COURSES OF STUDIES

FOR

THREE YEAR DEGREE COURSE

IN

SCIENCE HONOURS

PHYSICS

STUDENT COPY

Choice Based Credit System(CBCS)

First & Second Semester Examination – 2018-19

Third & Fourth Semester Examination – 2019-20

Fifth & Sixth Semester Examination – 2020-21

GOVERNMENT AUTONOMOUS COLLEGE,
PHULBANI, KANDHAMAL

SYLLABI FOR CBCS COURSE

Sem	CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill based Enhancement Compulsory Course (SECC) (2)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	CORE-I	AECC-1			GE-1 (Minor-1)
	CORE-II				
II	CORE-III	AECC-2			GE-1 (Minor-2)
	CORE -IV				
III	CORE-V		SECC-2		GE-2 (Minor-1)
	CORE-VI				
	CORE-VII				
IV	CORE-VIII		SECC-1		GE-2 (Minor-2)
	CORE-IX				
	CORE-X				
V	CORE-XI			DSE-1	
	CORE-XII			DSE-2	
VI	CORE-XIII			DSE-3	
	CORE-XIV			DSE-4 (Project)	

SECC-1 : To be offered by English Department.
SECC-2 : To be offered by Mathematics Department.
GE : Minor-1 and Minor-2 is to be decided by the college Based on Subject.

QUESTION PATTERN FOR MID SEM

Mid Semester Examination	Full Marks	No. of Short Answer type Questions (2 marks each) (Compulsory)	No. of Long Answer type Questions (8 marks each)	No. of Long Answer type Questions (12 marks each)
Practical Subject	20	6	1	*
Non-Practical Subject	20	4	*	1

QUESTION PATTERN FOR END SEM

End Semester Examination	Full Marks	GROUP – A					GROUP - B									
		No. of Short Answer type Questions (2 marks each) (Compulsory)					No. of Long Answer type Questions (8 marks each)					No. of Long Answer type Questions (12 marks each)				
Units -->		I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V
Non-Practical Subject	80	10					*	*	*	*	*	1	1	1	1	1
Practical Subject	50	5					1	1	1	1	1	*	*	*	*	*

- There is no alternative questions (choice) in Group-A questions (Short Answer type questions). All questions are compulsory.
- There is internal alternative questions (choice) in each number in Group-B questions (Long Answer type questions). Examinee has to answer one questions out of two alternative questions from each number.
- There is little deviation in question pattern of AECC (Eng Communication) & SECC-I & II. Details regarding question pattern of concerned subject is given at appropriate place.)
- The duration of Mid Sem exam of each paper is 1 hour irrespective of Full marks.
- The duration of End Sem exam of each paper is 3 hours for 80 marks/50 marks.

YEAR & SEMESTER-WISE PAPERS & CREDITS AT A GLANCE

Three-Year (6-Semester) CBCS Programme (B.Sc. Hons.) (Physics Hons.)				
Yr.	Sl.No.	Course Structure	Code	Credit Points
FIRST YEAR		**SEMESTER-I**		
	1	Mathematical Physics-I	C-1.1	4+2
	2	Mechanics	C-1.2	4+2
	3	Chemistry (Atomic Structure, Bonding, General Organic Chemistry & Aliphatic Hydrocarbons)	GE-1.3	4+2
	4	MIL Communication – Odia / English Communication	AECC-1.4	6
			TOTAL -	**24**
		SEMESTER-II		
	5	Electricity and Magnetism	C-2.1	4+2
	6	Waves and Optics	C-2.2	4+2
	7	Mathematics (Calculus and Ordinary Differential Equations)	GE-2.3	6
	8	Environmental Studies	AECC-2.4	6
			TOTAL -	**24**
SECOND YEAR		**SEMESTER-III**		
	9	Mathematical Physics-II	C-3.1	4+2
	10	Thermal Physics	C-3.2	4+2
	11	Digital Systems and Applications	C-3.3	4+2
	12	Chemistry (Chemical Energetics, Equilibria & Functional Organic Chemistry-I)	GE-3.4	4+2
	13	Quantitative and Logical Thinking	SECC-3.5	6
			TOTAL -	**30**
		SEMESTER-IV		
	14	Mathematical Physics-III	C-4.1	4+2
	15	Elements of Modern Physics	C-4.2	4+2
	16	Analog Systems and Applications	C-4.3	4+2
	17	Mathematics (Linear Algebra and Advanced Algebra)	GE-4.4	6
	18	Communicative English	SECC-4.5	6
			TOTAL -	**30**
FINAL YEAR		**SEMESTER-V**		
	19	Quantum Mechanics and Applications	C-5.1	4+2
	20	Solid State Physics	C-5.2	4+2
	21	Classical Dynamics	DSE-5.3	4+2
	22	Nuclear and Particle Physics	DSE-5.4	4+2
			TOTAL -	**24**
		SEMESTER-VI		
	23	Electromagnetic Theory	C-6.1	4+2
	24	Statistical Mechanics	C-6.2	4+2
	25	Nano Materials and Applications	DSE-6.3	4+2
	26	Project Work	DSE-6.4	6
			TOTAL -	**24**
			GRAND TOTAL -	**156**

Notes:

- C- Core Course
- GE- Generic Elective Course
- DSE- Discipline Specific Elective Course
- AECC- Ability Enhancement Compulsory Course
- SECC- Skill based Enhancement Compulsory Course
- For a 6 credit course, the total teaching hours are: Minimum- 50 Hours, Maximum-65 Hours

SEMESTER-I

C-1.1: MATHEMATICAL PHYSICS-I

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Calculus: **4 Lectures**

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers

Dirac Delta function and its properties: **3 Lectures**

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

UNIT-II

Orthogonal Curvilinear Coordinates: **7 Lectures**

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Comparison of velocity and acceleration in cylindrical and spherical coordinate system

UNIT-III

Vector Calculus: **5 Lectures**

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields

UNIT-IV

Vector Differentiation: **8 Lectures**

Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.

