiley & Sons (Asia) Pvt. Ltd.
4. Electronic lab manual Vol II, Kuriachan T.D, Syam Mohan, Ayodhya Publishing.
5. Electronic Laboratory Primer a design approach, S. Poornachandra, B. Sasikala, Wheeler Publishing, New Delhi.

Skill Enhancement Course – I ELECTRONICS IN DAILY LIFE

I YEAR - SECOND SEMESTER

UNIT – I : ELECTRONIC COMPONENTS

Resistors – Capacitors – Resistance values – Capacitor value – Fuse wire – Transistors – Integrated chips.

UNIT – II : ELECTRICAL APPLIANCES

Switch board – Main box – Metal circuit breakers (MCB) – AC – DC currents – Two Phase – Three Phase electrical connections – generators – un intrepid power supply (UPS)- stabilizer – voltage regulators – Electrical devices – Iron box – Fan – Electrical Oven – water Heaters Air conditioners – Refrigerators – washing machines.

UNIT – III: ELECTRONIC HOME APPLIANCES

Radio – Audio taper - speaker- televisions – VCR – CD Players – DVD – calculators – Computers – scanner – Printer – Digital Camera – LCD Projectors – Display devices.

UNIT – IV: COMMUNICATIONS ELECTRONICS

Principles of optical fiber Cables (OFC) – Telephone – Mobile phones – wireless phone – Antenna - Internet - Intranet.

UNIT - V : SAFETY MECHANISM

Handling Electrical appliances - Power saving methods – Hazards Prevention Methods - Protection of Hi –Fi electronic devices.

TEXT BOOKS

1. S.S. Kamble – Electronics and Mathematics Data book – Allied publishers Ltd, 1997.
2. William David Cooper, Electronic Instrumentation and Measurement Technique, Second Edition, Prentice-Hall, 1978.
3. Electronics In Every Day Life, William Charles Vergara, Dover Publications, 1983.
4. The Importance of Electronics in Modern Life, Edubirdie, 2022.

REFERENCE BOOKS

1. Electronics in Every Day Life, Text book solutions, HW Solutions, 2003-2023, Chegg Inc.
2. Making Every day Electronics Work: A Yourself Guide, Stan Gibilisco, First Edition, 2013.
3. Human Activity Recognition: Using wearable Sensors and Smart phones, Miguel A.Labrador, Oscar D. Lara Yejas, Chapman and Hall / CRC Computer and Information Science Series, First Edition, 2013.
4. Study of Electrical Appliances and Devices –Bhatia, Kanna Publications, 2014.

WEB RESOURCES

1. https://byjus.com/physics/electronics-in-daily-life/
2. https://www.linkedin.com/pulse/e-commerce-our-daily-life-dash-technologies-inc
3. https://www.quora.com/What-are-the-most-important-electronic-devices-for-everyday-life
4. https://edubirdie.com/examples/the-importance-of-electronics-in-modern-life/

Ability Enhancement Compulsory Course - LASER PHYSICS AND APPLICATIONS

I YEAR - SECOND SEMESTER

UNIT I : PRINCIPLE

Interaction of light with matter –absorption – transmission - Stimulated absorption - spontaneous and stimulated emission - Einstein coefficients – their relations – population inversion.

UNIT II: CHARACTERISTICS

Monochromaticity – Coherence – Directionality - Brightness - Short Time Duration – Light Amplification - laser pumping – two level laser – three level laser – four level laser.

UNIT III: COMPONENTS

Components of laser - resonators – vibrational modes of resonators – open resonantors - control resonators – Q- factor – losses in the resonance cavity - Modes of laser beam – transverse modes.

UNIT IV : TYPES

Five types of lasers - Gas laser – C02 – Solid state laser – Helium Neon laser - Fiber laser – Liquid laser – Dye laser – Semiconductor laser – diode laser.

UNIT V: APPLICATIONS

Application of lasers in industry – medicine – Science - Research – instrumentation.

TEXT BOOKS

1. M.N.Aravamudhan, An introduction to Laser theory and application, S. Chand & Co. Pvt. Ltd, 2012.
2. Nityanand Chowdry and Richa Verma, Laser systems and applications, PHI, 2011.
3. R. Murugeshan and Kiruthigasivaprasath, Optics and Spectroscopy, S.Chand & Co, 2010.
4. Subrahmanyam and Brijlal, A textbook of Optics, S.Chand & Co., 2001,
5. R. Murugeshan and Kiruthigasivaprasath, Modern Physics, S.Chand & Co, 2014.

REFERENCE BOOKS

1. Lasers, Fundamentals and Applications, K. Thyagarajan, Ajoy Ghatak, Springer, 2011.
2. Lasers and Nonlinear Optics - B.B. Laud, Cambridge University Press, Second Edition, 2004.
3. Laser Physics, Peter W. Milonni, Joseph H. Eberly, John Wiley & Sons, Inc., 2010.
4. An Advances in Optics, Photonics and Optoelectronics,Prem B Bishit, IOP Publishing Ltd,2022.
5. An introduction to Laser Spectroscopy, David L.Andrews and Andrey, A.Demidov, Springer (India) Private Limited, New Delhi, 1995

WEB RESOURCES

1. https://ocw.mit.edu/courses/res-6-005-understanding-lasers-and-fiberoptics-spring-2008/resources/laser-fundamentals-i/
2. https://ehs.msu.edu/_assets/docs/laser/laser-fundamentals-pt1-springer- 2005.pdf
3. https://technav.ieee.org/topic/laser-applications
4. https://onlinelibrary.wiley.com/doi/book/10.1002/9780470409718
5. https://www.olympus-lifescience.com/en/microscope-resource/primer/lightandcolor/lasersintro/

INTERNSHIP/ INDUSTRIAL ACTIVITY

I/II YEAR- II/ III SEMESTER

Internship will be carried out during the summer vacation of the first year and the Internship report will be submitted in the Third Semester when the date fixed by the University.

The Internship/ Industrial Activity report must contain the following:

1. TITLE/COVER PAGE
2. CERTIFICATE OF THE CANDIDATE FROM THE DEPARTMENT
3. OFFER LETTER
4. INTERNSHIP COMPLETION REPORT
5. ACKNOWLEDGEMENT
6. TABLE OF CONTENTS
7. EXECUTIVE SUMMARY
8. INTRODUCTION- ABOUT THE ORGANIZATION
9. DESCRIPTION OF DUTIES AND ACCOMPLISHMENTS
10. SKILLS LEARNED
11. CHALLENGES FACED
12. CONCLUSION
13. APPENDICES
14. USE THE STAR TECHNIQUE

Core Paper-8 QUANTUM MECHANICS – II I I YEAR - THIRD SEMESTER

UNIT 1: SCATTERING THEORY

Scattering amplitude – Cross sections – Born approximation and its validity – Scattering by a screened coulomb potential – Yukawa potential – Partial wave analysis – Scattering length and Effective range theory for s wave – Optical theorem – Transformation from centre of mass to laboratory frame.

UNIT II: PERTURBATION THEORY

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

UNIT III: RELATISTIC QUANTUM MECHANICS

Klein – Gordon Equation – Charge and Current Densities – Dirac Matrices – Dirac Equation – Plane Wave Solutions – Interpretation of Negative Energy States – Antiparticles – Spin of Electron – Magnetic Moment Of An Electron Due To Spin

UNIT IV: DIRAC EQUATION

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

UNIT V: CLASSICAL FIELDS AND SECOND QUANTIZATION

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

TEXT BOOKS

1. P. M. Mathews and K. Venkatesan, A Text book of Quantum Mechanics,2nd Edition, Tata McGraw-Hill, New Delhi, 2010.
2. G. Aruldhas, Quantum Mechanics, 2nd Edition, Prentice-Hall of India, NewDelhi,2009
3. L. I. Schiff, Quantum Mechanics, 3rd Edition, International Student Edition, McGraw-Hill Kogakusha, Tokyo, 1968
4. V. Devanathan, Quantum Mechanics, 1st Edition, Narosa Publishing House, New Delhi, 2005.
5. NouredineZettili, Quantum mechanics concepts and applications, 2nd Edition, Wiley, 2017.

