SACRED HEART COLLEGE (AUTONOMOUS)
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Ready for Every Good Work
A Don Bosco Institution of Higher Education, Founded in 1951 * Affiliated to Thiruvalluvar University, Vellore * Autonomous since 1987
Accredited by NAAC (4th Cycle – under RAF) with CGPA of 3.31 / 4 at 'A+' Grade

M.Sc. Physics [CBCS Pattern]
2021-22 Onwards

SEM	Subject	Title of the Paper	Ins.Hrs	Credits
I	MC	Mathematical Physics-I	5	4
	MC	Classical Mechanics and Statistical Mechanics	5	4
	MC	Quantum Mechanics-I	5	4
	MC	Advanced Physics Practicals	5	-
	MC	Electronic Experiments	6	-
	Elective	1. Electronic Devices and Applications 2. Energy and Environmental Physics 3. Astrophysics	4	4
II	MC	Mathematical Physics-II	5	4
	MC	Electromagnetic Theory	5	4
	MC	Quantum Mechanics-II	5	4
	MC	Advanced Physics Practicals	6	6
	MC	Electronic Experiments	5	6
	Elective	1. Microprocessor 8085 and Microcontroller 8051 2. Geophysics 3. Bio Physics	4	4
	SSP	1. Ultrasonics and its Applications	-	2*
		2. Dielectric Spectroscopy	-	2*
		3. Crystal growth techniques	-	2*
III	MC	Solid State Physics	5	4
	MC	Atomic and Molecular Spectroscopy	5	4
	MC	C Programming and Research Methodology	5	4
	MC	Modern Physics Practicals	5	-
	MC	Microprocessor and C Programming Experiments	5	-
	Elective	1. Nanoscience and Technology 2. Optical Physics 3.Computational Quantum Mechanics	4	4
	SSP	1. Shock Waves and High Pressure Physics in Material Science	-	2*
		2. Electrical Appliances	-	2*
		3. Research and Publication ethics	-	2*
	Core	Project	1	-
IV	MC	Electronic Instrumentation Techniques	5	4
	MC	Nuclear and Particle Physics	5	4
	MC	Modern Physics Practicals	5	6
	MC	Microprocessor and C Programming Experiments	5	6
	MC	Project	4	5
	Elective	1. Modern Optics 2. Reactor Physics	4	4

		3. Digital Signal Processing		
		Human Rights	**2**	**1**
Total			**120**	**90+4***

MC-Main Core SSP-Self Study Paper (4*)

Certificate course: **Analytical instrumentation and Characterization Techniques (2*)**

Internship/Summer research fellowship (1-3*)

Total Credits: 90+9*

Following is the evaluation procedure to be adopted for M.Sc. Physics theory papers, practicals and project for students admitted during the academic year 2021-2022 and thereafter.

1. For theory papers

Component	**Marks**
CA	50
End semester exam	50
Total	100

For theory papers, the CA will have the following components

Component	**Marks**
I CA test	15
II CA test	15
MCQ Test	10
Problem solving/Open book test/Poster presentation/E-content preparation/Seminar/Assignments	10
Total	50

Question paper pattern for CA test:

Section A (6 x 2 = 12 Marks)

Six short answer type questions. Each question carries 2 marks.

Section B (3 x 6 = 18 Marks)

Three either or type questions. Each question carries 6 marks.

Section C (2 x 10 = 20 Marks)
Answer any two out of three essay type questions. Each question carries 10 Marks.

Question paper pattern for theory papers for end semester examination:

Section A (10x 2 = 20 Marks)
Ten short answer type questions with two questions from each unit will be asked. All questions are compulsory and each question carries 2 marks.

Section B (5 x 7 = 35 Marks)
Five either or type questions. There should be one question from each unit. Each question carries 7 marks.

Section C (3 x 15 = 45 Marks)
Answer any three out of five essay type questions. There should be one question from each unit. Each question carries 15 Marks.

Minimum of two questions in Section A and a minimum of two (eithera or b) questions in Section B should be mandatorily be problems in all the core papers. Problems are not mandatory for any of the subject elective papers, however, it is highly recommended to ask problems wherever possible.

A student shall be declared to have passed in a paper, if he /she scores 50% and above in CA and semester examinations when put together, provided he /she scores a minimum of 50% in the semester examination. If a candidate fails, he/she shall be required to repeat the semester examinations in that paper.

2. For Practicals papers

Component	**Marks**
CA	50
End semester exam	50
Total	100

For Practicals, the CA will have the following components

Component	Marks
Lab performance	20
2 CA tests	20
Record	10
Total	50

Every student shall be evaluated for twenty marks in every practical session and this mark is calculated for 20 marks which is the lab performance mark. In addition to this, the students will have to appear for two CA tests of 100 marks each and this mark is calculated for 20 marks. Record carries 10 marks. The sum of these three marks is the internal mark. There shall be no passing minimum for CA. Improvement of CA will not be permitted.

The end semester practical examination is evaluated jointly by an internal examiner and an external examiner appointed by the controller of examinations. A candidate is declared to have passed in a practical paper if he/she scores an aggregate of 50% marks provided he/she scores a minimum of 25 marks in the end semester examination. The maximum mark for the end semester practical examination is 50.

3.Project and Viva

There shall be two project reviews. The students shall identify and propose a research problem and present their research plan during the first review which will be conducted during the middle of the III semester. Second project review shall be conducted during the middle of the IV semester wherein the students shall present their findings. All the final year students and all the supervisors shall be available for both the reviews.

Component	Marks
Dissertation	80
Viva-voce	20
Total	100

Candidates should submit a dissertation on or before the date fixed by the office of the controller of examinations. The dissertation shall be evaluated for 80 marks and the viva-voce examination shall be conducted for 20 marks. There shall be two evaluations of the dissertation, one by the supervisor and the other by an external examiner chosen from a panel of examiners recommended by the department. The average of the two marks shall be the mark for the dissertation. The viva- voce examination shall be conducted for 20 marks separately by the respective supervisor and the external examiner. The average of the marks awarded by the two examiners shall be the mark for the viva -voce.

4.Certificate Course

A certificate course on “Analytical instrumentation and Characterization Techniques”is offered in the second semester to provide hands-on training to handle different analytical instruments independently so as to provide them research exposure and to motivate them further towards research. Though this course is designed to suit M.Sc. Physics students, this course shall also be open to M.Sc Chemistry and M.Sc Biochemistry students due to its multidisciplinary dimensions. This course is also open to students from other neighboring colleges as well.

The fee for this course shall be fixed by the department depending on the number of takers and the revenue generated may be utilized to remunerate the resource persons. This course shall have 30 hours duration comprising both theory and practical sessions and will be conducted outside the class hours mostly on holidays. There shall be no Continuous Internal Assessment and Semester End Examination for this course, however the students must have attended minimum 30 hours to get the certificate and the credit for this certificate course is two.

5.Self-study Papers

The following self-study papers are offered to cater to the needs of bright students.

1. Ultrasonics and its applications and
2. Dielectric Spectroscopy
3. Crystal growth techniques
4. Shock Waves and High Pressure Physics in Material Science
5. Electrical Appliances
6. Research and Publication ethics

The first three papers are offered in the II semester while the last three papers are offered in the III semester. A student can choose a total of only two self-study papers, one from the first three during the II semester and one from the last three during the III semester of his/her study. There shall be no contact hours, however, there shall be an end semester examination and upon successful completion of each paper, the candidates shall be declared to have earned two extra credits.

6. Internship/Summer research fellowship

Extra credits will be given to those students who undergo internship in industries and summer research fellowship or any other similar summer/winter schools organized by national institutes/universities/collegeseither in the online or offline mode. The students shall be allowed to undergo these programmes according to their convenience in single or two slots. This is intended to provide them industry exposure so as to make them more employable/motivate them towards research. However, the credits are split according to the following slab subject to the condition that they submit a report along with a certificate duly signed by a competent authority. Students who wish to take this extra credit may be given a maximum of 15 days free attendance in order to facilitate their learning. This can be taken throughout the duration of the M.Sc programme and the students are advised to complete it before the end of the fourth semester. The research work they carry out during this fellowship period may be further extended for their project work. It is mandatory that the students have to get prior approval of the department.

Number of days	Credits
5 to 15 days	1
16 to 30 days	2
30 to 60 days	3

7.MOOC/NPTEL courses:

The students will be encouraged to select one or more MOOC/NPTEL courses during the course of the M.Sc.Programme. The students will earn two extra credits for each of the courses and the courses can either be from Physics or any non-major courses.

PSOs-POs Mapping

PSO	PO1	PO2	PO3	PO4	PO5	Mean Score
PSO1	3	2	1	3	1	2
PSO2	3	3	2	2	3	2.6
PSO3	3	2	1	3	2	2.2
PSO4	3	3	3	2	2	2.6
PSO5	3	1	2	2	3	2.2
Mean Overall Score						2.3
Result						High

Mathematical Physics - I

Semester - I **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To understand the basic concepts of matrices and complex numbers
2. To impart the knowledge of the integral transforms such as Fourier transform and Laplace transform in detail.
3. To make the students to understand and solve problems on linear differential equations and series solutions of differential equations
4. To enable the students to understand the basic principles and importance of tensor analysis,
5. To learn the basic notations, theorem and probability distribution in physics.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Revise and understand the concepts of matrices and to perform basic mathematical operations (arithmetic operations) with complex numbers in Exponential, circular functions and hyperbolic functions.	K1- K3
CO 2	Distinguish between Fourier and Laplace transform, and make them to apply the knowledge of F.T, L.T and Finite Fourier transforms in finding the solutions of differential equations, initial value problems and boundary value problems.	K1-K2
CO 3	Classify linear and partial differential equations and can solve problems of 1st and 2nd order linear differential equation, their solutions, also series solutions of linear differential equation.	K1-K3
CO 4	Understand tensors and their concise mathematical framework for formulating and solving physics problems in areas such as elasticity, fluid mechanics, and general relativity.	K1-K3
CO 5	Acquire the basic knowledge on probability concepts and theorems of probability	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcomes(PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	3	3	2	3	3	2.6
CO2	3	3	3	3	3	3	3	3	3	3	3
CO3	3	3	2	3	2	3	3	2	2	3	2.6
CO4	3	3	2	3	2	3	3	2	3	2	2.6
CO5	3	3	3	3	3	3	2	2	3	3	2.8
										Mean overall score	**2.7**
										Result	**High**

Unit-I: Matrices and Complex numbers

Matrices: Rank of matrix-Cayley-Hamilton Theorem-Eigen values and eigenvectors
Introduction to complex number - Arithmetic of Complex Numbers-Exponential and circular functions of complex numbers – Logarithmic functions of complex variables – Separation of real and imaginary parts of circular functions - Separation of real and imaginary parts of hyperbolic functions

Unit-II: Integral Transforms
Fourier transform: Fourier sine, cosine and complex integrals – Fourier sine and cosine transform (finite and infinite) – Properties of Fourier transforms (Linear property, change of scale property, shifting property and modulation theorem) - convolution theorem
Laplace Transform: Laplace formulae – Properties of Laplace transforms (Linear property – Change of scale property, first and second shifting theorems) – special functions of Laplace transform (Gamma, Bessel, error, Heaviside's unit step and Dirac delta)

Unit-III: Ordinary Differential equations:
General form of 1^{st} order linear differential equation – solution of 1^{st} order linear differential equation – General form of 2^{nd} order linear differential equation – Homogeneous differential equation – solutions with constant coefficient – series solution of linear differential equation

Unit –IV: Tensor Analysis
Introduction to tensors – transformation of coordinates-summation convention-Tensor transformation (contravarient, covariant tensors) – Rank of a tensor – Algebra of tensor: Addition, Subtraction, Product and Division (Quotient law) – Kronecker and Livi-Civita symbol – Symmetric and Anti-symmetric tensor – Isotropic tensor – Dual tensor – metric tensor – Christoffel's symbols (Both first and second kind)-Relations-transformations– Riemann curvature tensor, Ricci tensor-Tensor fields: Gradient of tensor fields (scalar, vector) – Divergence of vector – Curl of vector – Tensorial form of Gauss's and Stoke's theorem.

Unit –V: Probability
Definition-Sample space – event – probability theorem: Additive law & generalization – Multiplicative law & generalization – Probability distribution: Average – moments – constants: binomial– Poisson – Gaussian – variation – covariation and correlation.

Text Books

1. H K Dass, Dr. Rama Verma, Mathematical Physics, Sultan Chand & Sons, New Delhi, 2019
2. P Satyaprakash, Mathematical Physics, Sultan Chand & Sons, New Delhi 2019.
3. B. D, Gupta Mathematical Physics, New Delhi, Vikas publishing house, 2018.
4. B.S.Rajput, Mathematical Physics, 30^{th} edition, PragathiPrakashan, Meerut, 2017
5. G B Arfken, J Weber, Mathematical methods for physicists, Elsevier academic press, 2016
6. E Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt Ltd, New Delhi, 2015

Books for Reference

1. K F Riley, M P Hobson, Essential Matehmatical methods for physical sciences, Cambridge university press, USA, 2011
2. Suresh Chandra, A Text Book of Mathematical Physics, Narosa Publishing House, New Delhi, 2009.
3. Mary L.Boas, Mathematical methods in the physical sciences, Wiley India Pvt Ltd, New Delhi, 2006.
4. Tai L. Chow, Mathematical Methods for Physicists: A concise introduction, Cambridge university press, USA, 2000

Website references:

1. https://www.mathsisfun.com/algebra/matrix-introduction.html
2. https://yutsumura.com/linear-algebra/the-cayley-hamilton-theorem/
3. https://www.mathsisfun.com/numbers/complex-numbers.html
4. http://www.math.chalmers.se/Math/Grundutb/CTH/mve025/1516/Dokument/F-analys.pdf
5. https://nptel.ac.in/courses/111/102/111102129/
6. https://www.uou.ac.in/lecturenotes/science/MSCPHY-17/pdf%20ppt%20MATHEMATICAL%20PHYSICS%20tensor%20unit%207.pdf
7. https://www.math24.net/linear-differential-equations-first-order
8. http://www.sosmath.com/tables/diffeq/diffeq.html
9. https://nitsri.ac.in/Department/PHYSICS/M.Sc.__Mathematical_methods_for_Physics.pdf
10. https://www.stat.auckland.ac.nz/~fewster/325/notes/ch2.pdf
11. https://byjus.com/maths/probability-distribution/#:~:text=Probability%20Distribution%20Definition,outcomes%20of%20any%20random%20experiment

Classical Mechanics and Statistical Mechanics

Semester - I **Hours/week:5**
Sub. Code: **Credits: 4**

Course objectives:

1. To introduce the classical formulation approaches like Lagrangian and Hamiltonian dynamics and to study their application in mechanical systems and solving of problems.
2. To disseminate the theory and methods of Hamilton Jacobi's Formulation and small oscillation theory that can be effectively applied to solve mechanical problems.
3. To educate the students to identify, formulate and solve problems in rigid body dynamics.
4. To review the fundamental concepts of thermodynamics and to create an understanding of the principles of classical and quantum Statistical Mechanics and their applications.
5. To develop quantum simulations that bring into the statistical description using Bose-Einstein and Fermi-Dirac Statistics.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Have in-depth knowledge about Lagrangian and Hamiltonian dynamics	K1-K3
CO 2	Apply and solve problems in mechanical systems using Hamilton-Jacobi and Small Oscillations.	K1-K3
CO 3	Demonstrate and analyse principal coordinates and the principal moments of inertia for arbitrary rigid body application.	K1-K3
CO 4	Learn different statistical ensembles, their distribution functions, ranges of applicability and the corresponding thermodynamic potentials.	K1-K3
CO 5	Acquire knowledge to calculate basic thermo dynamical quantities: energy, specific heat, entropy, Helmoltz free energy, etc in classical and quantum statistical models.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	3	2	3	3	2	2	2	2	2.4
CO2	2	3	2	1	3	2	2	2	3	3	2.3
CO3	3	2	2	2	2	1	3	2	3	3	2.3
CO4	3	2	2	2	2	2	3	2	3	3	2.4
CO5	2	3	2	2	2	2	1	2	3	3	2.2
Mean Overall Score											2.3
Results											**High**

Classical Mechanics

Unit – I: Lagrangian and Hamiltonian Formalisms

Constraints–Classification-- Lagrange equation from D'Alembert's principle-Lagrange's problems(spherical pendulum)- Hamilton's equation of motion- Variational principle- deduction of Hamiltons equation from variational principle -cyclic coordinates and conservation theorems.
Canonical transformations- generating functions- condition for a function to be canonical- examples-Poisson brackets- Properties of Poisson's brackets- Invariance of Poisson's bracket under canonical transformation.

Unit – II: Hamilton-Jacobi Theory and Small Oscillations

Hamilton-Jacobi equation- Hamilton's characteristic function - Harmonic oscillator problem by Hamilton Jacobi method-Action- angle variables- Action- angle variables in systems of one degree of freedom - Application toKepler's planetary motion.
Theory of small oscillations- Normal modes - oscillations and frequencies of free vibration - linear tri atomic molecule.

Unit – III: Rigid body dynamics

Degrees of freedom -Independent coordinates of a rigid body- orthogonal transformation-Euler's angle-Euler's theorem-Moments of inertia and Products of inertia –Moment of inertia tensor-principal axes-Angular momentum and kinetic energy- Torque and angular momentum-Euler's equation of motion-torque free motion-Symmetric top –Precession and nutation.

Statistical Mechanics

Unit – IV: Basics of statistical mechanics and Fluctuations

Introduction- Ensembles- Micro canonical, Canonical and Grand canonical ensembles- average ensemble - Liouville's theorem-Entropy-Gibbs paradox-Sackur-Tetrode equation-Partition function -Derivation of partition function (micro canonical ensemble) -correlation with thermo dynamical quantities

Fluctuations and irreversible process- Fluctuations in micro canonical ensemble- Energy and concentration fluctuations in quantum statistics- one dimensional Random walk - Brownian motion.