UNIT-V

Vector Integration: **13 Lectures**

Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013,7th Edn., Elsevier
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India
- Essential Mathematical Methods, K.F. Riley & M.P. Hobson, 2011, Cambridge Univ. Press
- Mathematical Physics and Special Relativity --M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2nd Edition 2009
- Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011
- Mathematical Physics –C. Harper, (Prentice Hall India) 2006
- Mathematical Physics-Goswami (Cengage Learning) 2014
- Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006

PRACTICAL

End Sem Practical – 30/3 hrs

Introduction and Overview :

Computer architecture and organization, memory and Input/output devices.

Basics of scientific computing :

Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.

Errors and error Analysis :
Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals :
Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If---statement. If---else Statement. Nested if Structure. Else---if Statement. Ternary Operator)*
Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (*1D & 2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:
Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation :
Area of circle, area of square, volume of sphere, value of π
Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw---Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T. Pang, 2nd Edn., 2006, Cambridge Univ. Press.

C-1.2: MECHANICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Rotational Dynamics: **10 Lectures**

Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

UNIT-II

Non-Inertial Systems: **3 Lectures**

Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

Elasticity:

Relation between Elastic constants. Twisting torque on a Cylinder or Wire. **3 Lectures**

UNIT-III

Fluid Motion: **2 Lectures**

Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Gravitation **3 Lectures**

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.

UNIT-IV

Central Force Motion: **6 Lectures**

Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.

Oscillations: **5 Lectures**

SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

UNIT-V

Special Theory of Relativity: 8 Lectures

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
- Mechanics - J. C. Slater and N. H. Frank (McGraw-Hill)

PRACTICAL

End Sem Practical – 30/3 hrs

1. To study the random error in observations.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine **g** and velocity for a freely falling body using Digital Timing Technique
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
9. To determine the elastic Constants of a wire by Searle's method.
10. To determine the value of g using Bar Pendulum.
11. To determine the value of g using Kater's Pendulum

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

GE- 1.3 : ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: INORGANIC CHEMISTRY-1

UNIT-I : Atomic Structure (14 Periods)

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.

What is Quantum mechanics? Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrödinger equation for hydrogen atom. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers ml and ms. Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (ms).

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

UNIT-II : Chemical Bonding and Molecular Structure-I (16 Lectures)

Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character

UNIT-III: **Chemical Bonding and Molecular Structure-II** Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements

Concept of resonance and resonating structures in various inorganic and organic compounds

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for s-s, s-p and p-p combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO+ , Comparison of VB and MO approaches

SECTION B : ORGANIC CHEMISTRY-I

UNIT- IV : Fundamentals of Organic Chemistry (8 Lectures)

Physical Effects, Electronic Displacements: Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Benzenoids and Hückel's rule.

Stereochemistry (10 Lectures)

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

UNIT- V : Aliphatic Hydrocarbons (12 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

Alkenes: (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (Upto 5 Carbons) Preparation: Acetylene from CaC_2 and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, Ozonolysis and oxidation with hot alk. $KMnO_4$.

Reference Books :

1. J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
2. F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
3. Douglas, McDaniel and Alexader: Concepts and Models in Inorganic Chemistry, John Wiley.
4. James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
5. T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
6. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
7. E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.• I. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
8. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
9. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydroxide present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.
6. Estimation of Na_2CO_3 & $NaHCO_3$ present in a mixture.

Section B: Organic Chemistry

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the Rf value in each case (combination of two compounds to be given)
   (a) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography
   (b) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books :

1. Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
2. Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
3. Textbook of Practical Organic Chemistry, A.I. Vogel , Prentice Hall, 5th edition.
4. Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

AECC-1.4 : ଯୋଗାଯୋଗମୂଳକ ମାତୃଭାଷା- ଓଡ଼ିଆ (କଳା ଓ ବିଜ୍ଞାନ ବିଭାଗ ପାଇଁ)

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3hrs

ୟୁନିଟ୍-୧ : ବିଜ୍ଞାପନ କଳା ଓ ସାହିତ୍ୟ / ବିଜ୍ଞାପନର ଆବଶ୍ୟକତା ଓ ଉପକାରିତା

ୟୁନିଟ୍-୨ : ଗଳ୍ପ- କୃଷ୍ଣଚୂଡ଼ା- ସୁରେନ୍ଦ୍ର ମହାନ୍ତି
ପାଟଦେଈ- ବୀଣାପାଣି ମହାନ୍ତି
ବୁଢ଼ାଶଙ୍ଖାରୀ- ଲକ୍ଷ୍ମୀକାନ୍ତ ମହାପାତ୍ର

ୟୁନିଟ୍-୩ : କବିତା- ଶ୍ରୀରାଧା- ରମାକାନ୍ତ ରଥ
ପ୍ରତିମା ନାୟକ- ସଚ୍ଚି ରାଉତରାୟ
ଦୁର୍ଯ୍ୟୋଧନ- ସୀତାକାନ୍ତ ମହାପାତ୍ର