REFERENCE BOOKS

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

WEB SOURCES

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

Core Paper-9 **CONDENSED MATTER PHYSICS**

II YEAR - THIRD SEMESTER

UNIT I: CRYSTAL PHYSICS

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

UNIT II: LATTICE DYNAMICS

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

UNIT III: THEORY OF METALS AND SEMICONDUCTORS

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

UNIT IV: MAGNETISM

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

UNIT V: SUPERCONDUCTIVITY

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

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

TEXT BOOKS

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

REFERENCE BOOKS

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

WEB SOURCES

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

Core Paper-10 ELECTROMAGNETIC THEORY

II YEAR - THIRD SEMESTER

UNIT I: ELECTROSTATICS

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

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

UNIT II: MAGNETOSTATICS

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

UNIT III: MAXWELLEQUATIONS

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

UNIT IV: WAVEPROPAGATION

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

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

UNIT V:ELEMENTARYPLASMA PHYSICS

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

TEXT BOOKS

1. D. J.Griffiths , 2002, Introductionto Electrodynamics, 3rd Edition, Prentice-Hall of India, New Delhi.

2. J. R. Reitz, F. J. Milford and R. W. Christy, 1986, Foundations of Electromagnetic

Theory, 3rd edition, Narosa Publishing House, New Delhi.
3. J. D. Jackson, 1975, Classical Electrodynamics, Wiley Eastern Ltd. New Delhi.
4. J. A. Bittencourt, 1988, Fundamentals of Plasma Physics, Pergamon Press, Oxford.
5. Gupta, Kumar and Singh, Electrodynamics, S. Chand & Co., New Delhi

REFERENCE BOOKS

1. W. Panofsky and M. Phillips, 1962, *Classical Electricity and Magnetism*, Addison Wesley, London.
2. J. D. Kraus and D. A. Fleisch, 1999, *Electromagnetics with Applications,* 5th Edition, WCB McGraw-Hill, New York.
3. B. Chakraborty, 2002, *Principles of Electrodynamics*, Books and Allied, Kolkata.
4. P. Feynman, R. B. Leighton and M. Sands, 1998, *The Feynman Lectures on Physics*, Vols. 2, Narosa Publishing House, New Delhi.
5. Andrew Zangwill, 2013, Modern Electrodynamics, Cambridge University Press, USA

WEB SOURCES

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

Core Practical PRACTICAL – III MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

II YEAR - THIRD SEMESTER

(ANY FIFTEEN EXPERIMENTS)

1. 8-bit addition and subtraction, multiplication and division
2. Sum of a set of N data (8-bit number), picking up the smallest and largest number in an array. Sorting in ascending and descending order
3. Code conversion (8-bit number): a) Binary to BCD b) BCD to binary
4. Addition of multi byte numbers, Factorial
5. Clock program- 12/24 hours-Real time application – Six Digits Hexa Decimal and Decimal Counters
6. Interfacing of LED – Binary up/down counter, BCD up/down counter and N/2N up/down counter
7. Interfacing of seven segment display
8. Interfacing of 8-bit R / 2R ladder DAC (IC 741) – Wave form generation – Square, Rectangular, Triangular, Saw tooth and Sine waves
9. DAC 0800/ DAC 1048 interface and wave form generation (Unipolar/ Bipolar output)
10. ADC 0809 interface
11. Interfacing of DC stepper motor – Clockwise, Anti-clockwise, Angular movement and Wiper action
12. Interfacing of Temperature Controller and Measurement
13. Water level detector
14. Elevator
15. Traffic Light Controller
16. Key board Interface
17. Addition, Subtraction, Multiplication and Division of 8-bit numbers.
18. Sum of a series of 8-bit numbers
19. Average of N numbers
20. Factorial of number
21. Fibonacci series of N terms
22. Multi byte Addition / Subtraction Sorting
23. g in ascending and descending order – Picking up smallest and largest number
24. LED interface – Binary up/down counter, BCD up/down counter, Ring and twisted ring counter.

25. Interfacing seven segment displays
26. DAC 0800 / 1408 interface and wave form generation
27. ADC interfacing
28. Stepper motor interfacing
29. Temperature controller and Measurements
30. Traffic light controller

TEXT BOOKS

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

REFERENCE BOOKS

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

Professional Competency Course - COMMUNICATION ELECTRONICS

II YEAR – THIRD SEMESTER

UNIT I: ANTENNAS AND WAVE PROPAGATION

Radiation field and radiation resistance of short dipole antenna-grounded antenna-ungrounded antenna-antenna arrays-broadside and end side arrays-antenna gain-directional high frequency antennas-sky wave-ionosphere- Ecles and Larmor theory- Magnento ionic theory-ground wave propagation.

UNIT II: MICROWAVES

Microwave generation—multi cavity Klystron-reflex klystron-magnetron travelling wave tubes (TWT) and other microwave tubes-MASER-Gunn diode-wave guides-rectangular wave guides-standing wave indicator and standing wave ratio(SWR).

UNIT III: RADAR AND TELEVISION

Elements of a radar system-radar equation-radar performance Factors radar transmitting systems-radar antennas-duplexers-radar receivers and indicators-pulsed systems-other radar systems- colour TV transmission and reception-colour mixing principle-colour picture tubes- Delta gun picture tube-PIL colour picture tube-cable TV, CCTV and theatre TV.

UNIT IV: OPTICAL FIBER

Propagation of light in an optical fibre-acceptance angle-numerical aperture-step and graded index fibres-optical fibres as a cylindrical wave guide-wave guide equations-wave guide equations in step index fibres - fibre losses and dispersion-applications.

UNIT V: SATELLITE COMMUNICATION

Orbital satellites-geostationary satellites-orbital patterns-satellite system link models-satellite system parameters-satellite system link equation link budget-INSAT communication satellites.

TEXT BOOKS

1. Hand book of Electronics, Gupta and Kumar, 2008 edition.
2. Electronic communication systems – George Kennedy and Davis, Tata McGraw Hill, 4th edition, 1988.
3. Taub and Schilling, principles of communication systems, second edition, Tata Mc Graw Hill, 1991.
4. M. Kulkarani, Microwave and radar engineering, Umesh Publications, 1998.
5. Mono Chrome and colour television, R. R. Ghulathi, Prabhat Prakasan, 1990.

REFERENCE BOOKS

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

WEB SOURCES

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

Ability Enhancement Compulsory Course - SEWAGE AND WASTE WATER TREATMENT AND REUSE
I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: RECOVERY AND REUSE OF WATER

Recovery & Reuse of water from Sewage and Waste water: Methods of recovery: Flocculation - Sedimentation - sedimentation with coagulation - Filtration - sand filters - pressure filters - horizontal filters - vector control measures in industries - chemical and biological methods of vector eradication

UNIT II: DISINFECTION

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

UNIT III: CHEMICAL DISINFECTION

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

UNIT IV: PHYSICAL DISINFECTION

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

UNIT V: INDUSTRIAL VISIT

Industrial visit – data collection and analysis – presentation.

TEXT BOOKS

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

REFERENCE BOOKS

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

WEB SOURCES

1. https://www.google.co.in/books/edition/Drinking_Water_DisinfectionTechniques/HVbNBQAAQBAJ?hl=en
2. https://www.meripustak.com/Integrated-Solid-Waste-Management-Engineering-Principles-And-Management-Issues-125648?
3. .https://www.meripustak.com&gclid=Cj0KCQjwuuKXBhCRARIsAC-M0iVpismAJN93CHA1sX6NuNeOKLXfQJjxHCOVH3QXjJ1iACq30KofoaAmFsEALw_wcB
4. https://www.amazon.in/Design-Wastewater-Treatment-Systems-CV-424/dp/B00IG2PI6K/ref=asc_df_B00IG2PI6K/?tag=googleshopmob-21&linkCode=df0&hvadid=397013004690&hvpos=&hvnetw=g&hvrand=4351305881865063672&hvpone=&hvptwo=&hvqmt=&hvdev=m&hvdvcmdl=&hvlocint=&hvlocphy=9061971&hvtargid=pla-890646066127&psc=1&ext_vrnc=hi

Core Paper-12 NUCLEAR AND PARTICLE PHYSICS

II YEAR - FOURTH SEMESTER

UNIT I: NUCLEAR MODELS

Liquid drop model – Weizacker mass formula – Isobaric mass parabola –Mirror Pair - Bohr Wheeler theory of fission – shell model – spin-orbit coupling – magic numbers – angular momenta and parity of ground states – magnetic moment – Schmidt model – electric Quadrapole moment - Bohr and Mottelson collective model – rotational and vibrational bands.

UNIT II: NUCLEAR FORCES

Nucleon – nucleon interaction – Tensor forces – properties of nuclear forces – ground state of deuteron – Exchange Forces - Meson theory of nuclear forces – Yukawa potential – nucleon-nucleon scattering – effective range theory – spin dependence of nuclear forces - charge independence and charge symmetry – isospin formalism.

UNIT III:NUCLEAR REACTIONS

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

UNIT IV: NUCLEAR DECAY

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

UNIT V: ELEMENTARY PARTICLES

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

TEXT BOOKS

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

REFERENCE BOOKS

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

WEB SOURCES

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

Core Paper-13 SPECTROSCOPY II YEAR - FOURTH SEMESTER

UNIT I: MICROWAVE SPECTROSCOPY

Rotational spectra of diatomic molecules - Rigid Rotor (Diatomic Molecules)-reduced mass – rotational constant - - Effect of isotopic substitution - Non rigid rotator – centrifugal distortion constant- Intensity of Spectral Lines- Polyatomic molecules – linear – symmetric asymmetric top molecules - Hyperfine structure and quadrupole moment of linear molecules - Instrumentation techniques – block diagram -Information Derived from Rotational Spectra- Stark effect- Problems.