Unit-V: Classical and Quantum Statistics

Postulates of classical statistics-Maxwell-Boltzmann distribution-application to diatomic molecule-postulates of quantum statistics-Bose-Einstein distribution-Bose-Einstein condensation-Thermodynamic properties of Bose Einstein gas-Liquid Helium-Fermi-Dirac distribution-Degeneracy-energy of Fermi gas -thermionic emission.

Text books

1. Gupta, Kumar and Sharma, Classical Mechanics, PragatiPrakashan, Meerut, 2012.
2. Palash B. Pal, An Introductory Course of Statistical Mechanics, Narosa Publishers, New Delhi, 2008.

Books for Reference

1. Vimal Kumar Jain, Classical Mechanics, Ane Books Pvt. Ltd., 2009.
2. SrinivasaRao K. N., Classical Mechanics, Universities Press (India) Pvt. Ltd, 2003.
3. Laud B. B., Fundamentals of Statistical Mechanics, New Age International (P) Ltd. Publishers, New Delhi, 1998.
4. Kamal Sigh, Sigh S. P., Elements of Statistical Mechanics, S. Chand & Company Ltd., New Delhi, 1999.
5. Upadhyaya, Classical Mechanics, Himalaya Publishing Co., New Delhi, 1999.
6. Herbert Goldstein, Charles P. Poole Jr. and John L. Safko, Classical Mechanics 3rd Edition, Addison-Wesley, 2001.
7. Calkin M. G., Lagrangian and Hamiltonian mechanics, Allied Publishers Ltd., 2000.
8. Panat P. V., Classical Mechanics, Narosa Publishers, New Delhi, 2008.
9. Madhumangal Pal, A Course on Classical Mechanics, Narosa Publishing House, New Delhi, 2009.
10. Walter Greiner, Classical Mechanics, System of Particles and Hamiltonian Dynamics, New York, Springer, 2009.
11. Agarwal B. K., Melvin Eisner, Statistical Mechanics,New Age International (P) Ltd. Publishers, New Delhi, 2005.

Websites for Reference

1. http://astro.physics.sc.edu/selfpacedunits/unit56.html
2. http://www.phy.auckland.nz/staff/smt/453310SC.html
3. http://www.damtp.cam.ac.uk/user/tong/dynamics.htm
4. http://farside.ph.utexas.edu/teaching/301/lectures/lectures.html
   http://www.lancs.ac.uk/depts/physics/teaching/py332/phys332.htm

Quantum Mechanics – I

Semester – I **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To provide an understanding of fundamental principles of quantum mechanics and the one-dimensional applications of Schrodinger's equation.
2. To introduce the students to the basic ideas of operator formalism and also to apply Schrodinger's equation for three-dimensional quantum problems.
3. To gain knowledge on matrix formalism and to analysis the symmetries and conservation laws in unitary transformations.
4. To impart the knowledge on time independent approximations in quantum mechanics.
5. To make the students to understand the concepts of angular momenta and their commutational rules and also matrix representations.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Gain knowledge of development of quantum ideas and learn the wave nature of matter, uncertainty principle, Schrodinger's wave equation and its one-dimensional applications.	K1-K3
CO 2	Understand the operator formalism and its application for one dimensional and three-dimensional quantum problems.	K1-K3
CO 3	Gain knowledge on matrix formalism and unitary transformations.	K1-K3
CO 4	Understand the importance of few time dependent approximations and their applications.	K1-K3
CO 5	Acquire the knowledge on angular momentum, identical particles and Pauli's spin matrices.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	3	2	2	2	3	2	2	2.4
CO2	2	3	2	1	1	2	2	2	3	3	2.1
CO3	3	2	2	2	2	2	3	2	3	3	2.4
CO4	1	2	2	2	2	2	3	2	2	3	2.1
CO5	2	3	2	2	2	2	2	2	3	3	2.3
Mean Overall Score											2.3
Results											**High**

Unit – I: Basic formalism

Origin of matter waves – Time dependent and independent Schrodinger wave equations for free particles – uncertainty relation – Physical interpretations of wave functions –probability current density – Continuity equation – Stationary states – Expectation value –Ehrenfest's theorem by Schrodinger method.

One dimensional applications: particles in a square well potential with rigid walls – Barrier penetration through a square potential – transmission probability– particle in a periodic potential (Qualitative study) – Bloch waves – Simple Harmonic Oscillator by Schrodinger method.

Unit – II: Three Dimensional Problems and operator formalism

Three dimensional problems: Schrodinger equation in spherical polar coordinates– system of two interactive particles – reduction – rigid rotator – particle in a spherically symmetric potential – Hydrogen atom.

Operator formalism: linear operators-significant properties–Hermitian operator- properties-simultaneous measurability of observables: commuting operators-commutationrelations of position and momentum – Hamiltonian operators –Ehrenfest'stheorem by operator method – Ladder operators – Simple Harmonic Oscillator byoperator method.

Unit – III: Matrix Formalism and Symmetry in Quantum Mechanics

Hilbert's space–operators as matrices – matrix form of wave function– unitary transformations–Representation of Co–ordinate andMomentum in Schrodinger, Heisenberg and Interaction pictures–Symmetries and conservation laws: Unitary transformations associated with translations, rotations–Parity and time reversal.

Unit – IV: Time independent approximation Methods

Time independent perturbation theory for non-degenerate and degenerate cases –Applications to ground state of anharmonic oscillator –Variation method – Application to ground state of Helium atom – WKB approximation method – WKB quantization rule – Application to Simple Harmonic Oscillator.

Unit – V: Angular Momentum, Identical Particles and spin

Angular momentum operators – Commutation rules – Ladder operators – Eigen valuespectrum from angular momentum algebra – Matrix representation of angular momentum –Spin angular momentum– Addition of twoangular momenta – Clebsch–Gordan coefficients for $j_1 = j_2 = ½$– Symmetry and anti–symmetry of wavefunctions – Pauli's spin matrices.

Text Books

1. SatyaPrakash, Swati Saluja, Quantum Mechanics, KedarnathRamnath, Meerut, 2012.
2. Guptha Kumar Sharma, Quantum Mechanics, Jai prakashNath publications, Meerut,2012.
3. Aruldhas.G, Quantum Mechanics, Prentice Hall of India Pvt. Ltd., New Delhi, 2007.

Books for Reference

1. David J.Griffith, Introduction to Quantum Mechanics, Pearson EducationInternational, London, 2005.
2. Mathews P.M. andVenkatesan K., A Text book of Quantum Mechanics, Tata McGrawHill, New Delhi, 2010.
3. Chaddha G. S. Quantum Mechanics, New Age International (P) Ltd. Publishers, New Delhi,2006.
4. Thankappan V. K., Quantum Mechanics, New Age International (P) Ltd. Publishers, New Delhi, 2008.
5. Singh S. P. Bagde M. K., Kamal Singh, Quantum Mechanics, S.Chand and company Pvt. Ltd, New Delhi, 2000.
6. Devanathan.V, Quantum Mechanics, Narosa Publishing House, New Delhi, 2005.
7. Murugesan R., Modern Physics, S. Chand & Company Ltd., New Delhi, 2010.
8. Devanarayanan S. Quantum Mechanics, Scitech Publications (India) Pvt. Ltd., 2005.
9. Kamal Singh, Singh S.P., Elements of Quantum Mechanics, New Delhi, S.Chand and company Pvt. Ltd, New Delhi, 2005.

Websites for Reference

1. http://www.netsa.org.lk/OcwWeb/Physics/index.htm
2. http://www.theory.caltech.edu/people/preskill/ph229/
3. http://www.nscl.msu.edu/~pratt/phy851/lectures/lectures.html
4. http://walet.phy.umist.ac.uk/QM/LectureNotes/
5. http://www.ks.uiuc.edu/Services/Class/PHYS480/
6. http://www.mat.univie.ac.at/~gerald/ftp/book–schroe/index.html
7. http://people.deas.harvard.edu/~jones/ap216/lectures/lectures.html
8. http://www.netsa.org.lk/OcwWeb/Chemistry/5–73Introductory–Quantum MechanicsIFall2002/LectureNotes/index.htm
9. http://www.glue.umd.edu/~fivel/

Elective: Electronic Devices and Applications

Semester-I **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To introduce structures, physical operations and circuit applications of semiconductor devices.
2. To develop the ability design electronic circuits and to grasp the basic ideas of op-amps and its applications.
3. To acquaint and demonstrate the concepts on waveform generators using Op-amp and 555 timer.
4. To understand analog and digital signals and conversion techniques .
5. To impart the fixed function of combinational and sequential logical circuits and their implementation.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the characteristics and applications of special purpose diodes.	K1-K2
CO 2	Analyze input/output relations for various applications of Op-amp in analog circuits.	K1-K3
CO 3	Explain the operation of oscillators and multivibrators using op-amp and 555 timer.	K1-K2
CO 4	Recognize the relationship between digital and analog values in D/A and A/D converters.	K1-K3
CO 5	Analyze, design and implement combinational and sequential logic circuits	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	1	2	2	2	3	2	1	2.1
CO2	2	3	2	2	2	2	2	2	3	3	2.3
CO3	3	2	2	2	2	3	3	2	3	3	2.5
CO4	3	2	2	3	2	2	3	2	3	3	2.5
CO5	2	3	2	2	2	2	3	2	3	3	2.4
Mean Overall Score											2.4
Results											**High**

Unit-I: Special Devices

UJT– construction – working – characteristics– relaxation oscillator – Thyristors –Silicon controlled rectifier (SCR) – working – Equivalent circuit of SCR –characteristics–SCR as switch–SCR half-wave and full-wave rectifiers–LASCR–DIAC –construction–characteristics– TRIAC–construction–characteristics.

Unit-II: Op-Amp applications

Op-amp – characteristics –CMRR –Integrator – differentiator – comparator – Log and Antilog amplifiers – Instrumentation amplifier – V to I and I to V converters – Sample and Hold circuits – Analog computation: Solving Simultaneous equations and Second order differential equations – Design of Op-Amp Low pass, High pass and Band pass active filters (first order only).

Unit - III: Waveform generators

Op-amp:Phase shift oscillator– Wein bridge oscillator (no derivation) –Astablemultivibrator– Triangular wave generator –saw tooth wave generator.

555 Timer: Functional diagram – Monostablemultivibrator–Astablemultivibrator–Schmitt trigger.

Unit – IV D/A and A/D Converters

Basic DAC and ADC Techniques – D/A converters:Binary Weighted Resistor – R-2R ladder D/A converters. A/D converters: Counter type– Successive approximation type –Dual slope–parallel comparator A/D converters

Unit- V: Sequential and Combinational Circuits

Sequential circuits: Flip-Flops–JK and JK master slave flip-flops – Shift registers: Shift right shift register – Shift left shift register. Counters: Synchronous and Asynchronous decade counters – 4-bit binary up/down counters

Combinational Circuits: Multiplexer (2:1, 4:1)–Demultiplexer (1:2, 1:4)–Encoder –Decimal to BCD encoder –Decoder: 2 to 4 decoder– 3 to 8 decoder–BCD to Decimal decoder–BCD to Seven segment decoder (7447).

Books for study:

1. V. K. Mehta, Principles of Electronics, S. Chand & Co. Ltd., New Delhi, 2008.
2. Vijayendran.V, Introduction to Integrated Electronics: Digital and Analog, Third Reprint, S.Viswanathan (Printers &Publishers), PVT., Ltd, 2007.
3. Roy Choudhury.D and ShailB.Jain, Linear Integrated Circuits, 4th edition, New AgeInternational (P) Ltd, Chennai,2010.

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1. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Third Edition, Prentice Hall India, New Delhi,1997.
2. Donald P Leach, Albert Paul Malvino and GoutamSaha, Digital Principles and Applications, Sixth Edition, Tata McGrawHill publishing company Ltd, New Delhi,2008.
3. Allen Mottershead, Electronic devices and circuits, Prentice Hall India, New Delhi, 2000.
4. A.S.Sedra and K.C. Smith, Microelectronic Circuits, 6th edition, Oxford University Press, 2010.
5. Kenneth C. Smith, KC's Problems and Solutions for Microelectronic Circuits, 6th edition,Oxford University Press, New York 2009.
6. G. Roberts and A.S. Sedra, Spice,3rd edition, Oxford University Press, 1996.

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2. https://www.tutorialspoint.com/power_electronics/power_electronics_triac.htm
3. https://www.electronics-tutorials.ws/power/unijunction-transistor.html

4. https://www.circuitstoday.com/lascr-light-activated-scr
5. https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_basics_of_operational_amplifier.htm
6. https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_log_and_anti_log_amplifiers.htm
7. https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_digital_to_analog_converters.htm
8. https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_waveform_generators.htm
9. https://www.tutorialspoint.com/linear_integrated_circuits_applications/linear_integrated_circuits_applications_555_timer.htm
10. http://generalengineering.sjsu.edu/docs/pdf/mse_prj_rpts/spring2010/Successive%20Approximation%20Analog%20to%20Digital%20Converter.pdf
11. http://plc.cwru.edu/tutorial/enhanced/files/lcd/intro.htm
12. http://vsagar.com/2011/12/16/how-ic-555-works-fundamentals-of-ic-555-its-basicapplications/
13. http://www.ti.com/lit/ds/symlink/lm555.pdf
14. http://www.youtube.com/watch?v=nV_AtmUS7lE

Elective: Energy and Environmental Physics

Semester-I | **Hours/week: 4**
Sub. Code: | **Credits: 4**

Course objectives:

1. To introduce the students to energy and various types of energy conversion techniques, energy collection and laws of thermodynamics.
2. To impart the knowledge on nonrenewable energy to the students.
3. To ensure that the students gain knowledge regarding renewable energy.
4. To introduce the students regarding Bioenergy Resources and Fuel Cells
5. To enlighten the students regarding the energy crisis and environmental pollution and to inculcate various means to control pollution to safeguard environment.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Gain knowledge about energy, energy harvesting and saving.	K1-K3
CO 2	Acquire ideas about nonrenewable energy.	K1-K3
CO 3	Understand and gain knowledge about renewable energy.	K1-K3
CO 4	Gain knowledge about Biomass and various types of Fuel Cells.	K1-K3
CO 5	Be aware of environmental pollution and will know how to control them.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	3	3	2	2	3	2	2.4
CO2	2	2	2	2	3	3	2	2	3	3	2.4
CO3	3	2	2	2	3	3	2	2	3	3	2.5
CO4	3	2	2	2	3	3	2	2	3	3	2.5
CO5	3	3	2	2	3	3	2	2	3	3	2.6
										Mean Overall Score	2.5
										Results	**High**

Unit - I: Energy and Thermodynamics

Energy- Concept and demand of energy - Growing energy needs - Environmental ethics - over exploitation of energy sources and associated problems - use of alternate energy sources- the first and second laws of thermodynamics - Free energy - Converting heat in to work - Reversible process –Carnot theorem - Conversion of matter in to more useful forms – Conversion of energy - Synthetic chemical fuels - Electrochemical energy conversion– Nuclear fission reactors - Fission power and environment - Role of an individual in conservation of natural resources - Conservation of the energy.

Unit - II: Nonrenewable Energy

Fossil fuels - Classification of fossil fuels, composition, physico- chemical characteristics and energy content of coal, petroleum, and natural gas - Origin and use of coal, coal –power plant - Cleaner coal combustion - Origin and uses of petroleum and natural gas - Composition and classification of petroleum and natural gas - Petroleum refinery - Gas hydrates- Environmental problems associated with petroleum.

Unit - III: Renewable energy

Introduction - Types: Solar energy, geothermal, wind energy - Principals of generation of hydroelectric power - Principals of generation of solar electric power – Solar cell fabrication - I-V characteristics- Factors limiting the efficiency of silicon solar cells - Principles of Solar Water Heating System- Natural and Forced Circulation types - Principals of generation of electric power from wind - Ocean thermal energy conversion - Waste as renewable sources of energy - types of waste, classification based on chemical nature and physical state, composition of the waste - conversion of methane in to synthetic gas - factors effecting methane formation- Management of renewable energy.

Unit - IV: Bioenergy Resources and Fuel Cells

Biomass as a source of energy: Biomass and its uses - Classification of biomass – Biodiesel from Jatropha - Advantages and disadvantages of biodiesel - Storage and use of biodiesel - Biogas as a rural energy source - Biogas production mechanism from organic wastes - Gasification and combustion of biomass- Bioethanol production. Fuel cells: Hydrogen fuel cell, metal hydrate fuel cell, microbial fuel cell.

Unit - V: Environmental Pollution

Global warming as an energy problem - Impact of climate change on energy demand – Ozone layer depletion- Climate changes - Acid rain - Sea level raises - Nature and manmade disasters - air pollution - Types and sources of air pollutants - Methods to control air pollution - water pollution - Types and sources of water Pollutants - Methods to control water pollution - soil pollution - Types and sources of soil pollutants- - Methods to control soil pollution- Biodegradable plastics- Bio fertilizers - Bio pesticides.

Books for Study

1. Taylor and Miller,Environmental Science -10th Edition, Thomson Asia Pvt. Ltd. Publications, Singapore, 2008.
2. ViswanathanB,An Introduction to Energy Sources- Indian Institute of Technology, Madras, 2006.
3. Boyle GF Renewable Energy - Power for a Sustainable Future, Second edition, Oxford University Press, 2004.
4. Singh, J.S., Singh S.P. and Gupta S. R. Ecology, Environment and Resource Conservation, Anamaya Publishers, New Delhi, 2006.

Books for Reference

1. Glyll Henry and Gary W. Heinke Environmental Science and Engineering Pearson Education, New Delhi, 1996.
2. John Andrews and Nick Jelly ,Energy Science: Principle, Technologies, and Impacts - Oxford University Press, 2007.
3. Kurian Joseph and Nagendra R Essential of Environmental Studies, Pearson Education, New Delhi, 2004.
4. Sharma BK and Kaur SH Environmental Chemistry. GoelPublishing House, Meerut 1992.
5. Sukhatme K., Suhas P. Sukhatme, Solar Energy: Principles of Thermal Collection andStorage, Tata Mc-Graw Hill, New Delhi, 2006.
6. Nelson J., The Physics of Solar Cells, Imperial College Press, 2003.
7. Duffie J.A. and Beckman W.A., Solar Thermal Energy Engineering, John Wiley & Sons, 1990.
8. Mary D. Archer, Robert W. Hill, Clean Electricity from Photovoltaics, Imperial College Press, 2001.
9. J.N.B. Bell Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi 2002.
10. N.P Cheremisinoff, Biotechnology for Waste and Wastewater Treatment, William Andrew Publishing, New York, 1996.
11. Kothari, D.P., Singal, K.C. and Ranjan, R., Renewable energy sources and emerging technologies, prentice hall, New Delhi, 2008.