ୟୁନିଟ୍-୪ : ପ୍ରବନ୍ଧ- ଗାଡ଼ି ଛାଡ଼ିଦେଲା – ଚନ୍ଦ୍ରଶେଖର ରଥ
ଆମେରିକାରେ ଲୋକଚରିତ୍ର – ଗୋଲୋକ ବିହାରୀ ଧଳ
ସ୍ୱାଧୀନ ଚିନ୍ତା – ବିଶ୍ୱନାଥ କର

ୟୁନିଟ୍-୫ : କାରକ ଓ ବିଭକ୍ତି

ପୁସ୍ତକ :

୧. ଯୋଗାଯୋଗର ଭାଷା, ଫ୍ରେଣ୍ଡସ୍ ପ୍ରକାଶନ, କଟକ

୨. ଗଳ୍ପ, କବିତା ଓ ପ୍ରବନ୍ଧ - ସଂକଳିତ ପୁସ୍ତକ, କଲେଜ ଛକ, ଫୁଲବାଣୀ

AECC-1.4 : ENGLISH COMMUNICATION

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3hrs

UNIT-I : Introduction

1. What is communication?
2. Types of communication
   - Horizontal
   - Vertical
   - Interpersonal
   - Grapevine

UNIT-II : Language of Communication

1. Verbal : spoken and written
2. Non-verbal
   - Proxemics
   - Kinesics
   - Haptics
   - Chronemics
   - Paralinguistics
3. Barriers to communication
4. Communicative English

UNIT-III : Reading Comprehension (Prose & Poetry)

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas and information
- Read "between the lines" to understand underlying meanings
- Connect information to what they already know

UNIT-IV : Writing

- Expanding an Idea
- Note Making
- Information Transfer
- Writing a Memo
- Writing Formal Email
- Writing a Business Letter
- Letters to the Editor
- CV & Resume Writing
- Covering Letter
- Report Writing
- News Story
- Interviewing for newspaper

(The above mentioned writing activities are covered in the prescribed text book Vistas and Visions)

UNIT-V : Language functions in listening and conversation

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually
3. Group Discussion
4. Interview
5. Dialogue

(Practice to be given using the set pieces from the prescribed textbook)

Grammar and Usage :

1. Phrasal verbs
2. Collocation
3. Using Modals
4. Use of Prepositions
5. Common Errors in English Usage

(The above mentioned grammar items are covered in the prescribed text book Vistas and Visions)

Book Prescribed :

1. *Vistas and Visions: An Anthology of Prose and Poetry.* (Ed.) Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. OBS

Texts to be studied

Prose

1. Pleasures of Ignorance
2. Life style English
3. Playing the English Gentleman
4. Ecology and Community
5. My Lost Dollar

Poetry

1. Last Sonnet
2. The Darkling Thrush
3. The Felling of Banyan Tree
4. Meting Poets

All grammar and writing activities in the textbook *Vistas and Visions*

Pattern of Examination :

Mid-Semester Examination :

Using texts (500-600 words), students will be tested for

- Vocabulary : synonyms, antonyms, words used as different parts of speech = 10 marks
- Word order ; subject-predicate; subject-verb agreement = 10 marks

End-Semester Examination :

Using texts (600-700 words), students will be tested for

- Use of vocabulary in context 2 marks X 5 bits = 10 marks
- Use of grammar in context 2 marks X 5 bits= 10 marks
- Use of cohesive and transitional devices in one paragraph 2 marks X 10 bits = 20 marks
- Writing two paragraphs (expository/descriptive/narrative/ Argumentative) using topic sentences 10 marks X 2 qns = 20 marks
- Correcting in-text citation from given input 2 marks X 5 bits = 10 marks
- Preparing a correct version of Works Cited page from given input 2 marks X 5 bits = 10 marks

Suggested Readings:

1. *Fluency in English – Part II,* OUP, 2006
2. *Business English,* Pearson, 2008
3. *Communicative English* -E. Suresh Kumar and P. Sreehari
4. *Break Free : Unlock the Powerful Communicator in You*. Rajesh, V. Rupa, 2015
5. *Soft Skills* Shalini Verma, 2009
6. *Language, Literature and Creativity, Orient BlackSwan, 2013*
7. *Language through Literature.* (forthcoming) ed. Gauri Mishra, Dr. Ranajan Kaul, Dr. Brati Biswas

SEMESTER-II

C-2.1: ELECTRICITY AND MAGNETISM

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Electric Field and Electric Potential : 6 Lectures

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

UNIT-II

Capacitance: 4 Lectures

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter: **4 Lectures**

Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics

UNIT-III

Magnetic Field: **12 Lectures**

Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Ballistic Galvanometer**:** Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

UNIT-IV

Magnetic Properties of Matter: **4 Lectures**

Magnetization vector (**M).** Magnetic Intensity (**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.

Electromagnetic Induction: **2 Lectures**

Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field.

UNIT-V

Electrical Circuits: **4 Lectures**

AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Network theorems: **4 Lectures**

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevnin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P .Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

PRACTICAL

End Sem Practical – 30/3 hrs

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin and Norton theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.
14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P. Khandelwal, 1985, Vani Pub.