UNIT II: INFRA-RED SPECTROSCOPY

Vibrations of simple harmonic oscillator – zero-point energy- Anharmonic oscillator – fundamentals, overtones and combinations- Diatomic Vibrating Rotator- PR branch – PQR branch- Fundamental modes of vibration of H_2O and CO_2 -Introduction to application of vibrational spectra- IR Spectrophotometer Instrumentation (Double Beam Spectrometer) – Fourier Transform Infrared Spectroscopy - Interpretation of vibrational spectra– remote analysis of atmospheric gases like N_2O using FTIR by National Remote Sensing Centre (NRSC), India– other simple applications.

UNIT III: RAMAN SPECTROSCOPY

Theory of Raman Scattering - Classical theory – molecular polarizability – polarizability ellipsoid - Quantum theory of Raman effect - rotational Raman spectra of linear molecule - symmetric top molecule – Stokes and anti-stokes line- SR branch -Raman activity of H_2O and CO_2 -Mutual exclusion principle- determination of N_2O structure -Instrumentation technique and block diagram -structure determination of planar and non-planar molecules using IR and Raman techniques - FT Raman spectroscopy- SERS.

UNIT IV: RESONANCE SPECTROSCOPY

Nuclear and Electron spin-Interaction with magnetic field - Population of Energy levels - Larmor precession- Relaxation times - Double resonance- Chemical shift and its measurement - NMR of Hydrogen nuclei - Indirect Spin -Spin Interaction – interpretation of simple organic molecules - Instrumentation techniques of NMR spectroscopy – NMR in Chemical industries- MRI Scan.

Electron Spin Resonance: Basic principle –Total Hamiltonian (Direct Dipole-Dipole interaction and Fermi Contact Interaction) – Hyperfine Structure (Hydrogen atom) – ESR Spectra of Free radicals –g-factors – Instrumentation - Medical applications of ESR.

UNIT V:UV SPECTROSCOPY

Origin of UV spectra - Laws of absorption – Lambert Bouguer law – Lambert Beer law - molar absorptivity – transmittance and absorbance - Color in organic compounds- Absorption by organic Molecule -Chromophores -Effect of conjugation on chromophores - Choice of Solvent and Solvent effect - Absorption by inorganic systems - Instrumentation - double beam UV-Spectrophotometer - Simple applications

TEXT BOOKS

1. C. N. Banwell and E M McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.
2. G. Aruldhas, 1994, Molecular Structure and Molecular Spectroscopy, Prentice–Hall of India, New Delhi.
3. D.N. Satyanarayana, 2001, Vibrational Spectroscopy and Applications, New Age International Publication.
4. B.K. Sharma, 2015, Spectroscopy, Goel Publishing House Meerut.
5. P.S.Kalsi, 2016, Spectroscopy of Organic Compounds (7^{th} Edition), New Age International Publishers.

REFERENCE BOOKS

1. J. L. McHale, 2008, Molecular Spectroscopy, Pearson Education India, New Delhi.
2. J. M. Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.
3. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol. I, Chapman and Hall, New York.
4. K. Chandra, 1989, Introductory Quantum Chemistry, Tata McGraw Hill, New Delhi.
5. W.Demtroder, Laser Spectroscopy: Basic concepts and Instrumentation, Springer.

WEB SOURCES

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

Core Paper- 14 NUMERICAL METHODS AND COMPUTER PROGRAMMING

II YEAR - FOURTH SEMESTER

UNIT I: SOLUTIONS OF EQUATIONS

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

UNIT II: LINEAR SYSTEM OF EQUATIONS

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

UNIT III: INTERPOLATION AND CURVE FITTING

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

UNIT IV: DIFFERENTIATION, INTEGRATION AND SOLUTION OFDIFFERENTIAL EQUATIONS

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

UNIT V: PROGRAMMING WITH C

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

TEXT BOOKS

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

REFERENCE BOOKS

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

WEB SOURCES

1. https://www.scribd.com/doc/202122350/Computer-Oriented-Numerical-Methods-by-V-RajaRaman
2. https://www.scirp.org/(S(lz5mqp453edsnp55rrgjct55))/reference/referencespapers.aspx?referenceid=1682874
3. https://nptel.ac.in/course/122106033/
4. https://nptel.ac.in/course/103106074/
5. https://onlinecourses.nptel.ac.in/noc20_ma33/preview

Core Practical PRACTICAL - IV NUMERICAL METHODS AND COMPUTER PROGRAMMING (FORTRAN/C)

II YEAR - FOURTH SEMESTER

(ANY FIFTEEN EXPERIMENTS)

1. Program for matrix addition, subtraction and multiplication.
2. Program for transpose of a matrix.
3. Lagrange interpolation with Algorithm, Flow chart and output.
4. Newton forward interpolation with Algorithm, Flow chart and output.
5. Newton backward interpolation with Algorithm, Flow chart and output.
6. Curve-fitting: Least squares fitting with Algorithm, Flow chart and output.
7. Numerical integration by the trapezoidal rule with Algorithm, Flow chart and output.
8. Numerical integration by Simpson's rule with Algorithm, Flow chart and output.
9. Numerical solution of ordinary first-order differential equations by the Euler method with Algorithm, Flow chart and output.
10. Numerical solution of ordinary first-order differential equations by the Runge- Kutta method with Algorithm, Flow chart and output.
11. Numerical solution of wave functions of simple harmonic oscillator.
12. Computer simulation of Kroning- Penny Model.
13. Finding Roots of a Polynomial - Bisection Method.
14. Finding Roots of a Polynomial - Newton Raphson Method.
15. Solution of Simultaneous Linear Equation by Gauss elimination method.
16. Solution of Ordinary Differential Equation by Euler.
17. Runge Kutta Fourth Order Method for solving first order Ordinary Differential Equations.
18. Write a program to solve heat equation- finite difference method.
19. Newton's cotes formula
20. Trapezoidal rule
21. Simpson's 1/3 rule
22. Simpson's 3/8 rule
23. Boole's rule
24. Gaussian quadrature method (2 point and 3 point formula)
25. Giraffe's root square method for solving algebraic equation

TEXT BOOKS

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

REFERENCE BOOKS

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

Core Paper-16 **PROJECT WITH VIVA VOCE**

II YEAR -FOURTH SEMESTER

Each candidate shall be required to take up a research project under the supervision of the qualified teachers in the department. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the student in the beginning of the final year. At the end of fourth semester student should submit project report on or before the date fixed by the University. The Project will be evaluated by the project Guide as an internal examiner and an external examiner nominated by the University. The viva – voce examination will be conducted to assess the knowledge of the candidate and the results of the title of the project. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT /EVALUATION /VIVA-VOCE:

DISTRIBUTION OF MARKS:

I.	Assessment of the Project (CIA)	: 25 Marks
II.	Evaluation of the Project report	: 50 Marks
III.	Viva voce examination	: 25 Marks
	Total	: 100Marks

I. ASSESSMENT OF THE PROJECT (Internal):

a)	Plan of the project submission	: 20 Marks
b)	Individual Initiative	: 05 Marks
	Total	: 25 Marks

II. EVALUATION OF THE PROJECT REPORT (Internal and External):

a)	Execution of the Plan/Collection of Data/ Organisation of Materials / Presentation of the report /Novelty of the project	: 40 Marks
b)	Presentation of project in state level/National level Seminar / Publication	: 10 Marks
	Total	: 50Marks

III. VIVA VOCE EXAMINATION (Internal and External) :

Preparation, Presentation of work and response to questions : 25 Marks

A candidate shall be declared to have passed in the Project work if he/she gets not less than 50% in each of the Project Report and Viva-voce and also not than 50% in the aggregate of both the marks for Project Report and Viva-voce.

A candidate who gets less than 50% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce when the date fixed by the University.

Skill Enhancement Course - III CHARACTERIZATON OF MATERIALS

II YEAR – FOURTH SEMESTER

UNIT I: THERMAL ANALYSIS

Introduction – thermogravimetric analysis (TGA) – instrumentation – determination of weight loss and decomposition products – differential thermal analysis (DTA)- cooling curves – differential scanning calorimetry (DSC) – instrumentation – specific heat capacity measurements – determination of thermomechanical parameters.

UNIT II: MICROSCOPIC METHODS

Optical Microscopy: optical microscopy techniques – Bright field optical microscopy – Dark field optical microscopy – Dispersion staining microscopy - phase contrast microscopy –differential interference contrast microscopy - fluorescence microscopy - confocal microscopy - - digital holographic microscopy - oil immersion objectives - quantitative metallography - image analyzer.

UNIT III: ELECTRON MICROSCOPY AND SCANNING PROBE MICROSCOPY

SEM, EDAX, EPMA, TEM: working principle and Instrumentation – sample preparation –Data collection, processing and analysis- Scanning tunneling microscopy (STEM) - Atomic force microscopy (AFM) - Scanning new field optical microscopy.

UNIT IV: ELECTRICAL METHODS AND OPTICAL CHARACTERISATION

Two probe and four probe methods- van der Pauw method – Hall probe and measurement – scattering mechanism – C-V characteristics – Schottky barrier capacitance – impurity concentration – electrochemical C-V profiling – limitations. Photoluminescence – light – matter interaction – instrumentation – electroluminescence – instrumentation – Applications.