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1. www.physicalgeography.net/fundamentals/6e.html
2. www.conserve-energy-future.com/
3. www.jatrophabiodiesel.org/
4. www.gasification.org/
5. www.corecentre.co.in/Database/Docs/DocFiles/ems.pdf
6. http://www.altenergy.org/renewables/solar.html
7. http://en.wikipedia.org/wiki/Solar_power_in_India
8. http://en.wikipedia.org/wiki/Solar_energy
9. http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/how-solarenergy-works.html

Elective: Astrophysics

Semester - I **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To understand astrophysical processes and systems, ranging from sun to stars, galaxies and Universe.
2. To Study of birth and death of stars and types of stars.
3. To know the effect of temperature on stellar spectra and basics of its quantitative analysis
4. To know the members of our solar systems and its atmosphere.
5. To understand the working principle of Astronomical Telescope.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Classify different celestial objects and understand about universe	K1-K2
CO 2	Understand the impact of astronomical bodies and formation of stars.	K1-K3
CO 3	Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories.	K1-K3
CO 4	Describe the features of objects in the Solar System (Sun, planets, moons, asteroids, comets, planetary interiors, atmospheres)	K1-K3
CO 5	Demonstrate the ability to observe the celestial objects by astronomical telescopes and instrumentation.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	3	2	2	3	3	3	2	2.6
CO2	3	3	2	3	2	2	3	3	3	2	2.6
CO3	3	3	2	3	2	3	2	3	3	2	2.6
CO4	2	2	2	2	2	3	3	3	3	2	2.4
CO5	2	3	2	3	2	2	3	2	3	3	2.5
Mean Overall Score											**2.5**
Result											**High**

Unit - I: Galaxies and The Universe

The Milky Way galaxy: The composition of galaxies, the classification of galaxies, the interstellar medium, atomic and molecular clouds, the rotation curve of galaxies, Darkmatter in galaxies

The Universe: Clusters of galaxies, Active Galactic Nuclei, The Big bang cosmology, the Cosmic Background Radiation, The expansion rate of the universe, A review of current problems and ideas.

Unit - II: Stellar Evolution, Binary and Variable Stars

Nebulae – types of nebulae - The evaluation of the Stars: Birth of a star – Death of a star – Chandrasekhar limit – white dwarfs –Neutron Stars – black holes–Supernovaeexpolsions- Binary stars – visual Binary – spectroscopic Binary – Eclipsing Binary – Origin of Binary stars - Variable stars – types – cepheid variables, pulsating variables

Unit - III: Spectral Classification of Stars

The H-R diagram and the main sequence, The equation of hydrostatic equilibrium, Viral theorem, Eddington's theory of the stars, Mass luminosity relation, the life time of the stars of different masses, the solar neutrinos.

Unit - IV: Solar System

The Sun– physical and orbital data – photosphere – chromo sphere – corona - the internal temperature of the sun, the energy generation in the centre, nuclear reactions - Members of the solar system – Mercury – Venus – Earth – Mars- Jupiter – Saturn – Uranus - Neptune - Pluto – Moon - Asteroids – comets – Meteors.

Unit - V: Astronomical Telescope

Introduction to contemporary Astronomy: Optical, Infrared, Ultraviolet, Radio, X-ray and Gamma Ray Astronomy, Observational Techniques: Optical Telescopes: Reflecting and Refracting Telescope - Radio telescopes, Detectors for X-ray and Gamma rays – Hubble's space telescope.

Text Books:

1. K.S. Krishnaswamy, 'Astro physics a modern perspective', Reprint, New Age International (P) Ltd, New Delhi, 2002.
2. BaidyanathBasu, 'An Introduction to Astro Physics', second edition, Prentice Hall of India Private limited, New Delhi, 2010.
3. Sparke&Gallagher,Galaxies in the Universe, Cambridge Univ. Press, 2000
4. Longair M, High Energy Astrophysics Vol-I &II, , Cambridge Univ. Press, 1992
5. RydenB,Introduction to Cosmology, Cambridge Univ. Press, 2002

Books for Reference:

1. R.Murugesan, 'Modern Physics', Eighteenth edition, S. Chand & Company Ltd, New Delhi, 2019.
2. S.Kumaravelu, 'Astronomy', Janki calendar corporation, Sivakasi, 1993.
3. Baker and Fredrick, 'Astronomy, ninth edition, Van NO strand Rein hold, Co, New York, 1964.
4. Illustrated World of Science Encyclopedia – Vol I and Vol VIII – creative World publications, Chicago,1971
5. RydenB ,Introduction to Cosmology,Cambridge Univ. Press, 2002
6. Shu F.H., Physical Universe, University Science Books, 1982
7. T. Padmanabhan, An Invitation to Astrophysics, World Scientific, 2006.

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1. https://science.nasa.gov/astrophysics
2. http://solarviews.com/eng/solarsys.htm
3. http://hyperphysics.phy-astr.gsu.edu/hbase/Starlog/staspe.html
4. http://astro.unl.edu/naap/hr/hr_background1.html
5. http://www.enchantedlearning.com/subjects/astronomy/stars/startypes.shtml
6. http://hyperphysics.phy-astr.gsu.edu/hbase/geoopt/teles2.html
7. http://www.colorado.edu/physics/phys1230/phys1230_fa01/topic40.html
8. http://www.infoplease.com/cig/theories-universe/scientific-origins-universe.html
9. http://www.thebigger.com/physics/universe/explain-the-various-theories-of-the-origin-of-universe/
10. http://solarviews.com/eng/starformation.htm

Mathematical Physics - II

Semester - II **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To provide an insight into complex analysis and enable the students to solve problems.
2. To make the students to learn Green's function and its applications in different fields of physics.
3. To impart the knowledge to understand series solutions and special functions and enable them to apply it to solve Physics problems.
4. To make the students learn to solve various types of problems related to numerical techniques.
5. To enable the students to understand the basics of group theory, that will make them to analyze symmetries and their implications in the field of Physics.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Acquire the knowledge of complex derivatives function and operate analytic functions, and solve problems in complex integrations.	K1-K3
CO 2	Understand homogeneous and non-homogeneous equation to solve Green's functions along with boundary value problems.	K1-K3
CO 3	Gain the knowledge of series solutions and special functions and enable them to apply and solve problems in classical, statistical, quantum mechanics and electromagnetism.	K1-K3
CO 4	Distinguish numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, and solution of first order differential equations and enable them to solve problems.	K1-K3
CO 5	Recognize the basic ideas of groups, representations of groups, character table formation and application of group theory.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	3	2	3	3	3	2	2	2.6
CO2	3	3	3	3	3	3	3	2	2	2	2.7
CO3	3	3	3	3	2	3	3	2	2	2	2.6
CO4	3	3	2	3	3	2	3	3	1	3	2.6
CO5	3	1	3	3	3	3	2	3	3	3	2.7
										Mean Overall Score	**2.6**
										Results	**High**

Unit-I: Complex Analysis

Complex function – Analytic function – Limit, Continuity – Differentiability – Cauchy-Riemann conditions- Cauchy's integral theorem (simply and multiply connected regions) – Cauchy's integral formulae – singularities of an analytic function – Residues – Cauchy's residue theorem –Evaluation of definite integrals- Contour integration.

Unit –II: Green's function

Homogeneous and non homogeneous equation (introduction only) – Green's function for one dimensional case – Wronskian's determinant – General proof and symmetry property of Green's function – Boundary value problems – Eigen function expansion of Green's function- Green's function for Poisson's and its solution – Green's function for quantum mechanical scattering problem.

Unit –III: Special Functions

Series solutions – Legendre, Bessel, Hermite and Laguerre's differential equations - generating functions- orthogonal properties-Recurrence relations.

Unit –IV: Numerical Methods

Newton-Raphson method-Finite differences- Forward difference, Backward differences-Numerical integration- Trapezoidal rule- Simpson's $1/3^{rd}$and $3/8^{th}$rule-Interpolation- Newton forward and backward interpolation formula – Lagrange's interpolation- solving first order differential equations Runge-kutta method of fourth order.

Unit –V: Group Theory

Group – basic properties – Abelian group – isomorphic group – similarity transformation and classes – group multiplication tables - Representation of Groups: symmetric elements – transformation, matrix representation – Point groups – reducible and irreducible representations – The Great OrthogonalityTheoremd-Construction of character tables for point groups C2V and C3V, structure of character tables –Mulliken's notations for irreducible representations – Applications: IR and Raman active vibrations of XY_3 type molecule – Application of group theory to chemical bonding.

Text Books

1. H K Dass, Dr. Rama Verma, Mathematical Physics, Sultan Chand & Sons, New Delhi, 2013
2. Gupta B. D, Mathematical Physics, New Delhi, Vikas publishing house, 2006.
3. P Satyaprakash, Mathematical Physics, Sultan Chand & Sons, New Delhi 2004.
4. Suresh Chandra, A Text Book of Mathematical Physics, Narosa Publishing House, New Delhi, 2006.
5. S.S.Sastry, Introductory methods of numerical analysis, Prentice hall of indiaPvt Ltd, New Delhi, 2012
6. M K.Jain, S.R.K.Iyengar, R.K.Jain, Numerical Methods : For Scientific And Engineering Computation, New agePvt Ltd, New Delhi, 2012
7. P.Kandasamy, K.Thilagavathi, K.Gunavathi,Numerical Methods, S.Chand Pvt Ltd, New Delhi, 2006

Books for Reference

1. G.B Arfken, J Weber, Mathematical methods for physicists, Elsevier academic press, 2005
2. E Kreyszig, Advanced Engineering Mathematics, Wiley India Pvt Ltd, New Delhi, 2015
3. K F Riley, M P Hobson and S J Bence, Matehmatical methods for physics and Enginnering, Cambridge university press, USA, 2006
4. Mary L.Boas, Mathematical methods in the physical sciences, Wiley India Pvt Ltd, New Delhi, 2006.
5. Tai L. Chow, Mathematical Methods for Physicists: A concise introduction, Cambridge university press, USA, 2000
6. Chattopadhyay P. K., Mathematical Physics, , New Age International (P) Ltd, Madras

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1. https://math.mit.edu/~jorloff/18.04/notes/topic4.pdf
2. https://complex-analysis.com/
3. http://www.maths.lth.se/matematiklu/personal/olofsson/CompHT06.pdf
4. https://mathworld.wolfram.com/GreensFunction.html
5. https://brilliant.org/wiki/greens-functions-in-physics/
6. http://egyankosh.ac.in/bitstream/123456789/12543/5/Unit-3.pdf
7. http://ion.uwinnipeg.ca/~gkunstat/MathPhys2014W/Resources/math_phys_redbook/06-Special%20Functions.pdf
8. https://www.msuniv.ac.in/Download/Pdf/aa6c43e4d516475

9. https://www.vssut.ac.in/lecture_notes/lecture1428550358.pdf
10. https://medium.com/cantors-paradise/an-invitation-to-group-theory-c81e21ab739a
11. https://chem.libretexts.org/Bookshelves/Physical_and_Theoretical_Chemistry_Textbook_Maps/Supplemental_Modules_(Physical_and_Theoretical_Chemistry)/Group_Theory/Group_Theory%3A_Theory
12. http://www.matfys.lth.se/education/FYS256/aryasetiawan.pdf
13. https://ethz.ch/content/dam/ethz/special-interest/chab/physical-chemistry/ultrafast-spectroscopy-dam/documents/ lectures/ spectroscopy FS20/ Script/PCV_Ch4.pdf

Electromagnetic Theory

Semester - II **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To provide a clear and logical presentation of problems in electrostatics.
2. To apply Biot-Savart law, scalar and vector potentials to measure magnetic fields.
3. To learn Maxwell's Equations and their applications.
4. To understand Fields and Radiation of Electromagnetic Sources
5. To develop an understanding of the propagation of electromagnetic waves and their properties.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Solve few electrostatics problems using Laplace equation.	K1-K3
CO 2	Use Biot-Savart law, magnetic scalar and vector potentials to deduce magnetic fields due to current carrying elements.	K1-K2
CO 3	Apply Maxwell's equations for the conservation of electromagnetic energy and momentum.	K1-K2
CO 4	Understand fields and radiation from antennas and deduce expression for power radiated from radiation sources.	K1-K3
CO 5	Describe the propagation of electromagnetic waves in various media and discuss the kinematics and dynamic properties of electromagnetic waves.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	2	2	3	2	2	2.3
CO2	2	3	2	2	2	2	2	2	3	3	2.3
CO3	2	2	2	2	2	2	3	2	3	3	2.3
CO4	3	2	3	3	2	2	3	2	3	3	2.6
CO5	2	3	2	2	2	2	2	2	3	3	2.3
Mean Overall Score											**2.4**
Results											**High**

Unit – I: Electrostatics

Electric field due to a system of charges-Charge distribution-charge densities-Electrostatic Potential-Multipole expansion of charge distribution-Gauss law in integral and differential forms -Poisson's equation-Laplace's equation-Solution of Laplace's equation in spherical coordinates-Conducting sphere in a uniform field-Field at external and internal points-displacement vector-Dielectric Polarization-Dielectric sphere in a uniform field-Field at external and internal points-Electrostatic energy.

Unit – II: Magnetostatics

Biot-Savart law- Integral and differential form-Application to a Circular coil-Ampere's circuital law in differential and integral forms-Application to a straight wire and Force between two parallel wire-Magnetic vector potential- Characteristics of Magnetic vector potential- Application to a distant current loop-Magnetic scalar potential-Characteristics of Magnetic scalar potential-Application to a magnetic dipole(circular current loop)-Magnetostatic energy.

Unit– III: Maxwell's Equations and their applications

Faraday's laws of induction-Equation of continuity for charge-Maxwell's displacement current-Maxwell's equations in integral and differential form-significance-Non uniqueness of electromagnetic potential: Gauge invariance-Coulomb's and Lorentz gauges - Lorentz force-Lorentz force interms of electric and magnetic potentials -Energy and momentum of the field-Conservation laws for a system of charges and electromagnetic fields-Poynting's theorem-continuity equation for energy.

Unit - IV: Fields and Radiation of Electromagnetic Sources

Retarded potentials-Oscillating electric dipole: magnetic vector and scalar potentials-electromagnetic fields-poynting vector and radiated power-Radiation from a small current element: radiation power and radiation resistance-Radiation from a linear antenna-Centre fed half antenna-Antenna arrays.

Unit – V: Wave Propagation and properties

Wave equation and plane wave solution-Propagation of electromagnetic waves in free space, isotropic dielectric-Propagation in conducting media-Skin depth-Reflection and Refraction at a plane interface: kinematic properties-dynamic properties-Fresnel's formulae(oblique incidence)-Propagation between two perfectly conduction planes-Propagation of waves in a rectangular wave guide.

Text Books

1. SatyaPrakash, Electromagnetic theory and Electrodynamics, Meerut, KedarNath Ram, 2010.
2. David.J.Griffiths, Introduction to Electrodynamics, New Delhi, Addison Wesley, 2012.
3. Uma Mukherji,Electromagnetic field Theory and Wave Propagation, New Delhi, NarosaPublishing House, New Delhi, 2006.

Books for Reference

1. Agarwal G. C., Chopra K. K., Electromagnetic Theory, K Nath&Co.,Meerut 2019.
2. Edward C.Jordan, Keith G. Balmain, Electromagnetic waves and Radiating systems, Prentice Hall of India, 2005.
3. Reitz John R., Foundations of Electromagnetic Theory,Pearson Education India, New Delhi, 2009.
4. Puri S.P, Classical Electrodynamics,Tata McGraw-Hill publishing company Limited, New Delhi, 1997.
5. Prasad K.D, Antenna and Wave Propagation,Sathyaprakashan, New Delhi, 1993.
6. Meenakumari, R.,Subasri R., Electromagnetic fields, second edition,New Age International Publishers, New Delhi, 2008.
7. J.D.Jackson, Classical Electrodynamics, 3rd Edition, Wiley Eastern Ltd, New Delhi, 1998.

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1. http://www.thphys.nuim.ie/Notes/electromag/frame-notes.html
2. https://books.physics.oregonstate.edu/GSF/maxwell1.html
3. http://www.thphys.nuim.ie/Notes/em-topics/em-topics.html
4. https://en.wikipedia.org/wiki/Biot%E2%80%93Savart_law
5. http://odessa.phy.sdsmt.edu/~lcorwin/PHYS721EM1_2014Fall/Chap6p3_Hyun.pdf
6. https://winnerscience.com/2012/02/24/gauss-law-differential-form-derivation/
7. https://www.ece.mcmaster.ca/faculty/nikolova/antenna_dload/current_lectures/L03_RadIS.pdf
8. http://dmoz.org/Science/Physics/Electromagnetism/Courses_and_Tutorials/
9. https://www.everythingrf.com/community/what-is-skin-depth
10. http://web.mit.edu/6.013_book/www/chapter13/13.4.html

Quantum Mechanics–II

Semester–II **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To understand the concept of time dependent perturbation theory.
2. To provide knowledge on scattering theory in quantum mechanics.
3. To learn basic ideas of relativistic quantum mechanics of charged particles
4. To impart knowledge on Dirac equation and the transformations for Dirac equation.
5. To introduce the students to quantum field theory through the learning of relativistic Lagrangian and Hamiltonian formalisms.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Learn and understand the fundamental principle of time dependent perturbation theory and its application to physical situations.	K1-K2
CO 2	Gain knowledge on scattering phenomena occurring in quantum mechanics.	K1-K3
CO 3	Understand the fundamental principles of relativistic quantum mechanics and solution of KG equation for charged particles in electromagnetic field.	K1-K3
CO 4	Acquire knowledge of Dirac equation and matrices and their role in Lawrence transformation of Dirac equation.	K1-K3
CO 5	Understand the concept of quantum field theory by learning relativistic Lagrangian and Hamiltonian formulations.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	2	2	3	2	2	2.3
CO2	3	3	3	1	2	2	2	2	3	3	2.4
CO3	2	2	2	2	2	2	3	2	3	3	2.3
CO4	3	2	3	3	2	2	3	2	3	3	2.6
CO5	3	3	2	1	2	2	2	2	3	3	2.3
Mean Overall Score											**2.4**
Results											**High**

Unit– I: Time Dependent Perturbation Theory

Time dependent perturbation theory – first order transitions – Constant and harmonic perturbations – Transition probabilities – Fermi–Golden rule–Semi classical treatment of an atom with electromagnetic radiation – Selection rules for dipole radiation – Adiabatic approximation – Sudden approximation – The density matrix – Spin density

Unit – II: Quantum theory of Scattering

Kinematics of scattering – Scattering cross sections – Scattering amplitude – Transformation from centre of mass system to laboratory frame – Partial wave analysis: Asymptotic behaviour – Phase shifts – Differential and total cross sections – Optical theorem – Ramsaur–Townsen effect – Born approximation and its validity – Applications: Scattering by square well potential.