C-2.2: WAVES AND OPTICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Geometrical optics: **4 Lectures**

Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion. Application to thick lense, Ramsden and Huygens eyepiece.

Wave Motion: **4 Lectures**

Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

Superposition of two perpendicular Harmonic Oscillations: **2 Lectures**

Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses. Superposition of N harmonic waves.

UNIT-II

Wave Optics: **3 Lectures**

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Interference: **8 Lectures**

Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.

UNIT-III

Interferometer: **5 Lectures**

Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

UNIT-IV

Fraunhofer diffraction: **7 Lectures**

Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

UNIT-V

Fresnel Diffraction: **7 Lectures**

Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Optics - Brijlal & Subramaniam- (S. Chand Publication) 2014.
- Vibrations and Waves -- A. P. French, (CBS) Indian print 2003
- Optics, E. Hecht (PearsonIndia)

PRACTICAL

End Sem Practical – 30/3 hrs

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To investigate the motion of coupled oscillators.

3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

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

GE-2.3: CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS

Full Marks – 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

UNIT-I

Asymptotes, curvature and curve tracing, length, volume and area of surface of revolution

UNIT-II

Sphere, cone, cylinder and central conicoids

UNIT-III

Explicit and Implicit functions, limit and continuity of functions of several variables, partial derivatives, partial derivative of higher orders, homogeneous functions, change of variables mean value theorem, Taylor's theorem and Maclaurin's theorem for function of two variables, maxima and minima of functions of two and three variables, implicit functions

UNIT-IV

Ordinary Differential equation Ist order and Ist degree (variable separable, homogeneous exact, linear), Equation of Ist order but not Ist degree

UNIT-V

Second order linear equations (homogeneous and non-homogeneous) with constant coefficients, second order equations with variable coefficients, variation of parameters, Laplace transform, and its applications to solution of differential equation

Books Recommended:

1. Acourse of ordinary and partial differential equations by J. Sinha and S. Padhy, Kalyani Publication, New Delhi Chapter :1, 2(2.1-2.7), 3 4(4.1-4.7), 5, 7(7.1-7.4), 9(9.1-9.5, 9.10, 9.11, 9.13).
2. Text book of Calculus, part-II Shanti Narayan and P.K. Mittal, S. Chand and Co.
3. Text book of Calculus, part-III Shanti Narayan and P.K. Mittal, S. Chand and Co.
4. Analytical Geometry of Quadratic surfaces, B.P. Acharya and D.C. Sahu, Kalyani Publishers, New Delhi, Ludhina
5. S.C. Malik and S. Aroro-Mathematical Analysis, New age International publications,
6. Advanced Calculus by Santosh K. Sengar chapter: 2,4,5,6,7,11,12,13
7. Differential Equations and their Applications, Martin Baraun, Springer International.
8. Advanced differential Equations by M.D. Raisinghania, S. Chand & Company Ltd. New Delhi.
9. Analytical Solid Geometry by Shanti Narayan and P.K. Mittal, S. Chand and Co.
10. G. Dennis Zill, A First Course in differential equations with Modelling Applications, Cengage Learning India Pvt. Ltd.
11. Advanced Calculus by David V. Weider, Dover Publication.

AECC-2.4 : ENVIRONMENTAL STUDIES

Full Marks –100
Mid Sem – 20/1 hr
End Sem– 80/3hrs

UNIT-I :

Concept of environment : Ecology; Ecosystem; types and components of the ecosystem. Ecological adaptations of plants and animals

UNIT-II :

Functional aspects of ecosystem : Trophic level, food chain, food web, energy flow in the ecosystem, ecological pyramids, Biogeochemical cycles: Water cycle and Nitrogen cycle

UNIT-III :

Environmental Pollution : Source, causes and concept of air, water, noise, soil, pollution, Sewage & Sewage treatment, green house effect, Acid rain, Ozone layer depletion

UNIT-IV :

Conservation of Natural Resources : Resources, renewable & non renewable resources; soil, soil erosion and its conservation; Forest, deforestation; afforestation, conservation of Forest

UNIT-V :

Biodiversity and its Conservation : Introduction, Definition : genetic species and ecosystem diversity, value of biodiversity; consumptive use, productive use, social, ethical and aesthetic values, Biodiversity at global, national and local level, conservation of Biodiversity:- In situ and Ex-situ conservation, Bio-Geographic classification of India

Suggested Readings :

1. Shukla, R.S and Chandel, P.S : Plant Ecology and soil science, S. Chand & Company Ltd, New Delhi
2. Sharma, P.D. : Ecology and Environment, Rastogi Publication, Meerut.
3. Singh, J.S. Singh, S.P and Gupta, R.S (2006). Environmental Science, Kalyani Publishers, New Delhi

SEMESTER-III

C-3.1: MATHEMATICAL PHYSICS-II

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Fourier Series: **10 Lectures**

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

UNIT-II

Some Special Integrals: **4 Lectures**

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

UNIT-III

Frobenius Method and Special Functions: **12 Lectures**

Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations: Legendre & Hermite Differential Equations. Properties of Legendre & Hermite Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Associated Legendre polynomials and spherical harmonics.

UNIT-IV

Theory of Errors: **4 Lectures**

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

UNIT-V

Partial Differential Equations: **10 Lectures**

Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched string.

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
- Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011.
- Mathematical Physics –C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics-Goswami (CENGAGE Learning) 2014
- Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006
- Mathematics for Physicists, P. Dennery and A. Krzywicki Dover)
- Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.