UNIT V: X-RAY AND SPECTROSCOPIC METHODS

Principles and instrumentation for UV-Vis-IR, FTIR spectroscopy, Raman spectroscopy, ESR, NMR, NQR, XPS, AES and SIMS-proton induced X-ray Emission spectroscopy (PIXE) – Rutherford Back Scattering (RBS) analysis-application - Powder diffraction - Powder diffractometer -interpretation of diffraction patterns - indexing - phase identification - residual stress analysis - Particle size, texture studies - X-ray fluorescence spectroscopy - uses.

TEXT BOOKS

1. R. A. Stradling and P. C. Klipstain. Growth and Characterization of semiconductors. Adam Hilger, Bristol, 1990.
2. J. A. Belk. Electron microscopy and microanalysis of crystalline materials. Applied Science Publishers, London, 1979.
3. Lawrence E. Murr. Electron and Ion microscopy and Microanalysis principles and Applications. Marcel Dekker Inc., New York, 1991
4. D. Kealey and P. J. Haines. Analytical Chemistry. Viva Books Private Limited, New Delhi, 2002.
5. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).

REFERENCE BOOKS

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

WEB SOURCES

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

Ability Enhancement Compulsory Course **SOLAR PHYSICS**

II YEAR – FOURTH SEMESTER

UNIT I: THE STRUCTURE OF THE SUN

The interior – Thermonuclear Fusion- The Surface Atmosphere- The inner Corona- The outer Corona – Sun spots- Solar Wind – Solar Flare.

UNIT II : SURVEY OF PLANETS

Colour –magnitude relation, H R diagrams, Different spectral types of stars, Star formation in Molecular clouds, Stellar Evolution, End state of stars : Supernova, Neutron star and Black hole.

UNIT III: OUR GALAXY

.

Our Galaxy: Milky way, structure and morphology of our galaxy, Galactic rotation, Missing Mass Problem - Normal Galaxies, Classification scheme for external galaxies, Hubble's law .

UNIT IV: ASTRONOMICAL MEASUREMENTS AND TELESCOPES

.

Basic optics and optical telescopes, Detectors: photographic plate, Photo Multiplier Tube (PMT), Charge Coupled Device (CCD).

UNIT IV: OUR GALAXY

.

Our Galaxy: Milky way, structure and morphology of our galaxy, Galactic rotation, Missing Mass Problem - Normal Galaxies, Classification scheme for external galaxies, Hubble's law .

UNIT V: COSMOLOGY

.

The origin and evolution of universe, Standard and Alternate cosmologies.

TEXT BOOKS

1. Modern Astrophysics - B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co., 2007.
2. Introductory Astronomy and Astrophysics - M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing, 1998.
3. Textbook of Astronomy and Astrophysics with elements of cosmology - V.B. Bhatia, Narosa Publication, 2001.
4. Physics of Solar Flares and Coronal Mass Ejections - Dr. Bojan Vrnak, Create Space Independent Publishing Platform, 2015.
5. K.D.Abhyankar, Astrophysics:Stars and Galaxies, Tata McGraw Hill Publication, 1992.

REFERENCE BOOKS

1. Physics of the Sun: A First Course (Pure and Applied Physics) 1st Edition, Dermott J.Mullan, Chapman and Hall/CRC, 2009.
2. Physics of the Sun: A First Course, Dermott J. Mullan, CRC Press, 2022.
3. Lectures on Solar Physics, H.M. Antia, A.Bhatnagar, Peter Ulmschneider, Springer, 2008.
4. New Millennium Solar Physics, MJ. Aschwanden ·Springer, 2019.

5. Introduction to Ultrahigh Energy Cosmic Ray Physics, *Pierre Sokolsky, Gordon Thomson*, CRC Press, 2020.

WEB RESOURCES

1. https://est-east.eu/web-resources#EducationalProjects
2. https://www.nso.edu/for-public/educators/journeytothesun/jtts-curriculum/
3. http://solar-center.stanford.edu/
4. http://solar.physics.montana.edu/YPOP/
5. https://hesperia.gsfc.nasa.gov/sftheory/flare.htm

Elective : List 1 1.ENERGY PHYSICS I/II YEAR - FIRST/THIRD SEMESTER

UNIT I: INTRODUCTION TO ENERGY SOURCES

Conventional and non-conventional energy sources and their availability–prospects of Renewable energy sources– Energy from other sources–chemical energy–Nuclear energy– Energy storage and distribution

UNIT II: ENERGY FROM THE OCEANS

Energy utilization–Energy from tides–Basic principle of tidal power–utilization of tidalenergy – Principle of ocean thermal energy conversion systems.

UNIT III: WIND ENERGY SOURCES

Basic principles of wind energy conversion–power in the wind–forces in the Blades– Wind energy conversion–Advantages and disadvantages of wind energy conversion systems (WECS) - Energy storage–Applications of wind energy.

UNIT IV: ENERGY FROM BIOMASS

Biomass conversion Technologies– wet and dry process– Photosynthesis -Biogas Generation: Introduction–basic process: Aerobic and anaerobic digestion – Advantages of anaerobic digestion– factors affecting bio digestion and generation of gas- bio gas from waste fuel– properties of biogas- utilization of biogas.

UNIT V: SOLAR ENERGY SOURCES

Solar radiation and its measurements–solar cells: Solar cells for direct conversion of solar energy to electric powers–solar cell parameter–solar cell electrical characteristics– Efficiency–solar water Heater –solar distillation– solar cooking–solar greenhouse – Solar pond and its applications.

TEXT BOOKS

1. G.D. Rai, Non – convention sources of, 4th edition, Khanna publishers, New Delhi(1996).
2. S. Rao and Dr.ParuLekar, Energy technology, Khanna publishers(1994).
3. M.P. Agarwal, Solar Energy, S. Chand and Co., New Delhi (1983).
4. Solar energy, principles of thermal collection and storage by S. P. Sukhatme, 2nd edition, Tata McGraw-Hill Publishing Co. Lt., New Delhi (1997).
5. Ramesh C Bansal and Ahmed F Zobaa, Handbook Of Renewable Energy Technology & System,World Scientific(2021).

REFERENCE BOOKS

1. Renewable energy resources, John Twidell and Tonyweir, Taylor and Francis group, London and New York.
2. Applied solar energy, A. B. Meinel and A. P. Meinal

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

WEB SOURCES

1. https://www.open.edu/openlearn/ocw/mod/oucontent/view.php?id=2411&printable=1
2. https://www.nationalgeographic.org/encyclopedia/tidal-energy/
3. https://www.ge.com/renewableenergy/wind-energy/what-is-wind-energy
4. https://www.reenergyholdings.com/renewable-energy/what-is-biomass/
5. https://www.acciona.com/renewable-energy/solar-energy/

Elective: List 1 **2. CRYSTAL GROWTH AND THIN FILMS**

I/II YEAR – FIRST/THIRD SEMESTER

UNIT I: CRYSTAL GROWTH KINETICS

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

UNIT II: CRYSTALLIZATION PRINCIPLES

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

UNIT III: GEL, MELT AND VAPOUR GROWTH

Gel, Melt and Vapour growth techniques Principle of Gel techniques - Various types of Gel - Structure and importance of Gel - Methods of Gel growth and advantages - Melt techniques - Czochralski growth - Floating zone - Bridgeman method - Horizontal gradient freeze - Flux growth - Hydrothermal growth - Vapour phase growth - Physical vapour deposition - Chemical vapour deposition - Stoichiometry.

UNIT IV: THIN FILM DEPOSITION METHODS

Thin film deposition methods of thin film preparation, Thermal evaporation, Electron beam evaporation, pulsed LASER deposition, Cathodic sputtering, RF Magnetron sputtering, MBE, chemical vapour deposition methods, Sol Gel spin coating, Spray pyrolysis, Chemical bath deposition.

UNIT V: THIN FILM FORMATION

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

TEXT BOOKS

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

REFERENCE BOOKS

1. J.C. Brice, Crystal Growth Process (John Wiley, New York, 1986)
2. P. Ramasamy and F. D. Gnanam, 1983, "UGC Summer School Notes".
3. P. SanthanaRaghavan and P. Ramasamy, "Crystal Growth Processes", KRU Publications.
4. H.E. Buckley, 1951, Crystal Growth, John Wiley and Sons, New York
5. B.R. Pamplin, 1980, Crystal Growth, Pergman Press, London.