Unit – III: Relativistic Quantum Mechanics – I

Schrodinger relativistic equations – Klein–Gordon equation – K.G. equation for a charged particles in electromagnetic field – Solution of K.G. equation with Coulomb potential – Difficulties in K.G. equation – Dirac's relativistic wave equation – Dirac Hamiltonian – Dirac Matrices – Equation of continuity using Dirac's equation – Plane wave solutions of Dirac equation for a free particle – negative energy states.

Unit – IV: Relativistic Quantum Mechanics – II

Covariant form of Dirac equation – Properties of gamma matrices – Traces – Relativistic invariant of Dirac equation under Lorentz transformation – T–Transformation for the Dirac equation without and with electromagnetic field – Projection operators for energy and spin – Dirac equation under a central potential: Total angular momentum.

Unit– V: Quantization of Fields

Difference between classical and quantum fields – Relativistic Lagrangian and Hamiltonian of charged particle in an electromagnetic field –Lagrangian and Hamiltonian formulations of field – Second quantization of Klein–Gordon field – Creation and annihilation operators – Commutation relations– Quantization of non–relativistic Schrödinger's field

Text Books

1. Aruldhas.G, Quantum Mechanics,Prentice Hall of India Pvt. Ltd. NewDelhi,2007.
2. Sathyaprakash, Quantum Mechanics, KedranathRamnath , New Delhi, 2001.
3. Guptha Kumar Sharma, Quantum Mechanics, Jai prakashNath publications, 2012.

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1. Devanathan.V, Quantum Mechanics, Narosa Publishing House, New Delhi ,2005.
2. Devanarayanan S., Quantum Mechanics, ,Scitech Publications (India) Pvt. Ltd., New Delhi ,2005.
3. Chaddha G. S., Quantum Mechanics, , New Age International (P) Ltd. Publishers, New Delhi ,2006.
4. Thankappan V. K., Quantum Mechanics, New Age International (P) Ltd. Publishers, New Delhi ,2008.
5. Mathews P.M. andVenkatesan K., A Text book of Quantum Mechanics, , Tata McGraw–Hill, New Delhi ,2010.
6. Guptha S.L and Guptha S.D, Advanced Quantum Theory and Fields, , S.Chand and Co. Pvt. Ltd., New Delhi ,1986.
7. Sakurai J. J., Jim J. Napolitano, Modern Quantum Mechanics, 2nd Edition, , Addison Wesley, New Delhi ,2010.

Websites for Reference

1. http://www.physics.sfsu.edu/~greensit/book.pdf
2. http://webee.technion.ac.il/labs/Quantum_Engineering/files/papers/qm_lecture_notes.pdf
3. http://physics.bgu.ac.il/~dcohen/ARCHIVE/qmc.pdf

Advanced Physics Practicals
(Any 15 experiments)

Semester - II **Hours/week: 6**
Sub. Code: **Credits: 6**

Course objectives:

1. To provide the students with a broad understanding of experimental procedures, calculations of some physical parameters such as young's modulus, viscosity
2. To help the students towards the critical und creative thinking through few spectroscopic experiments
3. To make the students to evaluate the electrical resistivity and conductivity of semiconducting materials
4. To empower the students to demonstrate few heat experiments
5. To train the students towards the skill development of advanced general physics experiments

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Do Young's modulus experiments and to calculate the young's modulus, poisson's ratio and viscosity for the given materials	K1-K4
CO 2	Set up the apparatus to get the spectra of light sources such as hydrogen, arcs of alloys/metals etc.	K1-K3
CO 3	Determine the electrical conductivity and resistivity of a semiconducting material using four probe apparatus	K1-K4
CO 4	Obtain the saturation temperature of a black body and hence they are able to calculate the stefan's constant and temperature coefficient of thermistor	K1-K4
CO 5	Do themselves independently few advanced general experiments such as half shade polarimeter, Planck's constant experiment	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	2	2	3	2	2	2.3
CO2	3	3	3	3	2	2	2	2	3	3	2.6
CO3	2	2	2	2	2	2	3	2	3	3	2.3
CO4	3	2	3	3	2	2	3	2	3	3	2.6
CO5	3	3	2	3	2	2	3	2	3	3	2.6
Mean Overall Score											**2.5**
Results											**High**

List of experiments:

1. Cornu's method - Young's modulus and Poisson's ratio by elliptical fringes.
2. Cornu's method - Young's modulus by hyperbolic fringes.
3. Determination of Stefan's constant.
4. Band gap energy - Thermistor.
5. Hydrogen spectrum - Hartmann's Interpolation formula- Rydberg's constant.

6. **Viscosity of liquid - Meyer’s disc.**
7. **Solar spectrum - Hartmann’s Interpolation formula.**
8. **F.P. Etalon using spectrometer.**
9. **Iron / Copper arc spectrum.**
10. **Lasers: Study of laser beam parameters.**
11. **Particle size determination using Laser.**
12. **Electrical resistivity and conductivity of a semiconductor by four probe method.**
13. **Spectrometer - Charge of an electron.**
14. **Spectrometer- Polarizability of liquids by finding the refractive indices at differentwavelengths.**
15. **Determination of dielectric constant of a liquid by RF oscillator method.**
16. **Determination of Planck's constant.**
17. **Fiber optic experiments – Numerical aperture, Acceptance angle and Attenuation of givenoptical fiber.**
18. **Co efficient of linear expansion –air wedge method**
19. Impedance measurement using LCR Bridge
20. Dielectric constant of Liquids and Solids by capacitance method.
21. Experiment with Silicon solar cell
22. Measurement of absorption coefficient of a material (supplied) using laser light.
23. Laurentz half shade polarimeter

Electronics Experiments
(Any 20 Experiments)

Semester - II **Hours/week: 6**

Sub. Code: **Credits: 6**

Course objectives:

1. To familiarize students with various Electronic devices and their specifications.
2. To observe characteristics of electronic devices
3. To understand the design aspects of oscillator circuits
4. To familiarize the students with devices and circuit principles with special focus on applications related to instrumentations and measurements.
5. Develop skill for Design and Testing of different types of Electronic subsystems using Analog and Digital IC's.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Elucidate the basic operation of various power semiconductor devices.	K1-K4
CO 2	Describe and analyze the characteristics of different electronic devices.	K1-K3
CO 3	Measure voltage, frequency and phase of any waveform using CRO.	K1-K4
CO 4	Design and implement various digital circuits.	K1-K3
CO 5	Develop ability to diagnose faults and their rectification.	K1-K4

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	2	2	3	2	2	2.3
CO2	3	3	3	2	2	2	2	2	3	3	2.5
CO3	3	2	2	2	2	2	3	2	3	3	2.4
CO4	3	2	3	3	3	2	3	2	3	3	2.7
CO5	3	3	3	3	2	2	3	3	3	3	2.8
Mean Overall Score											**2.5**
Results											**High**

List of Experiments:

1. Characteristics of SCR and Triac
2. UJT characteristics and UJT as relaxation oscillator
3. Op-amp – Applications- Log amplifier, antilog amplifier, differentiator and integrator.
4. Op-amp -Study of the attenuation characteristics and design of the phase-shift oscillator.
5. Op-amp - Study of the attenuation characteristics and design of the Wien Bridge oscillator.
6. Op-amp-Schmitt trigger
7. Op-amp - Solving simultaneous equations
8. Op-amp - Design of square wave, saw tooth wave, and Triangular wave generators.
9. Op-amp - Design of active filters –Second order- low pass, high pass, band pass and band rejecter.
10. Op-amp – D/A converter - Binary weighted method - R/2R ladder method.
11. Modulus counters using IC 7490 and seven segment display.
12. 4 - Bit Synchronous/Asynchronous Up-down counters using IC 7473/IC7476.
13. 4 - Bit Shift Registers - Ring counter, Twisted Ring counter/Johnson's counter using IC 7473/IC7476.
14. IC 7483 - Arithmetic operations.
15. IC 555 –Astablemultivibrator and Voltage Controlled Oscillator.

16. IC 555 – Monostablemultivibrator and Frequency Divider.
17. IC 555 - Schmitt Trigger and Hysteresis loss.
18. Multiplexer and Demultiplexer.
19. Photodiode characteristics
20. Op-amp 8-bit DAC
21. Characteristics of LVDT
22. V-I Characteristics of Solar cell.
23. Op-amp: I to V, V to I converter
24. A/D converter: 4 bit simultaneous A/D converter and successive approximation A/D converter using IC0801/IC0804.

Elective: Microprocessor 8085 and Microcontroller 8051

Semester-II **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To illustrate the architecture and interrupts of 8085 Microprocessor.
2. To familiarize students with instruction sets, addressing modes and programming of 8085 microprocessor.
3. To familiarize the students with interfacing of memory with 8085microprocessor.
4. To illustrate the architecture of 8051 Microcontroller.
5. To familiarize students with instruction sets, addressing modes and programming of 8051 Microprocessor.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Gain knowledge about architecture and working of 8085 Microprocessor.	K1-K3
CO 2	Develop assembly language programs using various programming tools in 8085 Microprocessor.	K1-K3
CO 3	Illustrate how the different peripherals are interfaced with 8085Microprocessor.	K1-K3
CO 4	Understand the internal design of 8051 microcontroller along with the features.	K1-K3
CO 5	Develop assembly language programming to design microcontroller-based systems.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	2	2	2	2	3	2	2	2.2
CO2	3	3	3	2	2	2	2	2	3	3	2.5
CO3	3	2	2	2	2	2	3	2	3	3	2.4
CO4	2	2	3	3	3	2	3	2	3	3	2.6
CO5	3	2	3	3	2	2	3	3	3	3	2.7
Mean Overall Score											**2.5**
Results											**High**

Unit – I:Architecture and Interrupts of 8085A Microprocessor:

8085A Microprocessor: Features of 8085A Microprocessor-Pin configuration of 8085A Microprocessor- Architecture of 8085A Microprocessor.

Interrupts: Interrupt and its need **-** Classification of Interrupts- Priorities of Interrupts- Enabling, Disabling and Masking of interrupts: EI, DI, SIM and RIM instructions.

Unit - II:Instruction Set and programming of 8085A:

Instruction Set: Instructions-Classification of instructions based on length and function-Data TransferInstructions - Arithmetic instructions - Logical Instructions - Branch Instructions-Stack and Stack Related Instructions - I/O Instructions - Subroutines - Addressing Modes.

Programming 8085A:8-bit and 16 bit addition, 8-bit and 16 bit Subtraction, 8-bit BCD to HEX and HEX to BCD code conversions- Time delay subroutines and Delay calculations.

Unit - III:Interfacing Memory and I/O devices to 8085A

Memory Interfacing: Basic Concepts in Memory Interfacing- De-Multiplexing Address/Data bus-Interfacing memory chips: 2K×8, 4K×8 RAM interface-2K×8, 4K×8 EPROM interface.

Interfacing I/O Devices: I/O Mapped I/O-Memory Mapped I/O-Programmable Peripheral Interface (8255) - LED Interface-Flashing of LEDs-Multiplexed Seven segment display interface.

Unit –IV: Architecture of 8051 Microcontroller

Microcontroller- Difference between microprocessor and microcontroller- pin diagram of 8051 - Internal architecture of 8051 - Memory organization: Program memory and Data memory -Special function registers –Program status word- Port operation: Port 0, Port 1, Port 2, Port 3.

Unit – V: Instruction setof 8051 and Programming:

Instruction set: Data transfer instructions-Arithmetic instructions-Logic instructions-Control transfer instructions –Addressing Modes: Register addressing-Direct addressing-Register- Indirect addressing-Immediate addressing-Base register plus Index register-delay routines

Programming: 8-bit addition, subtraction, Multiplication and division.

Text Books

1. V.Vijayendran, Fundamentals of Microprocessor – 8085: Architecture, Programming and Interfacing, S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai,2009.
2. A. NagoorKani, Microprocessor and its Applications, 3rd Edition, RBA Publications, Chennai,2017.
3. Krishna Kant, Microprocessors and Microcontrollers Architecture, Programming and System Design 8085, 8086, 8051, 8096, Second edition, PHI Learning Private Limited, New Delhi, 2014.

Books for reference

1. Ramesh S. Gaonkar, Microprocessor Architecture, Programming and applications with the 8085, 6th edition, New Age International Publishers Ltd., New Delhi 2013.
2. Ram.B, Fundamentals of Microprocessor and Microcontroller, Seventh Edition, DhanpatRai Publications, New Delhi, 2012.
3. N. Senthilkumar, M. Saravanan, S. Jeevananthan, Microprocessors andMicrocontrollers, Oxford University Press, 2010.
4. A.P. Godse, D.A. Godse, Microprocessor and Applications, Second Edition, Technical Publications, Pune, 2018.
5. U.S. Shah, Microprocessor and Applications, McMillan Publishers India Ltd., New Delhi, 2011.
6. AdityaMathur, Introduction to Microprocessor, 3rd Edition, Tata McGraw Hill Publishing Company Ltd., 2017.
7. Muhammed Ali Mazidi, Janice GillispieMazidi, Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems, Second Edition, Pearson Pubilcations, 2007.
8. SubrataGhoshal, 8051 Microcontroller: Internals, Instructions, Programming &Interfacing, Second Edition, Pearson Publications, 2014
9. AlkaKalra, Sanjeev Kumar Kalra, Architecture and Programming of 8085 Microcontroller, University Science Press, New Delhi, 2010.
10. Kenneth J. Ayala, The 8051 MicroController, 3rd Edition, Cencage Learning, New Delhi, 2007.

Websites references:

1. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_architecture.htm
2. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_pin_configuration.htm.
3. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_addressing_modes_and_interrupts.htm
4. https://www.tutorialspoint.com/microprocessor/microprocessor_8085_instruction_sets.htm
5. https://www.tutorialspoint.com/microprocessor/microprocessor_intel_8255a_programmable_peripheral_interface.htm
6. https://www.tutorialspoint.com/microprocessor/microprocessor_intel_8255a_pin_description.htm
7. http://aturing.umcs.maine.edu/~meadow/courses/cos335/Intel8255A.pdf
8. http://northcampus.uok.edu.in/downloads/20161125104535111.pdf
9. https://www.tutorialspoint.com/microprocessor/microcontrollers_overview.htm
10. https://www.tutorialspoint.com/microprocessor/microcontrollers_8051_architecture.htm
11. https://www.tutorialspoint.com/microprocessor/microcontrollers_8051_pin_description.htm
12. https://www.tutorialspoint.com/microprocessor/microcontrollers_8051_input_output_ports.htm

Elective: Geophysics

Semester-II **Hours/week: 4**

Sub. Code: **Credits: 4**

Course objectives:

1. To explore the fundamental background of geophysics and its importance among the earth science.
2. To make them understand the geomagnetic field and Magnetic elements.
3. To provide an understanding of Laboratory measurements of the physical properties of rocks.
4. To Study Natural and Artificial seismology and its relation to other Earth System.
5. To familiarize the students with thephysical properties of minerals

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the physics and geology that form the basis for geophysical observation and measurement.	K1-K2
CO 2	Explain the principles of geothermal flux distribution over continents and oceans.	K1-K2
CO 3	Explain fundamental concepts underlying common exploration of petrophysics.	K1-K3
CO 4	Acquire the knowledge of application of seismology.	K1-K2
CO 5	Obtain knowledge about classification of minerals.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	1	3	2	3	2	2	3	2	3	3	2.4
CO2	2	3	2	3	2	2	3	2	3	2	2.4
CO3	3	2	3	2	2	3	2	3	3	2	2.5
CO4	3	3	2	3	2	2	3	2	3	2	2.5
CO5	3	2	3	2	3	2	3	2	3	2	2.5
Mean Overall Score											2.5
Result											High

Unit – I: Introduction to Geophysics

Geophysics and its importance among earth Sciences-Earth as a member of the solar system - Geosphere: Scope of study of various Geospheres, Atmosphere, Ionosphere, Asthenosphere, lithosphere-hydrosphere and Biosphere. Meteorology, Oceanography and Hydrology - Atmosphere:Constituent, vertical structure, weather analysis and fore casting.

Unit – II: Gravity field

Gravity field and its variations on the surface, internal and external Field – Geoid, spheroid and Ellipsoid of the earth-shape and size of the earth - Geomagnetic field, Magnetic elements-Origin and Reversals of the magnetic field- Geothermics: Heat sources, Geothermal flux distribution over continents and oceans. Geochronology: Rock dating methods, U-Th, C-14, Fission-Track and magnetic dating.

Unit – III: Petrophysics

Different physical and engineering properties of rocks - Laboratory measurements of the physical properties of rocks: Density, Seismic wave velocities, magnetic susceptibility, Electrical resistivity, thermal conductivity, porosity and permeability.

Unit–IV: Seismology

Natural and Artificial seismology and its relation to other Earth System sciences. Classification of Earth quakes, Causes and propagation of Different seismic wave and fundamental laws - Interior of the Earth and Earth quake prediction.