PRACTICAL

End Sem Practical – 30/3 hrs

Introduction to Numerical computation software Scilab:

Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).

Curve fitting, Least square fit, Goodness of fit, standard deviation:

Ohms law to calculate R, Hooke's law to calculate spring constant

Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method.

Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems:

Solution of mesh equations of electric circuits (3 meshes)

Solution of coupled spring mass systems (3 masses)

Solution of ODE, First order Differential equation Euler, modified Euler and Runge-Kutta second order methods, Second order differential equation. Fixed difference method

First order differential equation

- Radioactive decay
- Current in RC, LC circuits with DC source
- Newton's law of cooling
- Classical equations of motion

Second order Differential Equation

- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Over damped
- Critical damped
- Oscillatory
- Forced Harmonic oscillator
- Transient and
- Steady state solution
- Apply above to LCR circuits also

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.20 Bence, 3rd ed., 2006, Cambridge University Press

- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S. Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

C-3.2: THERMAL PHYSICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Introduction to Thermodynamics : **7 Lectures**

Recapitulation of Zeroth and First law of thermodynamics.

Second Law of Thermodynamics:

Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale

UNIT-II

Entropy: **7 Lectures**

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero

UNIT-III

Thermodynamic Potentials: **6 Lectures**

Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations

Maxwell's Thermodynamic Relations: **6 Lectures**

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) Tds Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process. '

UNIT-IV

Kinetic Theory of Gases

Distribution of Velocities: **4 Lectures**

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Molecular Collisions: **4 Lectures**

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance

UNIT-V

Real Gases: **6 Lectures**

Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. p-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1958, Indian Press

- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Heat and Thermal Physics-Brijlal & Subramaiam (S. Chand Publication) 2014
- Thermal Physics- C. Kittel and H. Kroemer (McMillan Education India) 2010

PRACTICAL

End Sem Practical – 30/3 hrs

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
8. To determine J by Caloriemeter.

Reference Books

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

C-3.3: DIGITAL SYSTEMS AND APPLICATIONS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Integrated Circuits (Qualitative treatment only): **3 Lectures**

Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital ICs.

Digital Circuits: **5 Lectures**

Difference between Analog and Digital Circuits. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

UNIT-II

Number system: **2 Lectures**

Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers.

Complement Arithmetic:

Binary Addition. Binary Subtraction using 2's Complement. **1 Lecture**

Boolean algebra: **1 Lecture**

De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra.

UNIT-III

Combinational Logic: **4 Lectures**

Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic

Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Data processing circuits: **4 Lectures**

Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Arithmetic Circuits: **4 Lectures**

Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

UNIT-IV

Introduction to CRO: **3 Lectures**

Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Timers: **3 Lectures**

IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

UNIT-V

Introduction to Computer Organization: **6 Lectures**

Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Shift registers: **2 Lectures**

Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers
(only up to 4 bits).

Counters(4 bits): **4 Lectures**

Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw 23
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
- Concept of Electronics: D.C.Tayal (Himalay Publication) 2011
- Electronics-V. K. Meheta (S. Chand Publication)2013
- The Art of Electronics, P. Horowitz and W. Hill, CUP

PRACTICAL

End Sem Practical – 30/3 hrs

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.

Reference Books:

- Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

GE- 3.4 : CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY-I

Full Marks – 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

SECTION A: PHYSICAL CHEMISTRY-1

UNIT-I : Chemical Energetics (10 Lectures)

Review of thermodynamics and the Laws of Thermodynamics.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.

Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Chemical Equilibrium: (8 Lectures)

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o , Le Chatelier's principle. Relationships between Kp, Kc and Kx for reactions involving ideal gases.

UNIT- II : Ionic Equilibria: (12 Lectures)

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle.

SECTION B: ORGANIC CHEMISTRY-2

UNIT- III : (8 Lectures)

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.

Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

Alkyl and Aryl Halides (8 Lectures)

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

UNIT- IV : (14 Lectures)

Alcohols, Phenols and Ethers (Upto 5 Carbons)

Alcohols: Preparation: Preparation of 1^0 , 2^0 and 3^0 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch Condensation, Schotten – Baumann Reaction.

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

UNIT-V: Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH2/NH3 (or NaNH2/NH3).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides

Aldehydes and ketones (aliphatic and aromatic): (Formaldehye, acetaldehyde, acetone and benzaldehyde)

Preparation: from acid chlorides and from nitriles.

Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

Reference Books :

1. T. W. Graham Solomons: Organic Chemistry, John Wiley and Sons.
2. Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
3. I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
4. R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
5. Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
6. G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
7. G. W. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
8. J.C. Kotz, P.M. Treichel & J.R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
9. B. H. Mahan: University Chemistry 3rd Ed. Narosa (1998).
10. R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co.: New York (1985).

PRACTICAL

End Sem Practical – 30/3 hrs

Expt. -15, Viva- 5 & Lab. Record- 10

Section A: Physical Chemistry : Thermochemistry

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.
b) Preparation of buffer solutions:
   (i) Sodium acetate-acetic acid
   (ii) Ammonium chloride-ammonium hydroxide Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone
4. Identification of simple organic compounds containing C, H, O & C, H, N & their confirmation using melting & boiling point only.