WEB SOURCES

1. https://www.youtube.com/playlist?list=PLbMVogVj5nJRjLrXp3kMtrIO8kZl1D1Jp
2. https://www.youtube.com/playlist?list=PLFW6lRTa1g83HGEihgwcy7KeTLUuBu3WF
3. https://www.youtube.com/playlist?list=PLADLRin7kNjG1Dlna9MDA53CMKFHPSi9m
4. https://www.youtube.com/playlist?list=PLXHedI-xbyr8xIl_KQFs_R_oky3Yd1Emw
5. https://www.electrical4u.com/thermal-conductivity-of-metals/

Elective - List 1 3. ANALYSIS OF CRYSTAL STRUCTURES

I/II YEAR – FIRST/THIRD SEMESTER

UNIT I: CRYSTAL LATTICE

Unit cell and Bravais lattices - crystal planes and directions - basic symmetry elements operations - translational symmetries - point groups - space groups - equivalent positions - Bragg's law - reciprocal lattice concept -Laue conditions - Ewald and limiting spheres - diffraction symmetry - Laue groups.

UNIT II: DIFFRACTION

X-ray generation, properties - sealed tube, rotating anode, synchrotron radiation - absorption - filters and monochromators Atomic scattering factor - Fourier transformation and structure factor - anomalous dispersion - Laue, rotation/oscillation, moving film methods- interpretation of diffraction patterns - cell parameter determination - systematic absences - space group determination.

UNIT III: STRUCTURE ANALYSIS

Single crystal diffractometers - geometries - scan modes - scintillation and area detectors -intensity data collection - data reduction - factors affecting X-ray intensities - temperature and scale factor - electron density - phase problem - normalized structure factor - direct method fundamentals and procedures -Patterson function and heavy atom method - structure refinement - least squares method - Fourier and difference Fourier synthesis - R factor - structure interpretation - geometric calculations - conformational studies - computer program packages.

UNIT IV: POWDER METHODS

Fundamentals of powder diffraction - Debye Scherrer method - diffractometer geometries - use of monochromators and Soller silts - sample preparation and data collection - identification of unknowns - powder diffraction files (ICDD) - Rietveld refinement fundamentals - profile analysis - peak shapes - whole pattern fitting - structure refinement procedures – auto-indexing – structure determination from powder data - new developments. Energy dispersive X-ray analysis – texture studies - crystallite size determination - residual stress analysis - high and low temperature and high pressure crystallography (basics only).

UNIT V: PROTEIN CRYSTALLOGRAPHY

Globular and fibrous proteins, nucleic acids - primary, secondary, tertiary and quaternary structures - helical and sheet structures - Ramachandran map and its significance – crystallization methods for proteins - factors affecting protein crystallization - heavy atom derivatives – methods used to solve protein structures - anomalous dispersion methods.

TEXT BOOKS

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

REFERENCE BOOKS

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

WEB SOURCES

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

Elective : List 1 **4. MATERIALS SCIENCE**

I/II YEAR - FIRST/THIRD SEMESTER

UNIT I: OPTOELECTRONIC MATERIALS

Importance of optical materials – properties: Band gap and lattice matching – optical absorption and emission – charge injection, quasi-Fermi levels and recombination – optical absorption, loss and gain. Optical processes in quantum structures: Inter-band and intra-band transitions Organic semiconductors. Light propagation in materials – Electro-optic effect and modulation, electro-absorption modulation – exciton quenching.

UNIT II: CERAMIC MATERIALS

Ceramic processing: powder processing, milling and sintering – structural ceramics: zirconia, almina, silicon carbide, tungsten carbide – electronic ceramics – refractories – glass and glass ceramics

UNIT III: POLYMERIC MATERIALS

Polymers and copolymers – molecular weight measurement – synthesis: chain growth polymerization – polymerization techniques – glass transition temperature and its measurement – viscoelasticity – polymer processing techniques – applications: conducting polymers, biopolymers and high temperature polymers.

UNIT IV: COMPOSITE MATERIALS

Particle reinforced composites – fiber reinforced composites – mechanical behavior – fabrication methods of polymer matrix composites and metal matrix composites – carbon/carbon composites: fabrication and applications.

UNIT V: NEW MATERIALS

Shape memory alloys: mechanisms of one-way and two-way shape memory effect, reverse transformation, thermo-elasticity and pseudo-elasticity, examples and applications -bulk metallic glass: criteria for glass formation and stability, examples and mechanical behavior - nanomaterials: classification, size effect on structural and functional properties, processing and properties of Nano crystalline materials, single walled and multi walled carbon nanotubes

TEXT BOOKS

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

REFERENCE BOOKS

1. B. S. Murty, P. Shankar, B. Raj, B. B. Rath and J. Murday. Textbook of Nanoscience and Nanotechnology. Springer- Verlag, 2012.
2. K. Yamauchi, I. Ohkata, K. Tsuchiya and S. Miyazaki (Eds). Shape Memory and Super Elastic Alloys: Technologies and Applications. Wood head Publishing Limited, 2011.
3. Lawrence H. Van Vlack, 1998. Elements of Materials Science and Engineering, 6th Edition, Second ISE reprint, Addison-Wesley.
4. H. Iabch and H. Luth, 2002, Solid State Physics – An Introduction to Principles of Materials Science, 2nd Edition, Springer.
5. D. Hull & T. W. Clyne, An introduction to composite materials, Cambridge University Press, 2008.

WEB SOURCES

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

Elective : List 1 **5. PHYSICS OF NANO SCIENCE AND TECHNOLOGY**

I/II YEAR – FIRST/THIRD SEMESTER

UNIT I: FUNDAMENTALS OF NANOSCIENCE AND TECHNOLOGY

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

UNIT II: PROPERTIES OF NANOMATERIALS

Physical properties of Nanomaterials: Melting points, specific heat capacity, and lattice constant - Mechanicalbehavior: Elastic properties – strength - ductility - superplastic behavior- Optical properties: - Surface Plasmon Resonance – Quantum size effects – Electrical properties - Conductivity, Ferroelectrics and dielectrics - Magnetic properties – super para magnetism – Diluted magnetic semiconductor (DMS).

UNIT III: SYNTHESIS AND FABRICATION

Physical vapour deposition - Chemical vapour deposition – sol-gel – Wet deposition techniques – electrochemical deposition method – Plasma arching - Electrospinning method - ball milling technique - pulsed laser deposition – Nanolithography: photolithography –Nanomanipulator.

UNIT IV: CHARACTERIZATION TECHNIQUES

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

UNIT V: APPLICATIONS OF NANOMATERIALS

Sensors: Nanosensors based on optical and physical properties - Electrochemical sensors – Nano-biosensors. Nano Electronics: Nanobots - display screens - GMR read/write heads - Carbon Nanotube Emitters –Photocatalytic application: Air purification, water purification -Medicine: Imaging of cancer cells – biological tags - drug delivery - photodynamic therapy - Energy: fuel cells - rechargeable batteries -supercapacitors-photovoltaics.

TEXT BOOKS

1. A textbook of Nanoscience and Nanotechnology, Pradeep T., Tata McGraw-Hill Publishing Co. (2012).
2. Principles of Nanoscience and Nanotechnology, M.A. Shah, Tokeer Ahmad, Narosa Publishing House Pvt Ltd., (2010).
3. Introduction to Nanoscience and Nanotechnology, K. K. Chattopadhyay and A.N. Banerjee, PHI Learning Pvt. Ltd., New Delhi, (2012).
4. Nanostructured Materials and Nanotechnology, Hari Singh Nalwa, Academic Press, (2002).

5. NanotechnologyandNanoelectronics,D.P.Kothari,V. Velmurugan and Rajit Ram Singh, Narosa Publishing House Pvt. Ltd, New Delhi, (2018).

REFERENCE BOOKS

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

WEB SOURCES

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

Elective : List 2 **6. PLASMA PHYSICS**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: FUNDAMENTAL CONCEPTS OF PLASMA

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

UNIT II: MOTION OF CHARGED PARTICLES IN ELECTRIC AND MAGNETIC FIELD

Particle description of plasma- Motion of charged particle in electrostatic field- Motion of charged particle in uniform magnetic field - Motion of charged particle in electric and magnetic fields- Motion of charged particle inhomogeneous magnetic field - Motion of charged particle in magnetic mirror confinement - motion of an electron in a time varying electric field- Magneto-hydrodynamics - Magneto-hydrodynamic equations – Condition for magneto hydrodynamic behaviour.

UNIT III: PLASMA OSCILLATIONS AND WAVES

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

UNIT IV: PLASMA DIAGNOSTICS TECHNIQUES

Single probe method - Double probe method - Use of probe technique for measurement of plasma parameters in magnetic field - microwave method - spectroscopic method - -laser as a tool for plasma diagnostics-X-ray diagnostics of plasma - acoustic method - conclusion.

UNIT V: APPLICATIONS OF PLASMA PHYSICS

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

TEXT BOOKS

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

REFERENCE BOOKS

1. Chen, F. F. Introduction to Plasma Physics. 2nd ed., New York, NY: Springer, 1984. ISBN: 9780306413322.
2. Introduction to Plasma Theory-D.R. Nicholson, John Wiley & Sons, 1983.
3. Shohet, J. L. The Plasma State. San Diego, CA: Academic Press Inc., 1971. ISBN: 9780126405507.
4. Hazeltine, R. D., and F. L. Waelbroeck. The Framework of Plasma Physics. Boulder, CO: Westview Press, 2004. ISBN: 9780813342139.
5. Huddlestone, R. H., and S. L. Leonard. Plasma Diagnostic Techniques. San Diego, CA: Academic Press, 1965.