Introduction to Seismograph: Principle and working of mechanical type seismograph, Milnes haw, wood Andersen seismograph, electromagnetic seismograph and broadband seismograph- Various methods for determination of focal depth and epicentre location.

Unit –V: Mineralogy

Introduction- symmetry and forms in common crystal classes –physical properties of minerals – isomorphism and polymorphism, classification of minerals – structure of silicates –mineralogy of common rock – forming minerals – mode of occurrence of minerals in rock.

Text books

1. William Lowrie, Fundamentals of Geophysics,2nd edition, Cambridge UniversityPress,NewYork,2007.
2. Markus .Bath, Introduction to Seismology,Revised edition, Springer Basel AG,2014.
3. G.W.Tyrrell,The principles of Petrology,2ndedition,Surjeet Publications, New Delhi,2019.

Books for Reference

1. D.K. Jha,Textbook of Geophysics , ALP Books,2015
2. Frank D.Stacey,Physics of Earth,4th edition ,Cambridge University Press, 2008.
3. John .M.Reynolds ,An introduction to Applied and Environmental Geophysics,2ndedition,Wiley,2011.
4. John Milsom, AsgerEriksen, Field Geophysics, 4th edition,Wiley,2011.
5. Peter Styles,IntroducingGeophysics,Dunedin Academic Press, 2021.
6. C.M.R.Fowler,The solid Earth,2nd edition, Cambridge University Press, 2004.
7. Karl Seibert,AppliedGeophysics,Syrawood Publishing house,2019
8. Robert J. Charlson, Gordon H. Orians,Earth System Science,1st edition, Academic Press,2000.

Websites for reference

1. https://earthquake.usgs.gov/learn/kids/become.php
2. http://www.eegs.org/what-is-geophysics
3. http://geophysics.geoscienceworld.org/
4. http://inside.mines.edu/Geophysics-Home
5. http://library.seg.org/journal/gpysa
6. www.uio.no/studier/emner/.../ppt/.../6-introduction-to-petrophysics-august-2015.pdf
7. http://petrowiki.org/Petrophysics
8. http://www.slb.com/services/characterization/petrophysics.aspx
9. http://www.geo.mtu.edu/UPSeis/waves.html
10. http://www.environmentalscience.org/career/seismologis
11. https://earthquake.usgs.gov/learn/glossary/?term=seismology
12. http://moes.gov.in/programmes/national-centre-seismology
13. http://serc.carleton.edu/NAGTWorkshops/mineralogy/index.html
14. http://www.environmentalscience.org/career/mineralogist

Elective: Biophysics

Semester-II **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To explore the fundamental background of physics behind the cellular and molecular structure and its dynamics.
2. To provide an insight knowledge about the application of light and bio compatible nonmaterial in the field of bio physics.
3. To know about the applications of bio sensors.
4. To make the students to understand the application of light and non-ionizing radiation effect on biological system
5. To make the students to know about the physiochemical techniques used for the detection and treatment of various diseases.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Explain physics behind the dynamics, molecular structure of proteins, amino acids and conduction system.	K1-K2
CO 2	Acquire the knowledge on various types of proteins, enzymes and its function in the bio metabolic activities.	K1-K3
CO 3	Acquire the knowledge of application of bio Nano sensors in diagnosing.	K1-K3
CO 4	Distinguish the effect of light, ionizing and non-ionizing radiation in the biological system	K1-K2
CO 5	Differentiate the physical and chemical approach of diagnosing and application of such techniques.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)					Mean Scores of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	2	3	3	3	2	2.5
CO2	3	2	3	2	3	2	3	2	2	3	2.7
CO3	2	2	2	3	3	2	2	3	3	2	2.4
CO4	3	2	2	3	3	2	2	2	3	2	2.4
CO5	2	3	3	4	3	2	3	3	2	2	2.5
Mean Overall Score											**2.5**
Result											**High**

Unit- I Cellular Structure and Dynamics

Cell -Discovery of cell and Cell Theory- Comparison between plant and animal cells- Cell wall-Kinetics of cell growth-Mitosis & Cell divisionMolecular mechanism-Synchronization of cell cycles-Cell transformation-Cell Junctions-Cell transportation and malignant tumor growth - Cell aging and death-Differentiation of cultured cells-Water and ion transport.

Unit - II: Molecular structure and functions

Intra molecular and intermolecular forces-Entropy transfer of living organisms-Structure and function of disaccharides and polysaccharide-Amino acids-Primary and secondary structures of proteins-Enzyme structure - Classification of enzymes -function relation-Semiconduction in biological macromolecules-concentration and mobility of charge carriers in proteins- cells and tissues-Determination of activation energy- Role of adsorbed water in tissues.

Unit-III: Biocompatible Nano materials and Bio sensors

Nanobiotechnology- definition and scope-Biocompatibility and cytotoxicity studies of Nanomaterials-Biological metal nanoparticle synthesis and biomedical application-Dendrimers, quantum dots-Biosensors: Ion sensors –Anion and cation sensors- Membrane electrodes, Enzyme electrodes–Biocatalyst based biosensors –ISFET for glucose, urea -Fibre optic sensors, Photo acoustic sensorsand Radiation thermometry.

Unit- IV: Photo-biophysics

Different sources of Non-Ionizing radiation-their physical- properties- Various types of optical radiations-UV- visible & IR sources- Lasers-Theory and mechanism-Optical properties of tissues-photo thermal –photochemical-photo ablation- electromechanical effect-Radiofrequency & Microwave radiation-Biomagnetism-Effects-application-Optical properties of skin, Acute and chronic effect of sunlight on skin, Photosensitivity, Photo toxicity.

Unit -V: Physiochemical Techniques

Sedimentation Principle- Types of rotors- Preparative and Analytical Centrifuges -Sterilization-Physical and Chemical methods of sterilization-Electrodes-types Design and properties and Utility, Skin contact impedance of Electrodes -chromatography-Instrumentation, working and biological applications of Column chromatography-Electrophoresis-Disc electrophoresis: Isoelectric focusing, -Radioisotopes and their Biological Applications

Books for study

1. P. Narayanan,Essentials of Biophysics, New Age International (P) Ltd. Publishers, New Delhi, 2000.
2. VasanthaPattabhi and N. Gautham,Biophysics, Narosa Publishing House, New Delhi,2002.
3. Pranab Kumar Banargy,Introduction of Biophysics, S Chand and Co, New Delhi,2000
4. N.Arumugam and Kumaresan “Biophysics” Saraspublication,2015

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1. Barrow C,Physical Chemistry for Life Sciences Mc-Graw Hill,2007
2. Khandpur R. S., Handbook of Biomedical Instrumentation, Tata McGraw-Hill Publishing Co. Ltd, 2003.
3. David Friefelder ,Molecular Biology, Narasa Publishing House, 2008
4. Thayalan, Basics of Radiobiological Principle” Jaypee Brothers Medical Publisher, New Delhi, 2003.
5. G Cooper & R Haussman, The Cell Molecular Approach,ASM Press, 2007.
6. HG Bohr,Handbook of Molecular Biophysics (Methods & Application), Wiley India Ltd, 2009.
7. Patric F Dillon, Biophysics A Physiological Approach, Cambridge Univ. Press, 2012.
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9. Roland Glaser “Bio physics: An Introduction”2ndedition, Springer, 2012.

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1. https://en.wikipedia.org/wiki/Biophysics
2. http://www.biophysics.org/
3. www.biophysics.jhu.edu/class_sites
4. https://www.cell.com/biophysj/collections/introduction-to-biophysics
5. http://www.moleculargenetics.utoronto.ca/cellular-molecular-structure-function\
6. https://en.wikipedia.org/wiki/Nanobiotechnology
7. https://www.nanowerk.com/nanobiotechnology.php
8. https://en.wikipedia.org/wiki/Biosensor
9. https://www.imamagnets.com/en/blog/what-is-biomagnetism/

Solid State Physics

Semester - III **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To provide an understanding of the basics of crystal physics and X-ray diffractions
2. To introduce the concept of Lattice dynamics
3. To familiarise the various theoretical models to study the properties of matter from a microscopic point of view.
4. To provide an understanding of magnetic materials and theirproperties.
5. To familiarise with superconducting materials.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand crystal structure and diffraction of X-rays in materials	K1-K3
CO 2	Acquire knowledge; understand the behaviour of electrons in solids based on classical and quantum theories and various theories of specific heat capacities of solids.	K1-K3
CO 3	Understand theoretical backgrounds of metals and semiconductors	K1-K3
CO 4	Describe the theories of magnetic materials and how the susceptibility varies with temperature.	K1-K3
CO 5	Explore superconductivity and its applications.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	3	3	2	2	1	2.3
CO2	2	2	3	2	2	2	2	2	3	2	2.2
CO3	3	2	3	1	2	3	2	3	2	2	2.3
CO4	2	3	2	3	1	2	3	2	3	1	2.2
CO5	3	2	2	2	1	3	3	2	2	1	2.1
Mean Overall Score											**2.2**
Results											**High**

Unit - I: Crystal Structure and Binding

Lattice- Crystal systems - Bravias lattices - Miller indices- Reciprocal lattice (SC, BCC, and FCC) -simple crystal structures-NaCl- ZnS and Diamond- X-ray diffraction-Bragg's law- Structure factor-Atomic form factor - Laue equations- crystal binding- crystals of inert gases - Van der Waals-London interaction-Cohesive energy - ionic crystals - Madelung constant- covalent crystals - Metal crystals-Hydrogen bonds.

Unit – II: Lattice Dynamics

One dimensional mono atomic lattice-one dimensional diatomic lattice- acoustical and optical modes - group and phase velocities-quantization of lattice vibrations-phonon momentum-Normal process-Umklapp process-Inelastic scattering by phonons-Lattice specific heat-Dulongpetit's law-Einstein's theory of specific heat-Debye's theory of specific heat.Thermal conductivity of solids – Thermal conductivity due to electrons – Thermal conductivity due to phonons.

Unit – III: Theory of Metals and Semiconductors

Free electron gas in three dimensions- Experimental methods in Fermi surface studies- De Hass Van Alphen effect- Hall Effect: Theory and Experiment- Band theory of solids metals and semiconductors- Bloch theorem-Kronig-Penny modelBrillouin zone-construction of first and second Brillouin zones-Semiconductors: Intrinsic carrier concentration-Extrinsic carrier concentration-Impurity conductivity. Band gap engineering

Unit – IV: Magnetism

Quantum theory of para magnetism-Rare earth ion-Hund's rule - Quenching of orbital angular momentum-Adiabatic demagnetization- Quantum theory of ferro magnetism-Curie point and exchange integral-Heisenberg's interpretation of Weiss fieldMagnons-Curie temperature and susceptibility of ferrimagnets-Theory of anti-ferromagnetism-Neel temperature.

Unit – V: Super Conductivity

Experimental facts-Effect of magnetic fields and temperature-Meissner effect-Entropy and heat capacity-Energy gap-isotope effect-Type I and Type II superconductors-theoretical explanation-thermodynamics of superconducting transition-London equations-Coherence length-Penetration depth-BCS theory-single particle tunneling-Josephson tunneling-DC and AC Josephson effects-High temperature super conductors-SQUIDS (analytical treatment)-applications and limitations of superconductors.

Text Books

1. Charles Kittel, Introduction to Solid State Physics, Wiley & Sons, New York, Eighth Edition, 2018.
2. Dekker A. J, Solid State Physics, McMillan& Co, New Delhi, Reprinted, 2014.
3. Rita John, Solid State Physics, McGraw Hill Education (India) Private Limited, 2016
4. Pillai S.O, Solid State Physics,New age international publishers, New Delhi, Ninth edition 2020.
5. Gupta H. C, Solid State Physics, Vikas Publishing House Pvt. Ltd., Mumbai, 2001.

Books for Reference

1. Wahab M. A, Solid State Physics Structure and Properties of Materials, Narosa Publishing House, New Delhi, 2009.
2. Keer H. V, Principles of the Solid State, New age international publishers, New Delhi 2017.
3. Neil W. Ashcroft, David Mermin N, Solid State Physics, A Harcourt Publishers, Singapore, 2003.
4. Kachhava C. M, Solid State Physics Solid State Devices and Electronics, New age international publishers, New Delhi, 2003.

Websites for Reference

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2. http://academic.uprm.edu/pcaceres/Courses/MEMO/id32.htm
3. http://academic.uprm.edu/pcaceres/Courses/MEMO/id3.htm
4. http://en.wikipedia.org/wiki/Spin_wave
5. http://www.cmmp.ucl.ac.uk/~ahh/teaching/3C25/Lecture07p.pdf
6. http://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/syllabus/MIT3_091SCF09_aln03.pdf
7. http://griffin.ucsc.edu/teaching/08Q1-155/download/Lecture%2019%20-%20Magnetic%20Order.pdf
8. http://www.eng.utah.edu/~lzang/images/lecture-11.pdf
9. http://nptel.iitm.ac.in/courses/103104045/pdf_version/lecture20.pdf
10. http://www.eng.utah.edu/~lzang/images/lecture-12.pdf

Atomic and Molecular Spectroscopy

Semester-III **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To provide a knowledge of interaction of electromagnetic radiation with atoms and molecules and systematically introduce to spectra and basic theoretical concepts in spectroscopic methods.
2. To expose to the fundamental principles of various spectroscopic techniques for structural applications.
3. To understand the theory and principles of electronic and vibrational and its techniques.
4. To Study microwave spectroscopy and its advantages/applications.
5. To understand the physics behind NMR and ESR spectroscopy, Mossbauer spectroscopic techniques.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Apply their knowledge and understand different branches of spectroscopy and carry out experimental and theoretical studies on atoms and molecules with focus on the structure and dynamics.	K1-K2
CO 2	Apply the knowledge of spectroscopy in interdisciplinary subjects like chemistry, mathematics and biological systems.	K1-K3
CO 3	Handle relevant experimental equipment and evaluate experimental results obtained	K1-K2
CO 4	Excel in research field related to materials science and various spectroscopic analyses.	K1-K3
CO 5	Apply NMR and ESR spectroscopy, Mossbauer spectroscopic techniques to examine new materials for novel drugs in the field of medicine	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	3	2	3	1	1	2	2.1
CO2	2	3	3	2	1	3	2	2	2	2	2.2
CO3	2	3	2	3	2	2	2	3	1	2	2.2
CO4	2	2	2	2	3	2	2	2	2	1	2
CO5	3	2	1	2	2	2	3	1	3	2	2.1
Mean Overall Score											**2.1**
Results											**High**

Unit-I: Electronic Spectroscopy

Interaction of electromagnetic radiation with matter-scattering, dispersion and transmissionof radiation -vibrational, rotational and electronic energy levels-types of molecular spectra-band width-factors contributing to band width. Fundamental laws of absorption-Beer's law-origin of UV-Visible spectra-Instrumentation progression and sequences-Frank-Condon principle-transition probability - colour of the compounds-types of transitions -solvent effects on electronic transitions- selection rules for electronic transitions

Unit-II: Rotational Spectroscopy

Microwave Spectroscopy: Rotation of molecules - Pure rotational spectra of diatomic molecules – polyatomic molecules - study of linear molecules and symmetric top molecules – Hyperfine structure and quadruple moment oflinear molecules – Experimental techniques – Molecular structure determination – Stark effect – inversion spectrum of ammonia – applications to chemical analysis.

Unit-III: Vibrational Spectroscopy

Infrared Spectroscopy: Vibrational spectroscopy of diatomic molecules – Harmonic oscillator – Anharmonicoscillator – Rotational vibrators – Normal modes of vibration of CO_2 and H2O molecules–IR spectrometer - FTIR spectrometer – Interpretation of FTIR spectra of H_2O,CCl_4, Benzene molecules.

Raman Spectroscopy: Raman effect- Classical and Quantum theory of Raman Scattering-Rotational, vibrational Raman spectra-Stokes and anti-stokes Raman lines-selection rules-Nuclear spin and its effecton Raman spectra - FT Raman instrumentation – Comparison of IR and Raman spectra – interpretation of Raman spectra (N_2 and O_2)

Unit –IV: Resonance Spectroscopy

Nuclear Magnetic Resonance (NMR) - Introduction-Interaction of spin and magnetic field population of energy levels-Larmor precession-Relaxation times- Bloch equations — steady state solution Double resonance-Chemical shift and its measurement- Coupling constant-Coupling between several nuclei- Quadrupole effects– Instrumentation:–13C and 1H NMR - Interpretation of NMR spectra.

Principle and theory of ESR – Nuclear interaction and hyperfine structure – Relaxation effects – ESR Instrumentation – Applications of ESR.

UNIT V: Mossbauer spectroscopy and Surface Spectroscopy

Principle of Mossbauer spectroscopy: Doppler shift, recoil energy. Isomer shift, quadrupole splitting, magnetic interactions. Applications: Mossbauer spectra of high and low-spin Fe and Sn compounds.

Electron energy loss spectroscopy (EELS)-Reflection absorption spectroscopy (RAIRS)- Photoelectron spectroscopy (PES) – Instrumentation – interpretation of spectrum; X-ray Flourescence spectroscopy (XRF)-SIMS - Surfaces for SERS study-SERS Microbes-Surface selection rules

Books for study:

1. Kaur. H, Spectroscopy, 7th Edition, PragatiPrakashan, Meerut, 2012.
2. R. Colin N. Banwell and Elaine M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi, 2013
3. Aruldas G., Molecular Structure and Spectroscopy, 2nd Edition, Prentice Hall of India Pvt.Ltd., 2007
4. A K Saxena, Atomic and molecular spectroscopy and Lasers, S Chand Publishing company (P) Ltd., 2015

Books for Reference:

1. Satyanarayana D. N., Vibrational Spectroscopy: Theory and Applications, New AgeInternational Publications, New Delhi, 2004.
2. Donald L. Pavia,Gary M. Lampman, George S. Kriz and James A. Vyvyan,Introductionto Spectroscopy, 4th Edition, Brooks Cole, 2008.
3. Towne and Schawlow, Microwave Spectroscopy, Tata McGraw Hill, New Delhi, 1995.
4. Dr. Ramphal Sharma, Fundamentals of Atomic and Molecular Spectroscopy, HimalayaPublishing House, New Delhi, 2008.
5. Gupta, Kumar, Sharma, Elements of Spectroscopy: Atomic, Molecular and LaserPhysics, PragatiPrakashan, Meerut, 2011.
6. Rita Kakkar, Atomic and molecular spectroscopy, Basic concepts and applications,Cambridge University Press,2015.