Reference Books :

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960)
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co

GE-3.5: QUANTITATIVE AND LOGICAL THINKING

Full Marks – 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

I. QUANTITATIVE APTITUDE & DATA INTERPRETATION

UNIT – I :

Whole numbers, Integers, Rational and irrational numbers, Fractions, Square roots and Cube roots, Surds and Indices, Problems on Numbers, Divisibility

Steps of Long Division Method for Finding Square Roots:

UNIT – II :

Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture

UNIT – III :

Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed; relationship among them

UNIT – IV :

Concept of Angles, Different Polygons like triangles, rectangle, square, right angled triangle, Pythagorean Theorem, Perimeter and Area of Triangles, Rectangles, Circles

UNIT – V :

Raw and Grouped Data, Bar Graphs, Pie charts, Mean, Median and Mode, Events and Sample Space, Probability

II. LOGICAL REASONING

UNIT – I :

Analogy basing on kinds of relationships, Simple Analogy; Pattern and Series of Numbers, Letters, Figures. Coding-Decoding of Numbers, Letters, Symbols (Figures), Blood relations

UNIT – II :

Logical Statements– Two premise argument, More than two premise argument using connectives

UNIT – III :

Venn Diagrams, Mirror Images, Problems on Cubes and Dices

SEMESTER-IV

C-4.1: MATHEMATICAL PHYSICS-III

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Complex Analysis: **9 Lectures**

Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula.

UNIT-II **5 Lectures**

Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

UNIT-III

Integrals Transforms: **9 Lectures**

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.).

UNIT-IV **9 Lectures**

Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function

UNIT-V **8 Lectures**

Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Complex Variables, A. S. Fokas & M. J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill 25
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
- Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6th Edition 2011.
- Mathematical Physics –C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics-Goswami (Cengage Learning) 2014
- Mathematical Method for Physical Sciences -- M. L. Boas (Wiley India) 2006
- Introduction to the theory of functions of a complex variable- E.T. Copson (Oxford) Univ. Press, 1970

PRACTICAL

End Sem Practical – 30/3 hrs

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:
   $dy/dx = e^{-x}$ with y = 0 for x = 0
   $dy/dx + e^{-x}y = x^2$
   $d^2y/dt^2 + 2\ dy/dt = -y$
   $d^2y/dt^2 + e^{-t}dy/dt = -y$
2. Dirac Delta Function:
   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{\frac{-(x-2)^2}{2\sigma^2}} (x+3)dx$ *for σ =1, 0.1, 0.01 and show it tends to 5*
3. Fourier Series:
   Program to sum $\sum_{n=1}^{\infty}(0.2)^n$
   Evaluate the Fourier coefficients of a given periodic function (square wave)
4. Frobenius method and Special functions:
   $$\int_{-1}^{1} P_n(\mu)P_m(\mu)d\mu = \delta n, m$$
   Plot $P_n(x)$, $J_v(x)$
   Show recursion relation
5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.
7. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.
8. Integral transform: FFT of e^{-x2}

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab (A free software to Matlab): H. Ramchandran, A.S.Nair. 2011 S. Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

C-4.2: ELEMENTS OF MODERN PHYSICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Atomic Spectra and Models: **13 Lectures**

Inadequacy of classical physics, Brief Review of Black body Radiation, Photoelectric effect, Compton effect, dual nature of radiation, wave nature of particles. Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle. Alpha Particle Scattering, Rutherford Scattering Formula, Rutherford Model of atom and its limitations, Bohr's model of H atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Expt. Sommerfeld's Modification of Bohr's Theory.

UNIT-II

Wave Particle Duality: **7 Lectures**

de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity. Superposition of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time.

Time development of a wave Packet ; Wave Particle Duality, Complementarity .

UNIT-III **6 Lectures**

Heisenberg Uncertainty Principle, Illustration of the Principle through thought Experiments of Gamma ray microscope and electron diffraction through a slit. Estimation of ground state energy of harmonic oscillator and hydrogen atom, non existence of electron in the nucleus. Uncertainty and Complementarities.

UNIT-IV

Nuclear Physics **6 Lectures**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

UNIT-V **8 Lectures**

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay-energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K. Ghatak & S. Lokanathan, 2004, Macmillan
- Modern Physics – Bernstein, Fishbane and Gasiorowicz (Pearson India) 2010
- Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles -- R. Eisberg (Wiley India) 2012

Additional Books for Reference:

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Quantum Physics, Berkeley Physics, Vol.4. E.H. Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K. Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore, 2003, McGraw Hill
- Modern Physics-Serway (CENGAGE Learnings) 2014
- Physics of Atoms and Molecules – Bransden (Pearson India) 2003

PRACTICAL

End Sem Practical – 30/3 hrs

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.

4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal

C-4.3: ANALOG SYSTEMS AND APPLICATIONS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Semiconductor Diodes: **4 Lectures**

P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

Two-terminal Devices and their Applications: **4 Lectures**

(1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell.

UNIT-II

Bipolar Junction transistors: **5 Lectures**

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

UNIT-III

Amplifiers: **6 Lectures**

Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers.

Coupled Amplifier: **4 Lectures**

RC-coupled amplifier and its frequency response

UNIT-IV

Feedback in Amplifiers: **4 Lectures**

Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Sinusoidal Oscillators: **4 Lectures**

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators.