WEB SOURCES

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

Elective : List 2 **7. BIO PHYSICS**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: CELLULAR BIOPHYSICS

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

UNIT II: MOLECULAR BIOPHYSICS

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

UNIT III: MEMBRANE AND NEURO BIOPHYISCS

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

UNIT IV: RADIATION BIO PHYSICS

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

UNIT V: PHYSICAL METHODS IN BIOLOGY

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

TEXT BOOKS

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

5. Bioinstrumentation, L. Veerakumari, MJP Publishers, 2006.

REFERENCE BOOKS

1. Chemical Biophysics by Daniel A Beard (Cambridge University Press, 2008).
2. Essential cell biology by Bruce Albert et al (Garland Science)
3. Biophysics, W. Hoppe, W. Lohmann, H. Markl and H. Ziegler. Springer Verlag, Berlin (1983).
4. Membrane Biophysics by Mohammad Ashrafuzzaman, Jack A. Tuszynski, (Springer science & business media).
5. Biological spectroscopy, Iain D. Campbell, Raymond A. Dwek, Benjamin-Cummings Publishing,1984.

WEB SOURCES

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

Elective: List 2 **8. NONLINEAR DYNAMICS**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: GENERAL

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

UNIT II: COHERENT STRUCTURES

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

UNIT III: BIFURCATIONS AND ONSET OF CHAOS

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

UNIT V APPLICATIONS

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

TEXT BOOKS

1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics: Integrability, Chaos and Patterns. Springer, 2003.
2. A. Hasegawa and Y. Kodama, Solitons in Optical Communications. Oxford Press, 1995.
3. Drazin, P. G. Nonlinear Systems. Cambridge University Press, 2012. ISBN: 9781139172455.
4. Wiggins, S. Introduction to Applied Nonlinear Dynamical Systems and Chaos. Springer, 2003. ISBN: 9780387001777.
5. Strogatz, Steven H. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering,West view Press, 2014. ISBN: 9780813349107.

REFERENCE BOOKS

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

WEB SOURCES

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

Elective: List 2 **9. GENERAL RELATIVITY AND COSMOLOGY**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: TENSORS

Tensors in index notation - Kronecker and Levi Civita tensors - inner and outer products - contraction - symmetric and antisymmetric tensors - quotient law - metric tensors - covariant and contravariant tensors - vectors - the tangent space - dual vectors - tensors - tensor products - the Levi-Civita tensor - tensors in Riemann spaces.

UNITII: TENSORS FIELD

Vector-fields, tensor-fields, transformation of tensors - gradient and Laplace operator in general coordinates - covariant derivatives and Christoffel connection - Elasticity: Field tensor - field energy tensor - strain tensor - tensor of elasticity- curvature tensor

UNIT III: GENERAL RELATIVITY

The space time interval - the metric - Lorentz transformations - space-time diagrams - world-lines - proper time - energy-momentum vector - energy-momentum tensor - perfect fluids - energy-momentum conservation - parallel transport - the parallel propagator - geodesics - affine parameters - the Riemann curvature tensor - symmetries of the Riemann tensor - the Bianchi identity.

UNIT IV: TENSOR IN RELATIVITY

Ricci and Einstein tensors - Weyl tensor - Killing vectors - the Principle of Equivalence - gravitational redshift - gravitation as space-time curvature - the Newtonian limit - physics in curved space-time - Einstein's equations - the Weak Energy Condition - causality - spherical symmetry - the Schwarzschild metric - perihelion precession.

UNIT V: COSMOLOGY

Expansion of the Universe - thermal history - and the standard cosmological model - Friedmann - Robertson-Walker type models of the Universe - Primordial inflation and the theory of cosmological fluctuations - Theory and observations of the cosmic microwave background and of the large-scale structure of the Universe - Dark matter and dark energy - theoretical questions and observational evidence - inflation - origin of galaxies and other open problems.

TEXT BOOKS

1. M. R. Spiegel, *Vector Analysis, Schaum'a outline series*, McGraw Hill, New York, 1974.
2. James Hartle, *Gravity: An introduction to Einstein's general relativity*, San Francisco, Addison-Wesley, 2002

3. Sean Carroll, *Spacetime and Geometry: An Introduction to General Relativity*, (Addison-Wesley, 2004).
4. Jerzy Plebanski and AndrzejKrasinski, *An Introduction to General Relativity and Cosmology*, Cambridge University Press 2006
5. Meisner, Thorne and Wheeler: *Gravitation* W. H. Freeman & Co., San Francisco 1973.

REFERENCE BOOKS

1. Robert M. Wald: *Space, Time, and Gravity: the Theory of the Big Bang and Black Holes*, Univ. of Chicago Press.
2. J. V. Narlikar, *Introduction to Cosmology*, Jones & Bartlett, 1983.
3. Steven Weinberg, *Gravitation and Cosmology*, New York, Wiley, 1972.
4. Jerzy Plebanski and AndrzejKrasinski, *An Introduction to General Relativity and Cosmology*, Cambridge University Press 2006.
5. R Adler, M Bazin& M Schiffer, *Introduction to General Relativity*, McGraw Hill Higher Education; 2nd edition, 1975.

WEB SOURCES

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

Elective : List 2 **10.ADVANCED OPTICS**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT 1: POLARIZATION AND DOUBLE REFRACTION

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

UNIT II: LASERS

Basic principles – Spontaneous and stimulated emissions – Components of the laser – Resonator and lasing action – Types of lasers and its applications – Solid state lasers – Ruby laser – Nd:YAG laser – gas lasers – He-Ne laser – CO_2 laser – Chemical lasers – HCl laser – Semiconductor laser

UNIT III: FIBER OPTICS

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

UNIT IV: NON-LINEAR OPTICS

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

UNIT V: MAGNETO-OPTICS AND ELECTRO-OPTICS

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

TEXT BOOKS

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

REFERENCE BOOKS

1. F. S. Jenkins and H. E. White, Fundamentals of Optics, (4th Edition), McGraw – Hill International Edition,1981.
2. Dieter Meschede, 2004, Optics, Light and Lasers, Wiley – VCH, Varley GmbH.

3. Lipson, S. G. Lipson and H. Lipson,Optical Physics, 4th Edition, Cambridge University Press, New Delhi, 2011.
4. Y. B. Band, Light and Matter, Wiley and Sons (2006).
5. R. Guenther, Modern Optics, Wiley and Sons (1990).

WEB SOURCES

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

Elective : List 3 11. ADVANCED SPECTROSCOPY

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: MOLECULAR SPECTROSCOPY AND GROUP THEORY

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

UNIT II: LASER SPECTROSCOPY

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

UNIT III: MOSSBAUER SPECTROSCOPY

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

UNIT IV: XRAY PHOTOELECTRON SPECTROSCOPY

Principle – XPS spectra and its interpretation- ECSA-EDAX- other forms of XPS – chemical shift - Applications : - stoichiometric analysis- electronic structure- XPES techniques used in astronomy, glass industries, paints and in biological research

UNIT V: MOLECULAR MODELLING

Determination of force constants- force field from spectroscopic data-normal coordinate analysis of a simple molecule (H2O) – analyzing thermodynamic functions, partition functions, enthalpy, specific heat and related parameters from spectroscopic data- molecular modelling using data from various spectroscopic studies

TEXT BOOKS

1. William Kemp, 2019, Organic Spectroscopy (2nd Edition) MacMillan, Indian Edition.
2. C N Banwell and McCash, 1994, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw–Hill, New Delhi.

3. D.N. Satyanarayana, 2001, *Vibrational Spectroscopy and Applications*, New Age International Publication.
4. B.K. Sharma , 2015, *Spectroscopy*, Goel Publishing House Meerut.
5. J M Hollas, 2002, Basic Atomic and Molecular Spectroscopy, Royal Society of Chemistry, RSC, Cambridge.

REFERENCE BOOKS

1. Demtroder. W, Laser Spectroscopy: Basic concepts and Instrumentation, Springer, 1996.
2. B. P. Straughan and S. Walker, 1976, Spectroscopy Vol I., Chapman and Hall, New York, 1976.
3. J. L.McHale, Molecular Spectroscopy, Pearson Education India, New Delhi, 2008.
4. David. L. Andrews**,** Introduction to Laser Spectroscopy, Springer, 2020.
5. Kalsi.P.S, Spectroscopy of Organic Compounds (7^{th} Edition) New Age International Publishers, 2016.

WEB SOURCES

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

Elective : List 3 12. MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: 8085 PROGRAMMING, PERIPHERAL DEVICES AND THEIR INTERFACING

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

UNIT II:8085 INTERFACING APPLICATIONS

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

UNIT III:8051 MICROCONTROLLER HARDWARE

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

UNIT IV: 8051 INSTRUCTION SET AND ASSEMBLY LANGUAGE PROGRAMMING

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

UNIT V: INTERRUPT PROGRAMMING AND INTERFACING TO EXTERNAL WORLD

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

TEXT BOOKS

1. A. Nagoor Kani, Microprocessors & Microcontrollers, RBA Publications (2009).
2. A. P. Godse and D. A. Godse, Microprocessors, Technical Publications, Pune (2009).