Websites References:

1.http://en.wikipedia.org/wiki/Spectroscopy
2.http://en.wikipedia.org/wiki/Rotational_spectroscopy
3.http://classes.uleth.ca/200303/chem3810a/NotesS2.pdf
4.http://www.pharmagupshup.in/2011/12/infared-spectroscopy-free-study.html
5.http://www.infochembio.ethz.ch/links/en/spectrosc_microwave.html
6.http://www.chem.ucla.edu/harding/notes/notes_14C_nmr02.pdf
7.http://nmr.wsu.edu/files/pdf/theory.pdf
8.http://www.news-medical.net/health/Spectroscopy-Types.aspx
9.http://www.chem.uni-wuppertal.de/quasaar/han-sur-lesse/files/Wlodarczak1.pdf
10.http://www.internetchemistry.com/chemistry/microwave-spectroscopy.htm
11.http://web.mit.edu/5.33/www/lec/spec5.pdf
12.http://www.chem.ucla.edu/harding/notes/notes_14C_IR.pdf
13.http://www.chem.uic.edu/tak/chem52411/notes16/notes16-11.pdf
14. http://www.eng.uc.edu/~beaucag/Classes/Characterization/RamanCALTECH.pdf
15. https://www.patnauniversity.ac.in/e-content/science/physics/MScPhy89.pdf

C Programming and Research Methodology

Semester – III **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To introduce to the students the fundamentals of C programming.
2. To enhance skill on problem solving by constructing algorithm/program.
3. To familiarize the students with the nature of research and scientific writing.
4. To introduce to the students various quality metrics to be followed while publishing paper.
5. To analyze, interpret and evaluate scientific hypotheses and theories using rigorous methods such as statistical and mathematical techniques.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Explain the fundamental concepts of C programming and applications in problem solving.	K1-K3
CO 2	Develop programs using the basic elements like control statements, arrays, strings and functions.	K1-K2
CO 3	Identify the good research problems and formulate the research design.	K1-K3
CO 4	Write quality research papers and publish them in reputed journals.	K1-K3
CO 5	Analyze the data with the use of appropriate tools and create the qualitative and quantitative solutions to problems.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	3	2	2	2.1
CO2	3	2	3	2	2	2	2	2	3	3	2.4
CO3	3	2	2	2	2	3	3	2	3	3	2.5
CO4	2	2	3	2	3	2	2	2	3	2	2.3
CO5	3	2	3	3	2	2	2	3	2	3	2.5
										Mean Overall Score	**2.4**
										Results	**High**

Unit – I: Introduction to C Programming

Features of C–Basic structure of C program– Character set – Trigraph characters– Keywords and Identifiers–Constants– data types – Variables – Declaration of variables – Assigning values to variables – Operators: Arithmetic – Relational– Logical– conditional–Assignment– Increment– Decrement – Input/output functions– Escape sequence–Control statements: Branching and Looping statements.

Unit – II: Arrays strings and Functions

Arrays: Declaring and initializing one and two dimensional arrays– Strings: Declaring and initializing string variables–string handling functions–Functions: Library and User defined functions– Need for user–defined functions– Function declaration– Return values and their types– Calling functions– Categories of functions– Simple Programs: Celsius to Fahrenheit– Fahrenheit to Celsius – Solution of the quadratic equation–largest of given three numbers

Unit – III: Identification of the problem and Manuscript writing:

Identification of the problem: Literature survey – awareness of current status of the art–Reference collection – Mode of approach of actual investigation – Drawing inferences from data– Results and conclusions.

Significance of report writing – research papers – review paper¬ – synopsis –Thesis – review process – publishing process.

Unit–IV: Quality Metrics and Error analysis

SCI– Web of science–SCOPUS indexed journals – importance of peer reviewed journals – Indexing: i, h and citation index – Intellectual property rights (patents and copyright) – professional ethics.

Error analysis: Presentation of physical quantities with their inaccuracies– significant figures–Errors: classification and propagation–Probability distributions–Processing of experimental data–Graphical handling of data with errors.

Unit –V: Statistical Techniques

Introduction to statistics – Functions – Limitations – Measures of central tendency– Arithmetic mean – Median – Mode – Standard deviation – Co–efficient of variation (Discrete serious and continuous serious) – Correlation – Regression – Multiple Regression – t test – ANOVA test. Curve fitting: Straight line, parabola, exponential curves.

Text Books

1. Balaguruamy. E, Programming in ANSI C, Tata McGraw–Hill, New Delhi, 2005.
2. Kothari. C. R. Research Methodology Methods and Techniques, New Age publishers, New Delhi, 2019.
3. Prathapan K, Research Methodology for Scientific Research, IK International Publishing House Pvt. Ltd, New Delhi and Bangalore, 2014.
4. John R. Taylor, An Introduction to Error Analysis: The Study of Uncertainties Measurements, 2nd Edition, University Science Books, California, 1997.
5. Vittal P. R, Mathematical statistics, Margham Publications, Chennai, 2002.

Books for Reference

1. Ashok N. Kamthane, Programming with ANSI and Turbo C, Pearson Education Ltd, New Delhi, 2002.
2. John E. Freund, Mathematical statistics, Prentice –Hall Pvt. Ltd., New Delhi, 1999.
3. Gupta S.C., Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand and Sons, New Delhi, 2014
4. Suresh Chandra, MohitKr.Sharma, Research Methodology, Narosa Publishing house, New Delhi, 2013.
5. Rajaraman V, Computer oriented Numerical Methods, Prentice Hall Pvt. Ltd., New Delhi, 2001.
6. SrinivasRao P. S. V., C programming and data structures, Scitech publications (India) Pvt. Ltd., Chennai, 2006.
7. SukhenduDey, DebobrataDutta, Complete knowledge in C, Narosa Publishing house, New Delhi, 2009.
8. A Hand Book of Methodology of Research, Rajammal, P. Devadoss and K. Kulandaivel, RMM Vidyalaya press, 1976.
9. Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd., New Delhi, 2011.
10. G.W. Snedecor and W.G. Cochrans, Statistical Methods, Lowa State University Press, United States, 1967.

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2. https://www.tutorialspoint.com/objective_c/objective_c_variables.htm
3. https://www.tutorialspoint.com/objective_c/objective_c_constants.htm
4. https://www.tutorialspoint.com/objective_c/objective_c_functions.htm
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8. http://www.ldeo.columbia.edu/~martins/sen_sem/thesis_org.html
9. http://www.math.ubc.ca/~anstee/math184/184newtonmethod.pdf
10. http://www.mini.pw.edu.pl/~marcinbo/strona/download/c.pdf
11. http://www.phys.unsw.edu.au/~jw/thesis.html
12. https://www.tutorialspoint.com/objective_c/objective_c_operators.htm
13. https://www.tutorialspoint.com/objective_c/objective_c_loops.htm
14. https://www.tutorialspoint.com/objective_c/objective_c_decision_making.htm
15. https://www.tutorialspoint.com/objective_c/objective_c_arrays.htm
16. https://www.tutorialspoint.com/statistics/arithmetic_mean.htm
17. https://www.tutorialspoint.com/statistics/arithmetic_median.htm
18. https://www.tutorialspoint.com/statistics/arithmetic_mode.htm
19. http://egyankosh.ac.in/bitstream/123456789/20446/1/Unit-5.pdf

Elective: Nanoscience and Technology

Semester-III **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To provide an introduction to nanomaterials, their properties and applications.
2. To know about synthesis of nanomaterials
3. To acquire knowledge about the preparation of nanomaterials by physical methods
4. To understand basic principles and instrumentation
5. To introduce to various thin films deposition techniques and characterization techniques.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Develop an understanding of nanomaterials applications	K1-K2
CO 2	Understand Advantages and disadvantages of chemical method	K1-K3
CO 3	Know the methods of nanomaterial preparations	K1-K3
CO 4	Acquire in depth knowledge about various characterization techniques which will in turn kindle their research interest.	K1-K3
CO 5	Know some of the applications of Nanomaterials and thin films that are applicable in day today life.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	2	3	3	2	2	3	2	2.4
CO2	2	3	2	2	3	3	2	2	3	3	2.5
CO3	3	2	2	2	3	3	3	2	3	3	2.6
CO4	3	2	2	2	3	3	3	2	3	3	2.6
CO5	3	3	2	2	3	3	3	2	3	3	2.7
Mean Overall Score											**2.6**
Results											**High**

Unit – I: Introduction to Nanomaterials

Introduction-Historical perspectives - Advantages and disadvantages of nanomaterials - Classification of nanomaterials based on dimension-Quantum semiconductors- Quantum confinement - Quantum dots- Different forms of Carbon- Carbon nano tubes- Types of CNT – Preparation, properties and applications of CNT- Fullerenes: synthesis and applications – Self Assembled Monolayers- synthesis of gold SAMs.

Unit – II: Preparation by chemical Method

Synthesis of nanomaterials: Top-down and Bottom-up approaches – Sol gel - Spin coating –Chemical bath deposition - Electro-deposition - Hydrothermal – Precipitation method – Reflux method – Advantages and disadvantages of chemical method.

Unit– III: Preparation by Physical Method

Introduction- Methods of preparation: Need for vacuum- working of vacuum pumps: Rotary and diffusion pumps - Gauges: pirani and penning gauges-Thermal evaporation- DC Sputtering – Need for RF sputtering- Pulsed Laser deposition- Plasma arching- Ball milling technique- Spray Pyrolysis -Advantages and disadvantages of Physical method.

Unit – IV: Characterization Techniques

Basic principles andinstrumentation: Powder XRD (Calculation of grain size), HRSEM- TEM-TGA-AFM.

Unit – V: Applications of Nanomaterials and Thin Films

Nanomaterials in Photocatalysis – Thin film Solar cells - Nanostructured Gas sensors -Bio-Sensors- Drug delivery systems - Diluted magnetic semiconductor (DMS) - Quantum computers –Thin Film Transistors - NEMS and MEMS.

Text Books

1. M.A.ShahTokeer Ahmad, Principles of Nanoscience and Nanotechnology,Alpha science international,2010
2. Chris Binns, Introduction to Nanoscience and Nanotechnology, JohnWiley& sons, Inc 2010
3. Chattopadhyay K. K., Banerjee A. N., Introduction to Nanoscience and Technology, PHI learning Pvt. Ltd., New Delhi, 2009.
4. Goswami A., Thin Film Fundamentals, New Age International (P) Ltd., New Delhi, 2007.

Books for Reference

1. Shanmugam S., Nanotechnology, MJP Publishers, Chennai, 2011.
2. Bandyopadhyay A. K., Nanomaterials, New Age International (P) Ltd., New Delhi 2009.
3. Pradeep. T, Nano: The Essentials, Tata McGraw- Hill Publishers Company Ltd., New Delhi, 2007.
4. Clive Whiston, X-Ray Methods, Wiley India Pvt. Ltd., New Delhi, 2008.
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6. Mark Ratner, Daniel Ratner, Nanotechnology: A Gentle Introduction to the Next Big Idea, Prentice Hall**,** 2002.
7. Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama, Nanoparticle Technology Handbook, Linacre House, Jordan Hill, 2007.
8. Joseph Goldstein, Scanning Electron Microscopy and X-ray microanalysis,Springer, London, 2003.
9. William F Smith, JavadHashemi, Foundations of Materials Science and Engineering, Tata McGraw Hill, New Delhi, 2005.

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2. https://www.cheaptubes.com/carbon-nanotubes-properties-and-applications/
3. https://www.geeksforgeeks.org/difference-between-bottom-up-model-and-top-down-model/
4. http://www.ch.ic.ac.uk/harrison/Teaching/L1_Introduction.pdf
5. http://faculty.uml.edu/zgu/Teaching/documents/Lecture6Synthesis_000.pdf
6. http://inside.mines.edu/~zhiwu/courses/550/lecture07.pdf
7. http://www.asp.unijena.de/physik_international_multimedia/MultiphotonLab/2011Nanomaterials_Lecture06_semiconductors.pdf
8. http://hanyangocw.hanyang.ac.kr/ocw/fusion-materials/nano-materials-characterization/1st.pdf
9. http://www.wright.edu/~lok.lewyanvoon/440/chp4.pdf
10. http://hanyangocw.hanyang.ac.kr/ocw/fusion-materials/nano-materials characterization/6th.pdf
11. http://hanyangocw.hanyang.ac.kr/ocw/fusion-materials/nano-materials-characterization/9th.pdf
12. http://www.uccs.edu/~tchriste/courses/PHYS549/549lectures/kinetics.html

Elective: Optical Physics

Semester-III **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To introduce the concept of waves, wave packets, polarization and Brewster angle
2. To make the students to understand the concept of coherence and interference
3. To acquire knowledge of working principle of different type of lasers
4. To get in depth knowledge on propagation of light in the fiber and wave guides
5. To understand the electro-optic and magneto-optic effects and their application

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the concept of waves, wave packets, polarization and Brewster angle	K1-K3
CO 2	Distinguish spatial and temporal coherent and they can understand the spectral resolution	K1-K2
CO 3	Realize the working principle of different type of lasers	K1-K3
CO 4	Explain construction and applications of optical fibers	K1-K3
CO 5	Understand and appreciate the various optical devices and their applications in different fields.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	3	2	2	2.1
CO2	2	2	3	2	2	2	2	2	3	3	2.3
CO3	3	2	2	2	1	3	3	2	3	3	2.4
CO4	2	2	3	2	3	2	2	2	3	2	2.3
CO5	3	2	2	3	2	2	2	2	2	3	2.3
Mean Overall Score											**2.3**
Results											**High**

Unit - I: Electromagnetic Waves

Electrical Constant-Plane Harmonic Waves-Wave packets - Doppler Effect-Relativistic Correction to the Doppler Formula-Linear Partial Polarization-Scattering & Polarization-Circular & Elliptical Polarization-Matrix Representation-Orthogonal Polarization-Eigen Vectors & Jones Matrices- Reflection and Refraction at a Plane Boundary-Amplitudes of Reflected and Refracted Waves- Brewster's Angle.

Unit - II: Coherence and Interference

Theory of Partial Coherence-Coherence Time and Coherence Length-Spectral Resolution of a Finite Wave Train-Coherence and Line Width-Spatial Coherence-Extended Sources-Measurement of Stellar Diameter-Hanbury Brown Twiss Intensity Interferometry-Fabry Perot Interferometer-Theory of Multilayer Films.

Unit - III: Lasers

Characteristics of Laser Light-Atomic Basis for Laser Action-Laser Pumping-Creating a Population Inversion-Laser Resonator-Single Mode Operation-Q Switching-Mode Locking-Helium-Neon Laser- Argon Ion Laser-Carbon dioxide Laser-Solid State Lasers-Semiconductor Laser-Applications.

Unit – IV: Optical Fibres

Propagation of Light in an Optical Fibre-Acceptance Angle-Numerical Aperture-Step and Graded Index Fibres-Fibre Fabrication Techniques-Optical Fibre as a Cylindrical Wave Guide-Wave Guide Equations- Wave Equations in Step Index Fibres-Flow of Power in SI Fibres-Fibre Losses and Dispersion-Applications.

Unit – V: Optical Devices

Electro-optic, Magneto-optic and acousto-optic effects – Material properties related to get these effects – important Ferroelectric, Liquid crystal materials for these devices—Piezoelectric, Electrostrictive and magnetostrictive effects – important materials exhibiting these properties – and their application in sensors & actuator devices –Acoustic delay line –High frequency piezoelectric devices – Surface acoustic wave devices.

Text Books

1. S.G. Lipson, H. Lipson, D.S. Tannhanser, Optical Physics, Cambridge University Press, New Delhi, 1999.
2. A. K. Ghatak, Optics, 3rd Edition, Tata McGraw Hill, New Delhi, 2002.

Books for Reference:

1. Shea D.C.O., RusellCallen W, and Rhodes W.T., Introduction to Lasers & their Applications, Addison Wesley, 2005.
2. Stewart D. Personick, Fibre Optics technology & Applications, Khanna Publishers, New Delhi, 2007.

Website References:

1. http://hyperphysics.phy-astr.gsu.edu/hbase/phyopt/polclas.html
2. electron9.phys.utk.edu/optics421/modules/m1/reflection_and_refraction.htm
3. https://en.wikipedia.org/wiki/Hanbury_Brown_and_Twiss_effect
4. http://hyperphysics.phy-astr.gsu.edu/hbase/optmod/lasgas.html
5. http://www.worldoflasers.com/lasertypes-solid.htm
6. http://www.ques10.com/p/5043/explain-any-one-fiber-fabrication-process-with-nea/
7. https://en.wikipedia.org/wiki/Surface_acoustic_wave
8. https://www.britannica.com/technology/piezoelectric-device
9. https://en.wikipedia.org/wiki/Liquid_crystal
10. https://en.wikipedia.org/wiki/Liquid-crystal_laser

Elective: Computational Quantum Mechanics

Semester - III **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To introduce modern methods of molecular modeling and culminating in electronic structure modeling.
2. To understand the Basic methods of molecular modeling.
3. To enable the students to acquire knowledge Roothaan-Hall Hartree-Fock method and its application
4. To introduce Ab initio formalism of quantum computation.
5. To explore the Knowledge on Density Functional theory and its application.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand quantum mechanical approximation models necessary for the description of molecules and atoms.	K1-K3
CO 2	Understand the relationship between the energy levels obtained as solutions to the time-independent Schrödinger equation and measurements made using spectroscopic methods.	K1-K3
CO 3	Plan and apply computer-based calculations to determine the geometry, energies and electronic properties of molecules.	K1-K2
CO 4	Describe theoretical methods and plan and conduct computer-based calculations of chemical properties in molecules	K1-K2
CO 5	Present and discuss density functional theory for computing the energy of molecules through a one-electron Schrödinger equation that includes electron correlation.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	3	2	2	2.1
CO2	2	2	3	2	2	2	2	2	3	3	2.3
CO3	3	2	2	2	2	3	3	2	3	3	2.5
CO4	2	2	3	2	3	2	2	2	3	2	2.3
CO5	3	2	3	3	2	3	2	3	2	3	2.6
Mean Overall Score											**2.4**
Results											**High**

Unit - I: Introduction to Computational Quantum Mechanics:

Schrödinger equation-Atomic orbital's - spectra of hydrogen-like (one electron) atoms and alkali atoms - variation theorem - Spin and spin wave functions-Many electron systems- electrostatic approximation- Time dependent perturbation theory for two-level and multi-level systems, Effect of constant - perturbation and oscillating perturbation.