UNIT-V

Operational Amplifiers (Black Box approach): **4 Lectures**

Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Applications of Op-Amps: **5 Lectures**

(1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S. Salivahanan & N.S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Electronic circuits: Handbook of design & applications, U. Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
- Concept of Electronics: D.C. Tayal (Himalay Publication) 2011
- Electronic devices :Circuits and Applications :W.D. Stanley Prentice Hall
- Electronics- V. K. Meheta (S. Chand Publication) 2013
- Electronic Circuits :L. Schilling and Velove: 3rd Ed Mc Graw Hill
- Electronics–Raskhit & Chattopadhyay (New age International Publication)2011
- Electricity and Electronic-D.C. Tayal (Himalaya Pub.)2011
- Electronic devices and circuits –R.L. Boylstad (Pearson India) 2009

PRACTICAL

End Sem Practical – 30/3 hrs

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt's oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a 1st/2nd order differential equation.

Reference Books:

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
- Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

GE-4.4: LINEAR ALGEBRA AND ADVANCED ALGEBRA

Full Marks – 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

UNIT-I

Vector space, subspace, span of a set, linear independence and dependence, dimension and basis Linear transformation, range kernel, rank, and nullity, Inverse of a linear map, rank-nullity theorem

UNIT-II

Matrices and linear maps, rank and nullity of a matrix, transpose of a matrix, types of matrices, elementary row operations, System of linear equations, Matrix inversion using row operations, determinant and rank of matrices, Eigen values, Eigen vectors, quadratic forms

UNIT-III

Group theory : Definition and examples, subgroups, normal subgroups, cyclic groups, cosets, quotients groups, permutation groups, homomorphism

UNIT-IV

Ring theory : Definition and examples, some special classes of rings, ideals, quotients rings, ring homomorphism, isomorphism theorems

UNIT-V

Theory of equations : roots of an equation, relation between roots and coefficients, sum of power of roots, symmetric functions transformation of equations

Books Recommended :

1. An introduction to linear algebra by V. Krishna Murty, V.P. Mainra, J.L Arora, Affiliated –east-west press Pvt. Ltd. New Delhi, Chapter: 3, 4(4.1-4.7), 5(except 5.3), 6(6.1,6.2,6.5,6.6,6.8), 7(7.4)
2. Abstract Algebra, by I.H. Seth, Prentice Hall of India Pvt. Ltd, New Delhi, Chapter: 13, 14, 15, 16, 17, 18, 19, 20
3. A text book of Algebra –Rabindra Kumar and Sri Krishna Washna, Pitamber Publication
4. Joseph A. Gallian, Contemporary Abstract Algebra (4^{th} Edn.), Narosa publishing House, New Delhi.
5. A course in abstract algebra by V.K. Khana and S.K. Bhamri, Vikash Pub. House New Delhi.
6. Abstract Algebra, M. Artin, 2^{nd} Ed. Pearson, 2011.
7. Introduction to linear algebra, S. Lang, 2^{nd} Ed. Springer, 2005
8. Topics in Algebra, I.N. Herstain, Wiley Easten Limited, India, 1975.
9. Linear algebra and its application, by Gibert Strang. Cengage Learning India Pvt Ltd.
10. Linear algebra by S. Kumar, A Geometric Approach, Prentice Hall of India, 1999.

SECC-4.5 : COMMUNICATIVE ENGLISH

(Enriching Linguistic Knowledge & Communication Proficiency)

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3hrs

UNIT-I : BUSINESS COMMUNICATION AND GRAMMAR

Why English Communication is Essential and How to Improve the Skill?

Introduction to Voice and Accent, Why do we have such different accents?, Accent Training-Consequences, Voice and accent in the Enterprise Industry, Globally Comprehensible Accent, Introduction to Phonetics, International Phonetic Alphabet

Consonant Sounds

Vowels

Diphthongs

A Few Phonic Rules

Word Stress: Syllables

Intonation : Intonation and Stress

Pacing and Chunking : Common Patterns of Pacing, Importance of Chunking

Fluency

Indianisms : Errors relating to Grammar, Vocabulary

UNIT-II : GRAMMAR

English: Spoken Versus Written Communication

Nouns : Kinds of Nouns, Activity 3: Noun Ping-pong, Nouns-Number, Noun-Gender, Countable and Uncountable Nouns

Pronouns : Reflexive Pronouns, Relative Pronouns, Demonstrative Pronouns, Interrogative Pronouns, Indefinite pronouns, Activity 4: Sentence Auction

Adjectives : Activity 5 : Picture perfect, Positioning of adjectives, Comparative Degrees of Adjectives, Order of Adjectives

Adverbs : Kinds of Adverb, Degree of Comparison, Word Order with Adverbs, Activity 6: Relay Race

Prepositions : Activity 7: Treasure Hunt, Activity 8: Route Map, Prepositions with Adjectives, Nouns and Verbs

Conjunctions : Coordinating conjunctions, Subordinating Conjunctions, Correlative Conjunctions, Connecting Adverbs, Activity 9: The Socks Story

Verbs : Verb Classification, List of irregular verbs, Activity 10: Word Search

Subject and verb agreement, Activity 11: Tossed Word Salad, Activity 12: The Sentence Pageant Determiners and Modifiers : Kinds of determiners, The Definite and the Indefinite Article, Definite Article: The, Activity 13: Proof Reading

Tenses : Reference Table, Present Tense, Activity 14: Instruction Manual, Activity 15: Commentary, Past Tense, Activity 16:The Chain List, Activity 17: Transcription, Future Tense, Activity 18: This Week for You, Activity 19: Verb Grand Prix

Punctuation : Forms of Punctuation

UNIT-III : READING COMPREHENSION

Reading – A 7 Step Process, Techniques to enhance students' reading skills, Types of reading skills, Skimming, Scanning, Extensive reading, Intensive reading, Three levels of Reading, Improving your reading speed, Reading Comprehension Practice Exercises

SEMESTER-V

C-5.1: QUANTUM MECHANICS AND APPLICATIONS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Schrodinger equation & the operators: **8 Lectures**

Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Hermitian operator, Eigen values and Eigen functions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

UNIT-II

Time independent Schrodinger equation: **6 Lectures**

Hamiltonian, stationary states and energy eigen values; expansion of an arbitrary wave function as a linear combination of energy eigen functions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wave function; Position-momentum uncertainty principle.