3. Ramesh Gaonkar, Microprocessor Architecture, Programming and Applications with 8085, Penram International Publishing (2013).
4. B. Ram, Fundamentals of Microprocessors & Microcontrollers, DhanpatRai publications New Delhi (2016).
5. V. Vijayendran, 2005, Fundamentals of Microprocessor-8085", 3rd Edition S.VisvanathanPvt, Ltd.

REFERENCE BOOKS

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

WEB SOURCES

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

Elective : List 3 **13. MEDICAL PHYSICS**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: X-RAYS AND TRANSDUCERS

Electromagnetic Spectrum – Production of X-Rays – X-Ray Spectrum –Bremsstrahlung – Characteristic X-Ray – X-Ray Tubes – Coolidge Tube – X-Ray Tube Design – Thermistors – photo electric transducers – Photo voltaic cells – photo emissive cells –Photoconductive cells– piezoelectric transducer

UNIT II: BLOOD PRESSURE MEASUREMENTS

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

UNIT III: RADIATION PHYSICS

Radiation Units – Exposure – Absorbed Dose – Rad to Gray – Kera Relative Biological Effectiveness –Effective Dose – Sievert (Sv) – Inverse Square Law – Interaction of radiation with Matter – Linear Attenuation Coefficient – Radiation Detectors –Thimble Chamber – Condenser Chambers – Geiger Counter – Scintillation Counter

UNIT IV: MEDICAL IMAGING PHYSICS

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

UNIT V:RADIATION PROTECTION

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

TEXT BOOKS

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

REFERENCE BOOKS

1. Muhammad Maqbool, An Introduction to Medical Physics, 1st ed, Springer International Publishing, 2017.
2. Daniel Jirák, FrantišekVítek, Basics of Medical Physics, 1st ed, Charles University, Karolinum Press, 2018
3. Anders Brahme, Comprehensive Biomedical Physics, Volume 1, 1st ed, Elsevier Science, 2014.
4. K. Venkata Ram, Bio-Medical Electronics and Instrumentation, 1st ed, Galgotia Publications, New Delhi, 2001.
5. John R. Cameron and James G. Skofronick, 2009, Medical Physics, John Wiley Interscience Publication, Canada, 2nd edition.

WEB SOURCES

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

Elective: List 3 **14. SOLID WASTE MANAGEMENT**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: SOLID WASTE MANAGEMENT

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

UNIT II: SOLID WASTE CHARACTERISTICS

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

UNIT III: TOOLS AND EQUIPMENT

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

UNIT IV: ECONOMIC DEVELOPMENT

SWM for economic development and environmental protection - Linking SWM and climate change and marine litter.

UNIT V: INDUSTRIAL VISIT

SWM Industrial visit – data collection and analysis – presentation.

TEXT BOOKS

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

REFERENCE BOOKS

1. Municipal Solid Waste Management, Christian Ludwig, Samuel Stucki, Stefanie Hellweg, Springer Berlin Heisenberg, 2012.

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

WEB SOURCES

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

Elective: List 3 **15. SOLAR ENERGY UTILIZATION**

I/II YEAR – SECOND/THIRD SEMESTER

UNIT I: HEAT TRANSFER & RADIATION ANALYSIS

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

UNIT II: SOLAR COLLECTORS

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

UNIT III: SOLAR HEATERS

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

UNIT IV: SOLAR ENERGY CONVERSION

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

UNIT V: NANOMATERIALS IN FUEL CELL APPLICATIONS

Use of nanostructures and nanomaterials in fuel cell technology - high and low temperature fuel cells, cathode and anode reactions, fuel cell catalysts, electrolytes, ceramic catalysts. Use of Nano technology in hydrogen production and storage.

Industrial visit – data collection and analysis - presentation

TEXT BOOKS

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

REFERENCE BOOKS

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

WEB SOURCES

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

MODEL QUESTION PAPER PATTERN

M.Sc., PHYSICS DEGREE EXAMINATION

SEMESTER : III

TITLE OF THE PAPER CONDENSED MATTER PHYSICS

Time : 3 Hours **Maximum Marks : 75**

Part – A (15 x 1 = 15 Marks)
Answer All Questions

1. Miller indices for octahedral plane in cubic crystal _____
   a. (100) b. (110) c. (111) d. (101)

2. The Bragg's angle theta is fixed in _____
   a. Roentgen diffraction method b. Debye-Scherrer's diffraction method
   c. Laue diffraction method d. All of the above3.In

3. In the BCC structure, the packing fraction is _____
   a. 0.068 b. 0.68 c. 6.8 d. None of the these

4. The effective number of lattice points in a primitive unit cell is_____
   a. one b. two c. zero d. four

5. The Total number of states in first Brillouin zone of one-dimensional crystal of length L willbe (a-distance between lattice points)
   a. L/a b.$2L^2/a$ c. L^2/a d. La

6. In Debye's theory of specific heat of solids, the frequency of vibrations of lattice has_____
   a.continuous spectrum up to a finite value b. Some discrete value
   c. Fixed value d. None of these

7. The Widemann-Franz law connects the
   a. Thermal conductivity and electrical conductivity of a material
   b. Thermal conductivity and specific heat of a material
   c. Thermal intertia and specific heat of a material
   d. None of the above

8. In a good conductor, the energy gap between the conduction band and the valance band is_____
   a. infinite b. wide c. narrow d. zero

9. Which of the following quantities cannot be measured using Hall Effect?

a. Mobility of change caviers b. Carrier concentration
c. Type of semiconductors (p or n) d. Diffusion constant

10. For paramagnetic materials, magnetic susceptibility (X) is_____

a. Positive & small b. Negative & small
c. Negative & large d. Positive & large

11. Which one of the following is not a ferromagnetic material?

a. Cobalt b. Iron c. Nickel d. Bismuth

12. Curie-Weiss law is_____

a. $X_m = C/T$ b. $X_m = C/\Theta$.

c. $X_m = C/(T-\Theta)$ d. $X_m = CT$

13. Energy band gap of an insulting material is_____

a. 0 eV b. greater than 5 eV c. less than 5eV d. none14.The London equation in a super conductor is___

a. $\nabla^2 B = B (m c^2) / (4 \pi n q^2)$

b. $\nabla^2 B = B (m c^2) / (4 \pi n q^2)^{1/2}$

c. $\nabla^2 B = B (m c^2) / (4 \pi n q^2)^2$

d. $\nabla B = B (m c^2) / (4 \pi n q^2)$

15. SQUIDS are used to measure_____associate with brain and chest.
a. Power b. Energy c. Stress d. Voltages

Part-B (2x5=10Marks)
Answer Any Two Questions

16. What are miller indices? Illustrate with examples.

17. What is Phonon? Derive an expression for phonon momentum.

18. Explain the Widemann-Franz law.

19. Explain the Quantum theory of Ferromagnetism.

20. Describe the Meissner effect. Mention the applications of Superconductors.

Part-C (5x10=50Marks)
Answer All the Questions

21. a). Derive Bragg's law. Describe and explain X-ray spectrometer method of determining the wavelength of X-rays.

(or)

b). Write a detail note on inert gas crystals?

22. a). What are Brillouin Zones? Describe and give the sketches of the first Brillouin zonesof BCC & FCC lattices.

(or)

b). What is Umkalpp Phonon process? Give the importance of V-process in explainingthe thermal conductivity in non-metallic solids.

23. a). Discuss Kronig-penney model for a linear lattice. How does it lead to the formationof energy bands in solids?

(or)

b). Give an account of the de Hass-van Alphen effect. Explain how it provides a Powerful method for the study of Fermi surface.

24. a). Discuss Quantum theory of Para magnetism.

(or)

b). Give the details of Ferromagneticdomains and its types.

25. a). Give the qualitative description of the BCS theory. How does it account for the superconducting state?

(or)

b) Write notes on following:

i. DC Josepson effect.

ii. AC Josepson effect.

MODEL QUESTION PAPER PATTERN
M.Sc., PHYSICS DEGREE EXAMINATION
SEMESTER : IV

CORE PAPER - 12 NUCLEAR AND PARTICLE PHYSICS

Time : 3 Hours **Maximum Marks : 75**

Part – A (15 x 1 = 15 MARKS)

Answer All Questions

1. Which of the following explain the process of Nuclear-Fission?

(a) Liquid drop model (b) Proton-proton cycle

(c) Independent particle model of the nucleus (d) Somerfield model

2. An isotope without any neutron is

(a) Tritium (b) Deuterium (c) Protium (d) None of these

3. How many neutrons are in the $_{11}Na^{23}$ atom?

(a) 12 (b) 11 (c) 18 (d) 24

4. Which of the following is correct for the nuclear force?

(a) Nuclear forces are charge independent

(b) Nuclear forces are the central force

(c) Both 1 and 2

(d) None of these

5. What is the force that bind proton and neutrons in a nucleus?

(a) Electromagnetic force (b) Weak force

(c) Gravitational force (d) Strong nuclear force

6. According to yukawa's theory of nuclear forces, the origin of nuclear force between nucleons is due to the exchange of

(a) mesons (b) protons (c) electrons (d) None of these

7. The mass number of an element is not changed, when it emits_____radiations.

(a) α & γ (b) α, β & γ (c) α & β (d) β & γ

8. 1 amu is equivalent to?