Unit - II: Basic Methods of Molecular Modeling:

Force Field- semiempirical, *ab initio* and Density Functional methods.Applicability- comparison of accuracy - basics of electronic structure theory- Atomic units - qualitative role of kinetic and potential energy in shaping the orbitals- Bhorn- opphenier approximation-Geometric optimization.

Unit - III: Roothaan-Hall Hartree-Fock Method:

Energy expression- Slater determinantal wavefunction- Basis set expansion of the orbitals- Basis set types: atomic, plane wave and grid basis sets- Atomic basis sets: Slater-type and Gaussian functions The Self-Consistent Field (SCF) method- Fock's theorem - invariance of the total wavefunction with respect to linear combination of occupied spin-orbitals- Hund's theorem and its implications.

Unit - IV: Ab initio Calculation:

Basic principles of ab initio method – Hatreeself consistent field method-Calculation of molecular energy- minimizing energy equation – Ab initio calculation using Roothaan –Hall equation (SCF procedure) - Application to Ab initio method.

Unit - V: Density Functional Theory (DFT):

Orbital energies, Koopmans' theorem, electrostatic properties - Canonical and localized molecular orbital's - molecular properties- Density functional theory-Major exchange-correlation function - calculation of equilibrium geometries- force constants- vibrational spectra- transition states.

Books for Study

1. F. Jensen, Introduction to Computational Chemistry, John Wiley & Sons, 2004.
2. V. C. Gupta,Principles and Applications of Quantum Chemistry,Kindle Edition, 2015.
3. Errol Lewars, Computational chemistry, Introduction to the theory and application of molecular and quantum mechanics, Springer publication, 2008.
4. M.B Smith and J. March, Advanced organic chemistry, John Wiley & Sons, 2001.

Books for Reference

1. C. J. Cramer Essentials of Computational Chemistry, John Wiley &Sons ,2002.
2. T. Clark A Handbook of Computational Chemistry, Wiley, New York, 1985.
3. R. Dronskowski Computational Chemistry of Solid State Materials, Wiley-VCH ,2005.
4. D. Rogers, Computational Chemistry Using the PC, 3rd Edition, John Wiley & Sons ,2003
5. Szabo, N.S. Ostlund, Modern Quantum Chemistry, McGraw-Hill, New Delhi, 1982.

Website References

1. https://en.wikipedia.org/wiki/Computational_chemistry
2. https://www.google.co.in/?gfe_rd=cr&ei=iihZWMRIILT8gfEmKmoCQ&gws_rd=ssl#q=introduction+to+quantum+computational+chemistry
3. http://www.ccl.net/cca/documents/dyoung/topics-orig/compchem.html
4. http://nptel.ac.in/courses/104101002/downloads/lecturenotes/module1/chapter1.pdf

Electronic Instrumentation Techniques

Semester-IV **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To expose the students to the principles and working of Transducers
2. To make the students to understand the digital instrumentation used in measurement of various physical quantities.
3. To make the students to understand the working of electrical and magnetic measurement instruments and to provide basic knowledge about the working of Compositional analysis instruments and Bio-medical instruments.
4. To impart the knowledge on analytical instrumentation for the identification of various elements.
5. To make the students on the application of various instrumentation used for the measurement of potentials developed by the body cells including ECG, EMG etc

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the principles and working of Transducers and Analog and Digital Instruments used in measurement of various physical quantities.	K1-K2
CO 2	Distinguish the analog and digital instrumentation and its working principle.	K1-K3
CO 3	Apply the knowledge of electrical and magnetic property of the material in the measurement of conductivity	K1-K2
CO 4	Understand the difference in the approach of absorption and emission property of radiation in detecting the elements of the surface and also the emission of electrons.	K1-K3
CO 5	Acquire the knowledge of blood pressure, potentials produced by the cells of various organs including heart, muscle, brain and its measurement.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	1	2	3	3	2	1	2.2
CO2	3	2	2	1	2	1	3	2	2	3	2.1
CO3	2	3	2	3	2	1	2	3	2	2	2.2
CO4	2	3	3	1	2	3	2	3	1	2	2.2
CO5	3	2	2	1	3	2	2	3	1	2	2.1
Mean Overall Score											**2.2**
Results											**High**

Unit – I: Transducers

Transducers -Classification of Transducers –factors for selection of a transducer- Principle, construction and working of Thermistor and LVDT, Electrical strain gauges and capacitive transducers : change in area of plates and change in distance between plates, Advantages and disadvantages of capacitive transducers- Hall effect transducer -Photovoltaic transducer, Photo emissive transducer, Moving coil type velocity transducer- Sesmic type velocity transducer- Measurement of pressure using resistive transducer.

Unit – II: Digital Instrumentation

Principle, block diagram and working: Ramp type digital voltmeter, potentiometric type digital voltmeter -Digital Multimeter, digital LCR meters, digital pH meter, digital conductivity meter and digital storage Oscilloscope – introduction to virtual instrumentation, Supervisory control and data acquisition.

Unit - III: Electrical and Magnetic Measurements Instrumentation

Principles and Experimental techniques: AC and DC Photoconductivity measurement (method name)-Electrical Conductivity and Resistivity measurement by Vanderpauw four probe method - dielectric measurement, Vibrating Sample Magnetometer and magnetic susceptibility measurement by Gouy's method.

Unit – IV: Analytical Instrumentation techniques

Principles and Experimental techniques: X-ray Photoelectron Spectroscopy (XPS),Auger Electron Spectroscopy, Atomic Absorption Spectroscopy, Atomic Emission Spectroscopy, Flame Photometry-SIMS, CHNS.

Unit – V: Bio-Medical Instrumentation

Introduction- Origin of bioelectric signals-Action and resting potential - Physiological transducers to measure blood pressure, Hb meter, Blood cell counters-Bio potential electrodes- types – bio potential recorders - block diagram – ECG - waveform – electrodes and leads – Einthoven triangle – block diagram - EEG- EMG - CT scanners .

Text books

1. Kealey D. and Haines P. J., Analytical chemistry, Viva Publications, New Delhi, 2002.
2. Lakshmi Rekha R., Ravikumar C., Biomedical Instrumentation and Medical electronics, Lakshmi Publications, Chennai, 2009.
3. Douglas A.Skoog, F.James Holler, Timothy A.Nieman, Principles of Instrumental Analysis, Harcourt College publishers, 5th edition, 2001.
4. Rajendra Prasad, Electronic Measurements and Instrumentation, Khanna Publications, Chennai, 2004.
5. Ramambhadran S., Electronic Measurements and Instrumentation, Khanna Publications, Chennai, 2003.
6. R.S. Khandpur "Handbook of Biomedical Instrumentation",2nd Edition, Tata McGraw Hill, 2003.

Books for Reference

1. Cooper W. D. and Helfrick A. D., Electronic Instrumentation and Measurement Techniques, First edition, Dorling Kindersly *Pvt. Ltd. India, 2009.*
2. Bouwens A. J., Digital instrumentation, McGraw Hill international, New Delhi, 2002.
3. Robert B. Northrop, Analysis and Application of Analog Electric Circuits to Biomedical instrumentation, CRC press, Noida, 2004.

Websites for Reference

1. http://www.sjsu.edu/faculty/selvaduray/page/papers/mate210/thinfilm.pdf
2. http://www.leapsecond.com/pdf/an200.pdf
3. http://academic.amc.edu.au/~hnguyen/JEE326_10/lecture03.pdf
4. http://www.eng.hmc.edu/NewE80/PDFs/SensorsAndTransducers2012.pdf
5. http://en.wikipedia.org/wiki/Secondary_ion_mass_spectrometry
6. http://www.casaxps.com/help_manual/XPSInformation/XPSInstr.htm
7. http://en.wikipedia.org/wiki/X-ray_photoelectron_spectroscopy
8. http://www.eaglabs.com/mc/rbs-instrumentation.html
9. http://www-pub.iaea.org/MTCD/publications/PDF/te_1190_prn.pdf
10. http://www-odp.tamu.edu/publications/tnotes/tn30/tn30_10.htm
11. http://www.rsc.org/images/CHNS-elemental-analysers-technical-brief-29_tcm18-214833.pdf
12. http://cdn.intechopen.com/pdfs/26275/InTech-Atomic_absorption_spectrometry_aas_.pdf
13. http://www.intechopen.com/books/atomic-absorption-spectroscopy
14. http://biomedikal.in/2010/01/short-and-precise-lecture-notes-on-ecg-electrocardiogram/

Nuclear and Particle Physics

Semester-IV **Hours/week: 5**
Sub. Code: **Credits: 4**

Course objectives:

1. To provide brief introduction on the basic concept of nucleus including size, force and nuclear models
2. To impart the knowledge on two body system and nuclear interaction.
3. To provide an in-depth knowledge on types of nuclear reactions and its relation
4. To enhance the knowledge about various fundamental particles, their decay and transitions.
5. To make the students to understand about the basic ideas on elementary particles and its classifications and interaction of quarks

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Differentiate the different models of the nucleus and apply their idea in calculating the parameters theoretically.	K1-K3
CO 2	Solve the two body problems in connection with nuclear interaction	K1-K2
CO 3	Be able to identify the reason behind the mode of decay, transitions between the nuclear decays and have strong physical reasoning and problem solving skill and able to find solutions to the problems related with nuclear physics	K1-K3
CO 4	Be able to demonstrate the different types of nuclear reaction and its applications in day today life including nuclear fission, fusion and its role in the construction of nuclear reactor.	K1-K3
CO 5	Be able to explain the basic concept of elementary particles based on the combination quarks projection and also acquire knowledge on strong and weak interaction.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	2	3	3	2	3	2	3	1	2.4
CO2	3	1	3	2	2	3	3	2	2	3	2.4
CO3	1	2	3	3	2	2	2	3	1	2	2.1
CO4	2	3	2	2	3	1	1	2	2	3	2.1
CO5	3	2	1	3	2	3	2	2	3	2	2.3
										Mean Overall Score	**2.3**
										Results	**High**

Unit– I: Nucleus and Nuclear Models

Basic properties: Nuclear size, shape, charge distribution, spin, parity, binding energy-Magnetic dipole moment-Electric quadrupole moment-Nuclear models:Liquid drop model-Semi-empirical mass formula of Weizsacker-Application-Nuclear stability-Mass parabolas- -Shell model-Magic numbers-Spin-Orbit coupling- validity and limitations - Angular momenta and paritiesof nuclear ground state- qualitative discussion and estimation of transition rates-Magneticmoments -Collective model of Bohr and Mottelson.

Unit – II: Nuclear Interactions

Nuclear forces-characteristics-Two body problem- Deuteron-properties-Ground state ofdeuteron using square well potential -Magnetic moment-Quadrupole moment-Tensor forces-Meson theory of nuclear forces-Yukawa potential-Nucleon-nucleon scattering:Low energy npscattering-Effective range theory-Spin dependence, charge independence and chargesymmetry of nuclear forces.

Unit – III: Nuclear reactions and fission

Types of nuclear reactions, Quantum mechanical theory, Resonance scattering and reactions —BreitWigner dispersion relation; Compound nucleus formation and break-up, Statistical theory of nuclearreactions and evaporation probability, nuclear fission: Spontaneous fission- Bohr-Wheeler theory of fission-**barrier penetration-statistical model. Elementary ideas about astrophysical reactions, Nucleosynthesis and abundance ofelements.**

Unit – IV: Nuclear Decay

Elementary ideas of α, β and γ decay -Fermi's theory of beta decay-Fermi-Kurie plot-Fermiand Gamow-Teller selection rules for allowed and forbidden decays-Non-conservation ofparity-Decay rates-Theory of electron capture- Theory of neutrino- neutrino detection–Originof Gamma decay-energetics of gamma decay-Multipole transitions in nuclei-Internalconversion- Nuclear isomerism-Angular correlation in successive gamma emissions.

Unit – V: Particle Physics

Elementary particles- Classification of elementary particles-Types of interactions betweenelementary particles- Conservation laws – quantum numbers-**The problem of mass generation and the need forthe Higgs mechanism** - Elementary ideas of CP and CPT invariance-Hadrons-Classification of Hadrons-Symmetry-SU(2)-SU(3). **Quarks; Colour; Gell-Mann –Okubo mass relation.**

Text Books

1. Thayal D.C., Nuclear Physics, Himalaya Publishing house, Mumbai, 2011.
2. Goshal S. N., Nuclear Physics, S. Chand Publications, New Delhi, 2004.
3. S L Kakani Shubra Kakani, Nuclear and Particle Physics,2nd edition, VIVA books company India Ltd, 2008.
4. Suresh Chandra and Mohit K Sharma "Nuclear and Particle Physics"Narosa Publishing company, 2012.

Books for Reference

1. Roy R. R. and Nigam B. P., Nuclear Physics, New age international Ltd., New Delhi 2005.
2. Devanathan V., Nuclear Physics, Narosa publishing House Pvt. Ltd, New Delhi, 2006.
3. Hans H. S., Nuclear Physics Experimental and Theoretical, New Age International (P) Limited Publishers, New Delhi, 2001.
4. Bernard L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill Publishing, New Delhi, 2002.
5. Irving Kaplan, Nuclear Physics, Narosa publishing House Pvt. Ltd, New Delhi, 2002.
6. Santra A. B., Kailas S and Bhalerao R. S, Mesons and Quarks, Narosa publishing House Pvt. Ltd, New Delhi, 2004.
7. SatyaPrakash, Nuclear Physics and Particle Physics, Sultan Chand, 2005.
8. V K Mittal, R C Verma, S C Gupta, Introduction to Nuclear and Particle Physics3rd edition - Prentice hall India learning P(Ltd),2013.

Websites for Reference

1.http://www.sjsu.edu/faculty/watkins/nuclearstruct.htm
2.http://en.wikipedia.org/wiki/Nuclear_shell_model
3.http://www.sjsu.edu/faculty/watkins/semiempirical.htm
4.http://www.physics.lancs.ac.uk/people/kormos/P235_1b.pdf
5.http://library.thinkquest.org/3471/nuclear_forces.html
6.http://www.physicshandbook.com/topic/topicn/nuclearf.htm
7.https://www2.lbl.gov/abc/wallchart/chapters/03/0.html
8.https://www.britannica.com/science/radioactivity
9.https://www.quantamagazine.org/a-new-map-of-the-standard-model-of-particle-physics-20201022/
10. http://www.ucolick.org/~woosley/ay220-15/lectures/lecture5.4x.pdf

Modern Physics Practicals
Any 15 experiments

Semester - IV **Hours/week: 5**
Sub. Code: **Credits: 6**

Course Objectives:

1. **To relate theoretical concepts to real world applications and experiments.**
2. **To familiarize the students with optics, sound, magnetic and electric laboratory experiments and procedures.**
3. **To observe reliable data and record the observations.**
4. **To organize the measurements, estimate errors and write the laboratory record.**
5. **To develop an understanding of basic concepts and hands on training of advanced experiments.**

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	**Explain the theoretical concepts and working principle of the experiments.**	K1-K4
CO 2	**Organize the experiments and observe the reliable data.**	K1-K3
CO 3	**Analyze the observed data and calculate the value of a physical quantity without error.**	K1-K3
CO 4	**Measure the velocity of ultrasonic waves in different liquid medium.**	K1-K4
CO 5	**Apply physics concepts and ideas from lab to real time problems.**	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	3	3	2	2	3	3	1	2	2	2.3
CO2	3	3	3	2	2	3	3	3	2	2	2.6
CO3	3	3	1	3	2	3	3	3	3	1	2.5
CO4	3	3	3	3	2	3	1	3	3	2	2.6
CO5	3	3	3	2	2	3	3	3	2	2	2.6
Mean Overall Score											**2.5**
Results											**High**

List of Experiments:

1. Michelson Interferometer -Wavelength and separation of wavelengths of sodium light.
2. Hall Effect-Determination R_H,n, μ and θ_H
3. Molecular Spectra – CN/ALO Bands
4. Susceptibility of a liquid by Quincke's method.
5. Susceptibility of a liquid by Guoy's method.
6. Ultrasonic Diffraction - Velocity and Compressibility of a liquid.
7. Ultrasonic Interferometer - Velocity and Compressibility of a liquid.
8. B-H curve using CRO- Coercivity and retentivity
9. Spectral analysis of a salt.
10. Absorption Spectra-Determination of wavelength by Hartmann's Interpolation formula.
11. Laser diffraction at a straight wire, Thickness determination and verification by air-wedge method.

12. Laser diffraction at a circular aperture, diameter determination and verification using microscope.
13. Determination of dielectric loss using CRO.
14. G.M. counter-Characteristics, inverse square law and Absorption co-efficient.
15. **B-H loop using Anchor ring.**
16. **Specific charge of an electron -Thomson's method / Magnetron method**
17. Michelson Interferometer -Wavelength of laser beam
18. Franck Hertz experiment – Critical potential
19. Study of Zeeman effect — determination of e/m, Lande g-factor of electrons.
20. Millikan's oil drop experiments – charge of electron.
21. Laser beam - Interference Experiments
    a. Using an optically plane glass plate
    b. Using Lloyd's single mirror method.
22. Determination of strain hardening coefficients

Microprocessor, Microcontroller and C Programming Experiments
(Any 20 out of the given 25)

Semester - IV **Hours/week: 5**
Sub. Code: **Credits: 6**

Course objectives:

1. To develop the skill of understanding Instruction sets and opcode of 8085 microprocessor and 8051 Microcontroller.
2. To familiarize the students with interfacing with 8085 microprocessors to other Input/ output devices.
3. To enable students to write assembly language programs for software and interfacing devices.
4. To familiarize the students about the C programming.
5. To analyze and evaluate the various theories, statistical methods and mathematical techniques using C programming.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Write assembly level language programs for both software and hardware interfacing using 8085 microprocessors.	K1-K4
CO 2	Write an assembly level language programs for software and hardware interfacing using 8051 microcontrollers.	K1-K4
CO 3	Understand the different applications of microprocessor and microcontroller.	K1-K4
CO 4	Develop C programs using the basic elements like control statements, arrays, strings and functions.	K1-K3
CO 5	Use appropriate mathematical techniques and concepts to obtain quantitative solutions to problems in Physics using C program.	K1-K4

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	1	2	3	2	3	2	3	2.5
CO2	3	3	3	3	2	2	3	3	1	2	2.5
CO3	3	3	2	3	2	3	3	2	3	3	2.7
CO4	3	2	3	2	2	3	3	2	2	3	2.5
CO5	3	3	3	3	2	3	3	1	3	2	2.6
Mean Overall Score											**2.6**
Results											**High**

List of Experiments:
Microprocessor and interfacing Programming

1. Number conversion -8 bit: BCD to Binary, Binary to BCD, Hex to ASCII using 8085.
2. Number conversion -16 bit: BCD to Binary(HEX), Binary(HEX) to BCD using 8085
3. Square and square root of BCD and HEX numbers 8 bit 8085.
4. Time delay subroutine and a clock program using 8085
5. Double and Triple precision addition and subtraction subroutine using 8085.
6. Sum of Arithmetic operation using 8085 MPU
7. Switching an array of LEDs by using 8085.

8. ADC and interfacing 0809 with MPU.
9. Analog to digital conversion using a DAC Comparator and MPU system.
10. DAC interface- wave form generation using CRO - ramp, square wave. Rectangular wave, Triangular wave and Step up followed by step down.
11. Interfacing a DC stepper motor to the MPU system - clockwise and anticlockwise - full stepping and half stepping.
12. Serial and parallel communication between two 8085 Microprocessors.
13. Interfacing Traffic controller using 8085 MPU.

Microcontroller 8051

1. Interfacing Traffic controller using 8051.
2. Interfacing seven segment displays with 8051.
3. Interfacing a Stepper motor to 8051.
4. Wave form generation using 8051.
5. Finding the sum of two numbers in decimal using 8051.
6. Addition, Subtraction, Multiplication and Division using 8051.

C Programming

1. Lagrange's interpolation.
2. Numerical integration by Trapezoidal rule.
3. Solution of a polynomial equation by Newton Raphson method.
4. Curve fitting - Least square fitting-Straight line fit.
5. Matrix multiplication
6. Numerical Integration by Simpson's rule.

Elective: Modern Optics

Semester-IV **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. Provide a thorough foundation in the optical physics of both second order and third order nonlinear optical phenomena.
2. Understand nonlinear phenomena from the fundamental perspective of quantum mechanics.
3. To understand third order nonlinear optical phenomena of the materials.
4. To expose the students to the optical fiber communication systems and to explain the importance and advantages of optical fiber communications, basic problems and possible mitigations.
5. To understand the fundamentals of optical properties of materials for various applications.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Predict the frequencies generated by a nonlinear optical process	K1-K3
CO 2	Understand stimulated Raman and Brillouin scattering	K1-K2
CO 3	Estimate the upper bound of optical power in silica fiber due to nonlinearity	K1-K3
CO 4	Recall the basic structure of an optical fiber and the pulse propagation in optical fibers and also can explain the various types of dispersions in optical fibers and their mitigations by deploying various types of optical fibers	K1-K3
CO 5	Obtain knowledge about optoelectronic materials, their properties and applications.	K1-K2

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	2	2	2	3	3	2	2	1	2.3
CO2	2	2	3	2	2	2	2	2	3	2	2.2
CO3	3	2	3	1	2	3	2	3	2	2	2.3
CO4	2	3	2	3	1	2	3	2	3	1	2.2
CO5	3	2	2	2	1	3	3	2	2	1	2.1
										Mean Overall Score	**2.2**
										Results	**High**

Unit 1: Principles of Lasers:

Emission and absorption of Radiation –Einstein Relations, pumping Mechanisms – Optical feedback - Laser Rate equations for two, three and four level lasers, pumping threshold conditions, Laser modes of rectangular cavity - Laser Systems: Gas, Liquid and Solid Lasers-Gas lasers and Energy level schemes: Argon, CO_2 Gas lasers- Applications. Solid State lasers: Neodymium - Ti-Sapphaire Lasers – Dye lasers- Applications.

Unit - II: Non-linear Optics

Linear optics - Wave propagation in isotropic and anisotropic media – Polarization response of materials to light – Nonlinear Wave Propagation – three wave mixing - nonlinear susceptibility - second harmonic generation – Kurtz and Perry method - sum and difference frequency generation – optical parametric oscillation.

Unit - III: Third order Non-linear process

Electro-optic (Pockels) effect – Electro optic Modulators - four wave mixing - third harmonic generation - nonlinear index of refraction - self focusing - self phase modulation – cross phase modulation - short pulse generation - z scan – open aperture and closed aperture scans - Quadratic electro-optical (Kerr) effect - stimulated Raman scattering - stimulated Brillouin scattering.

Unit –IV Fiber Optics

Optical fibers – basic structure – light propagation in a step index fiber – conditions – linear effects – attenuation – measuring attenuation – dispersion – inter and intra – fiber modes – V-parameter – mode field diameter - Mitigations to Linear Effects Novel Fibers: Mitigations to attenuation – repeaters – optical amplifier – semiconductor optical amplifier – Erbium doped fiber amplifier – fiber Raman amplifier – mitigations to dispersion – dispersion shifted fiber – nonzero dispersion shifted fiber – dispersion flattened fiber – dispersion compensating fiber. Fiber Bragg grating – Dispersion compensation –Photonic crystal fiber – Photonic Devices.

Unit V: Optoelectronic Materials

Optical and Optoelectronic Materials - Principles of photoconductivity – simple models – effect of impurities – principles of luminescence – types and materials.

Applications: LED materials – binary, ternary photo electronic materials – Optical storage materials – LCD materials – photo detectors – applications of optoelectronic materials.

Books for Study

1. R. Murugesan, KiruthikaSivaprasath, Modern Physics, S. Chand publisher, New Delhi, 2016.
2. Ajoy Ghatak K. Thyagarajan, Fiber Optics and Lasers: The Two Revolutions, Infinity Press, 2016.
3. Hechst, Optics, Pearson Education, 2008.
4. Robert W. Boyd, Nonlinear Optics, 3rd Edition, Academic Press, 2008.
5. G. P. Agarwal, Nonlinear Fiber Optics,4th edition, Academic press , 2007.
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7. Kittel C, Introduction to Solid State Physics, 8th Edition, Wiley Eastern, New International Publishers, 2005.

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1. G.R.Fowles, Introduction to modern optics, Cambridge University Press, 2005.
2. Ter-Mikirtychev, Vartan, Fundamentals of Fiber Lasers and Fiber Amplifiers,Springer press, 2014.
3. AjoyGhatak, Optics, McGraw Hill Education India Private Limited, 2017
4. N. Bloembergen, Nonlinear Optics, 4th edition, World Scientific, 1996.
5. R. L. Sutherland, Handbook of Nonlinear Optics, 2nd edition, Marcel Dekker press, 2003.
6. Y. R. Shen, Principles of Nonlinear Optics, Wiley publishers, 1984.
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2. https://www.sciencedirect.com/book/9780123970237/nonlinear-fiber-optics
3. https://www.cambridge.org/core/books/elements-of-nonlinearoptics/F6B3C66E6115CD3DE8F615DF16BBB47C
4. https://link-springercom.libproxy1.usc.edu/book/10.1007%2F978-3-540-46793-9
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9. https://hithaldia.in/faculty/sas_faculty/Prof_A_B_Maity/Lecture%20Note_EI_503A.pdf
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Elective: Reactor Physics

Semester-IV **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To make the students to understand the concepts of nuclear reaction, cross section and chain reaction.
2. To make the students to differentiate between the types of neutrons produced in a nuclear reaction and the concept of neutron diffusion.
3. To provide an in-depth knowledge of fuels and materials used for the nuclear energy production.
4. To explain the concept of moderation of neutron in a nuclear reactor and its critical condition in the operation of a nuclear reactor
5. To provide an extravagant details on the types of nuclear reactors and it working principle.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the basic ideas of nuclear reaction, cross section and the process of chain reaction.	K1-K2
CO 2	Identify and differentiate the various energy ranges of neutrons produced in a chain reaction and its diffusion property	K1-K3
CO 3	Explain and analyze the properties of fuels and materials used in a typical reactor	K1-K3
CO 4	Demonstrate the importance of neutron production and critical condition through diffusion equation	K1-K2
CO 5	Apply the knowledge chain reaction ,able to calculate the critical value for a typical nuclear reactor and understand the working concept of different reactors and their applications.	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	3	2	2	3	1	2	2	2	2.1
CO2	2	1	2	2	3	1	3	2	2	3	2.1
CO3	2	2	3	2	3	2	3	2	2	2	2.3
CO4	3	2	2	2	1	2	3	2	2	2	2.1
CO5	3	2	2	2	2	2	2	2	2	3	2.2
										Mean Overall Score	**2.2**
										Results	**High**

Unit – I: Chain Reactions

Slow neutron reactions-nuclear reaction cross section-neutron cross section-determination of neutron cross section-attenuation of neutrons-macroscopic cross section and mean free path-neutron flux and reaction rate-energy dependence of neutron cross sections-fission cross section-neutron flux and reaction rate-energy dependence of neutron cross sections-fission cross section.

Unit – II: Thermal Neutrons and neutron diffusion

Energy distribution of thermal neutrons-effective cross section for thermal neutrons-the slowing down of reactor neutronsDiffusion – diffusion Equation- solution of diffusion equation for a point source in an infinite medium and for an infinite plane source in a finite medium -thermal diffusion Length- diffusion Length for a fuel-moderator mixture-fast neutron diffusion and Fermi age equation- Correction for neutron capture.

Unit – III: Nuclear fuels and structural materials

Nuclear Fuels: Introduction to Uranium, Plutonium and Thorium Fuels: Physical Properties, Ceramic Fuels: Ceramic Uranium Fuels, Uranium Dioxide (Urania), Uranium Carbide, Uranium Nitride, Plutonium-Bearing Ceramic Fuels, Thorium-Bearing Ceramic Fuels.

Fundamentals of iron carbon alloys and phase diagram, time temperature transformation diagram and heat treatments, special steels and their properties for nuclear reactor components, Pressure vessel steels, Nickel-base alloys-stellites.

Unit – IV: Neutron Moderation and Critical Equation

Energy loss in elastic collision - moderation of neutrons in Hydrogen - Space dependent slowing down -Moderation with absorption-Diffusion equation applied to a thermal reactor-thermal neutron source as obtained from the Fermi age equation-critical equation and reactor buckling-the non-leakage factors-criticality of large thermal reactors-critical equation for reactors with heterogeneous moderators-critical size and geometrical buckling- extrapolation length correction-effect of reflector.

Unit – V: Nuclear Reactors

Classification of reactors-Heterogeneous reactors-properties of heterogeneous system-resonance capture and resonance escape probability-calculation of the thermal utilization-resonance escape probability and fast fission factor-Commercial reactors: Pressurized Water Reactor (PWR)- Boiling Water Reactor (BWR)- Heavy Water Reactor (HWR)- Water Moderated Enriched Reactors- The breeder reactor- future of nuclear fission power.Generation-I, II, III, IV Reactors-Nuclear Reactors in India.

Text Books

1. John R. Lamarsh, Introduction to Nuclear Reactor Theory, Addison Wisley, 2002.
2. Samuel Glasstone, Milton C. Edlund, The Elements of Nuclear Reactor Theory, Van Nostrand, 1995.
3. James J Duderstadt,Louis J Hamilton, Nuclear reactor analysis,Wiley India Pvt Ltd,2013
4. Robert E.Masterson, "Introduction to Nuclear reactoir Physics" CRC Press, 1st edition 2018

Books for Reference

1. Thayal D.C., Nuclear Physics, Himalaya Publishing house, Mumbai, 2007.
2. Goshal S. N., Nuclear Physics, S. Chand Publications, New Delhi, 2004.
3. Bannet D. J. and Thomson J. R, The elements of nuclear power, Longman Scientific and Technical, New York, 1989.
4. Murray R. L., Nuclear Physics, 5th edition Butterworth, Heineman, 2001.

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3. https://en.wikipedia.org/wiki/Chain_reaction
4. www.ans.org/PowerPlants
5. www.world-nuclear.org/info/inf53.html
6. npcil.nic.in/main/AllProjectOperationDisplay.aspx
7. https://www.amacad.org/sites/default/files/academy/pdfs/nuclearReactors.pdf
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10. https://www.tandfonline.com/doi/abs/10.1080/00223131.2016.1208593
11. https://www.coursera.org/lecture/ferrous-technology-2/iron-carbon-system-aUbv1

Elective: Digital Signal Processing

Semester - IV **Hours/week: 4**
Sub. Code: **Credits: 4**

Course objectives:

1. To introduce the basic principles of digital signal processing (DSP) and provide an understanding of the fundamentals, implementation and applications of DSP techniques.
2. To introduce signals, systems, time and frequency domain concepts and the associated mathematical tools those are fundamental to all DSP techniques.
3. To provide a thorough understanding and working knowledge of design, implementation, analysis and comparison of digital filters for processing of discrete time signals.
4. To impart the knowledge of spectral properties of discrete-time systems through the use of Discrete Fourier transform (FFT) of sequences.
5. To introduce various sampling techniques and different types of filters.

Course outcomes:

CO	CO Statements	Cognitive Level
CO 1	Understand the fundamental concepts such as linearity, time-invariance, frequency response, z-transforms and the discrete time Fourier transform as applied to discrete time signal processing systems.	K1-K3
CO 2	Understand the analytical tools such as Fourier transforms, Discrete Fourier transforms, Fast Fourier Transforms and Z-Transforms required for digital signal processing.	K1-K3
CO 3	Get familiarized with various structures of IIR and FIR systems.	K1-K2
CO 4	Design and realize various digital filters for digital signal processing.	K1-K3
CO 5	Familiarize with techniques of analysis of discrete-time signals and the use of Z-transforms	K1-K3

Mapping of COs with POs and PSOs

CO	Programme Outcome (PO)					Programme Specific Outcome (PSO)					Mean score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	2	2	2	2	2	2	2	3	2	2	2.1
CO2	2	3	3	2	3	2	2	2	3	3	2.5
CO3	3	2	2	2	2	3	3	2	3	3	2.5
CO4	2	2	3	2	2	2	3	2	3	2	2.3
CO5	3	3	3	1	1	3	3	3	2	3	2.5
										Mean Overall Score	**2.4**
										Results	**High**

Unit-I: Introduction to DSP:

Signals, systems and signal processing, classification of signals, elements of digital signal processing system, concept of frequency in continuous and discrete time signals, Periodic Sampling, Frequency domain representation of sampling, Reconstructions of band limited signals from its samples

Unit-II: Discrete-Time Signals and Systems:

Z-transform & Inverse z-transform, Linear convolution and its properties, Linear Constant Coefficient Difference equations, Frequency domain representation of Discrete-Time Signals & Systems, Representation of sequences by discrete time Fourier Transform, (DTFT), Properties of discrete time Fourier Transform, and correlation of signals, Fourier Transform Theorems.

Unit-III: Structures for Discrete Time Systems:

Block Diagram and signal flow diagram representations of Linear Constant-Coefficient Difference equations, Basic Structures of IIR Systems, lattice and lattice-ladder structures, Transposed forms, Direct and cascade form Structures for FIR Systems, Linear Phase FIR structure, Effects of Co-efficient quantization.

Unit-IV: Filter Design Techniques:

Design of Discrete-Time IIR filters from Continuous-Time filters Approximation by derivatives, Impulse invariance and Bilinear Transformation methods; Design of FIR filters by windowing techniques.

Unit-V: Advance DSP Techniques:

Multirate Signal Processing: Decimation, Interpolation, Sampling rate conversion by rational factor Adaptive filters: Introduction, Basic principles of Forward Linear Predictive filter and applications such as system identification, echo cancellation, equalization of channels, and beam forming.

Books for Study

1. John G. Proakis and Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, PHI learning 4th Edition, New Delhi, 2008.
2. Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck, “Discrete-Time SignalProcessing” Pearson Education India,2nd Edition, 2013
3. P.RameshBabu, “Digital Signal processing”, Scitech Publications, 2007.

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1. L. R. Rabiner and B. Gold, “Theory and Application of Digital Signal Processing” PHI Learning, New Delhi, 1998.
2. Mitra, Sanjit K, Digital Signal Processing : A Computer Based Approach, 4th Edition, McGraw-Hill, 2011.
3. KuoSen M, Lee Bob H and TianWenshun, Real-Time Digital Signal Processing: Implementations and Applications, 2nd Edition, John Wiley, 2006.
4. Oppenheim Alan V, Schafer Ronald W, and Buck John R, Discrete-Time Signal Processing, 3rd Edition, Prentice-Hall, 2009.
5. Lapsley Phil, DSP Processor Fundamentals: Architectures and Features, IEEE Press, 1997.
6. Ackenhusen John G, Real Time Signal Processing: Design and Implementation of Signal Processing Systems, Prentice-Hall, 1999.

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5. https://www.youtube.com/watch?v=6dFnpz_AEyA
6. https://www.youtube.com/watch?v=1mVbZLHLaf0
7. https://www.tutorialspoint.com/digital_signal_processing/dsp_static_systems.htm
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15. https://www.tutorialspoint.com/digital_signal_processing/digital_signal_processing_pdf_version.htm