(a) 931 Mev (b) 93.1 ev (c) 9.31 ev (d) 931 J

9. What type of reaction takes place in sun?

(a) Nuclear fusion (b) Nuclear fission

(c) Spontaneous fission (d) Double beta decay

10. A free neutrons decays spontaneously into proton, an electron and _____

(a) A neutrino (b) An antineutrino (c) Both (d) None of these

11. The decay of the proton to neutron is

(a) Not possible as proton mass is less than the neutron mass.

(b) Possible only inside the nucleus

(c) Always possible as it is associated only with β^+ decay

(d) Not possible

12. The unit of Radioactivity

(a) Becqueral (b) Gauss (c) Kelvin (d) Newton

13. An antiproton is an atomic particle that has

(a) the mass of a proton and the charge of an electron

(b) the mass of an electron and the charge of a proton

(c) the mass of a neutron and charge of a proton

(d) None of these

14. The quark model content of neutron is

(a) uud (b) uuu (c) udd (d) ddd

15. Which of the following is not Bosons?

(a) Pion (b) Photon (c) muon (d) None of these

Part – B (2x 5 = 10 Marks)
Answer any two questions out of Five

16. Explain the weizacker mass formula.

17. Explain the meson theory of nuclear forces.

18. Explain the Reciprocity theorem.

19. Explain the nuclear isomerism.

20. Explain the four types of interactions.

Part – C (5x10=50Marks)
Answer all questions

21. a) Explain in detail about the liquid drop model.

(or)

b) Explain in detail about the shell model.

22. a) Explain the ground state of deuteron.

(or)

b) Explain the nucleon-nucleon interaction.

23. a) Explain the Breit wigner one level formula

(or)

b) Explain the nuclear chain reaction.

24. a) Explain in detail about Fermi theory of β decay.

(or)

b) Explain the allowed and forbidden decay.

25. a) Explain the classification of elementary particles.

(or)

b) Explain in detail about Quark model for Baryons and mesons.

MODEL QUESTION PAPER PATTERN
M.Sc., PHYSICS DEGREE PRACTICAL EXAMINATIONS
SEMESTER : I

TITLE OF THE PAPER PRACTICAL I – GENERAL PHYSICS EXPERIMENTS
Time : 3 Hours Maximum Marks : 75

1. Determine the Young's modulus of glass plate and Poisson's ratio of the given glass plate by forming Elliptical fringes.
2. Determine (i). Thickness of a wire (ii). Diameter of a circular aperture and (iii) Wavelength of He-Ne Laser/Diode laser using diffracting grating.
3. Determine the Refractive index of two liquids using Laser.
4. Determine the value of Refractive index of a liquid using Biprism.
5. Determine (i) the thickness of Fabry-Perot Etalon (ii)the change in wavelength for shift of one fringe and (iii)the change in wavelength of a satellite line associated with a main line.
6. Determine the wavelength of the given monochromatic source using Michelson's Interferometer.
7. Determine the velocity of Ultrasonic waves in the given liquid using Ultrasonic Interferometer. Also determine the compressibility of the given liquid. Also determine the Compressibility of the given liquid.
8. Calculate the Charge of an Electron using Spectrometer.
9. Determine the following using Hall effect in Semiconductor:(i). Charge of the carriers (ii).Hall voltage (iii).Hall Coefficient (iv).Carrier density.
10. Determine the band gap energy and temperature coefficient of a thermistor.
11. Determine the Absorption coefficient using GM Counter.
12. Using the given experimental setup, determine the value of Stefan's constant.
13. Determine the magnetic susceptibility of the given liquid by Guoy's method.
14. Determine the resistivity of a Semiconductor by Four Probe Method.
15. Using Quincke's method, determine volume susceptibility and mass susceptibility of a paramagnetic solution.

MODEL QUESTION PAPER PATTERN
M.Sc., PHYSICS DEGREE PRACTICAL EXAMINATIONS
SEMESTER : II

TITLE OF THE PAPER **PRACTICAL II - ANALOG AND DIGITAL EXPERIMENTS**

Time : 3 Hours **Maximum Marks : 75**

1. Construct adder, subtractor, differentiator and integrator circuit using the given OP-AMP and verify its outputs.
2. Construct an FET amplifier circuit, based on its output draw the characteristiccurve.
3. Construct a monostable multivibrator using IC 555 and measure the pulse width for different R and C values. Also, Construct and study the behaviour of bistable multivibrator using IC 555 timer.
4. Study the Voltage–Ampere characteristic curve of the Tunnel Diode.
5. Obtain the Voltage–Ampere characteristic curve of the UJT and hence calculate the intrinsic stand-off ratio.
6. Construct a single and multistage RC coupled amplifier and study its frequencyresponse.
7. Construct an astable multivibrator using IC 555 and study its operation.
8. Study the operation and characteristics of SCR and determine the forward breakover voltage.
9. Construct a multiplexer and demultiplexer circuits and verify their truth tables.
10. Using NAND gates, construct a half-adder and full-adder circuit and verify itsoutputs.
11. Using IC 7476, construct a Shift register and verify its truth table.
12. Construct the half adder and full adder circuits using NAND gates.
13. Construct the BCD counter circuit and verify its operation.
14. Construct Flip flops – RS, JK, Master Slave and T flip flops and study theirperformance.
15. Construct a decimal to BCD encoder using IC 7432 OR gates and study itsperformance.

MODEL QUESTION PAPER PATTERN
M.Sc., PHYSICS DEGREE PRACTICAL EXAMINATIONS
SEMESTER : III

TITLE OF THE PAPER PRACTICAL III - MICROPROCESSOR 8085 AND MICROCONTROLLER 8051

Time : 3 Hours **Maximum Marks : 75**

1. Write an ALP to find (i).square of a given number (ii).square root of given number.
2. Write a program to convert ASCII to HEX using microprocessor 8085 and store their results in the desired locations.
3. Write and execute the program for sum of 'n' numbers using 8085 microprocessor.
4. Write and execute the program to find out ascending and descending order of numbers.
5. Write and execute the programs for interfacing of DAC with 8085 microprocessors to generate square, saw tooth and triangular waves.
6. Write and execute the program for largest and smallest number in a set of numbers.
7. Write an assembly language program to interface the stepper motor using microprocessor8085 and verify the function of the stepper motor.
8. Write an assembly language program to interface the water level detector using microprocessor 8085 and verify the function of the water level detector.
9. Write and execute the 8 bit Multiplication and Division programs in 8085 microprocessor.
10. Write an assembly language program to determine the factorial of a given number usingmicroprocessor 8085 and store the results in the desired locations.
11. Write and execute the program for largest and smallest number in a set of numbers.
12. Write and execute the 16-bit Multiplication and Division programs in 8086microprocessor.
13. Write and execute the program for searching a number or character in a string.
14. Write and execute the program to count number of vowels in a given string.
15. Write and execute the program to determine the sum of elements in an array.

MODEL QUESTION PAPER PATTERN
M.Sc., PHYSICS DEGREE PRACTICAL EXAMINATIONS
SEMESTER : IV

TITLE OF THE PAPER **PRACTICAL IV – NUMERICAL METHODS AND COMPUTER PROGRAMMING(FORTRAN/C)**

Time : 3 Hours **Maximum Marks : 75**

1. Write and execute the program for largest and smallest number in a set of numbers.
2. Write and execute the program for Code conversion programs using microcontroller.
3. Write and execute the 16-bit Addition and Subtraction programs in 8051microcontroller.
4. Write an assembly language program to interface the Traffic signal control using 8051Microcontroller and verify the function of the controller.
5. Write the program for Binary to BCD conversion and Hex to ASCII conversion and execute them.
6. Write the program for interfacing HEX key board interface.
7. Write and execute the program for interfacing Stepper motor control using Microcontrollers.
8. Write and execute the program for interfacing Seven segment display using Microcontrollers.
9. Write and execute the 16-bit Multiplication and Division programs in 8051Microcontroller.
10. Write and execute the program for Timer and Counter programming usingMicrocontrollers
11. Write a C programme to find the straight line fit by the method of least squares.
12. Write a C programme to find the transpose and inverse of a matrix.
13. Write a C programme to find the solution of differential equation by Fourth order Runge-Kutta Method
14. Write a C Programme to find Newton's (Forward/backward difference) and Lagrange's Interpolation.
15. Write a C Programme for calculation of standard deviation of a given range.