UNIT-III

General discussion of bound states in an arbitrary potential: **8 Lectures**

continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions ground state, zero point energy & uncertainty principle.

UNIT-IV **6 Lectures**

One dimensional infinitely rigid box- energy eigen values and eigen functions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

UNIT-V

Atoms in Electric & Magnetic Fields: **12 Lectures**

Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Atoms in External Magnetic Fields:

Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Reference Books:

- A Text book of Quantum Mechanics, P. M. Mathews and K. Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

- Quantum Physics----S. Gasiorowicz (Wiley India) 2013
- Quantum Mechanics -J.L. Powell and B. Craseman (Narosa) 1988
- Introduction to Quantum Mechanics- M. Das, P.K. Jena,(Sri Krishna Prakashan)
- Basic Quantum Mechanics –A. Ghatak (Mc Millan India) 2012
- Introduction to Quantum Mechanics – R. Dicke and J. Wittke
- Quantum Mechanics- Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer
- Quantum Mechanics - F. Mandl (CBS) 2013

PRACTICAL

End Sem Practical – 30/3 hrs

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:
   Here, m is the reduced mass of the electron. Obtain the energy eigen values and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 (eVÅ)1/2, ħc = 1973 (eVÅ) and m = 0.511x106 eV/c2.
2. Solve the s-wave radial Schrodinger equation for an atom:
   where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e = 3.795 (eVÅ)1/2, m = 0.511x106 eV/c2, and a = 3Å, 5Å, 7Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.
3. Solve the s-wave radial Schrodinger equation for a particle of mass m:
   For the anharmonic oscillator potential for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c2, k = 100 MeV fm-2, b = 0, 10, 30 MeV fm-3In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.
4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:
   Where μ is the reduced mass of the two-atom system for the Morse potential Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
   Take: m = 940x106eV/C2, D = 0.755501 eV, α = 1.44, ro = 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

Reference Books:

- Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw---Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn., 2007, Cambridge University Press.
- An introduction to computational Physics, T. Pang, 2nd Edn.,2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- Scilab Image Processing: L.M. Surhone. 2010 Betascript Publishing ISBN:978-6133459274

C-5.2: SOLID STATE PHYSICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I

Crystal Structure: 8 Lectures

Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Types of Lattices, Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

UNIT-II

Elementary Lattice Dynamics: **6 Lectures**

Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law

UNIT-III

Magnetic Properties of Matter: **6 Lectures**

Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia–and Paramagnetic Domains. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Dielectric Properties of Materials: **4 Lectures**

Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability.

UNIT-IV

Elementary band theory: **8 Lectures**

Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient.

UNIT-V

Superconductivity: **4 Lectures**

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)

Lasers: **4 Lectures**

Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- Solid State Physics – S. O. Pillai (New Age Publication)
- Solid State Physics- R.K. Puri &V.K. Babbar (S. Chand Publication)2013
- Lasers and Non linear Optics –B.B. Laud-Wiley Eastern.
- LASERS: Fundamentals and Applications – Thyagarajan and Ghatak (Mc Millan India) 2012

PRACTICAL

End Sem Practical – 30/3 hrs

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150^0C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

DSE-5.3 : CLASSICAL DYNAMICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

UNIT-I

Classical Mechanics of Point Particles: **10 Lectures**

Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators.

UNIT-II **10 Lectures**

Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Motion of charged particles in external electric and magnetic fields.

UNIT-III

Special Theory of Relativity: **10 Lectures**

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction & twin paradox

UNIT-IV **10 Lectures**

Four-vectors: space-like, time-like & light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four vector perspective.

UNIT-V **10 Lectures**

Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Reference Books:

- Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press
- Classical Mechanics-J. C. Upadhyay (Himalaya Publication) 2014
- Classical Dynamics of Particles and Systems – S. T. Thornton (Cengage Learning) 2012
- Introduction to Classical Mechanics-R. K. Takwale, S. Puranik (Tata Mc Graw Hill)
- Classical Mechanics-M. Das, P.K. Jena, M. Bhuyan, R.N. Mishra (Sri krishna Prakashan)

DSE-5.4 : NUCLEAR AND PARTICLE PHYSICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

UNIT-I

General Properties of Nuclei: **10 Lectures**

Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

UNIT-II **10 Lectures**

Nuclear Models:

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model

UNIT-III **10 Lectures**

Radioactivity decay:

(a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law.
(b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis.
(c) Elementary idea of Gamma decay.

Nuclear Reactions:

Types of Reactions, Conservation Laws, kinematics of reactions, Q-value

UNIT-IV

Detector for Nuclear Radiations: **10 Lectures**

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Particle Accelerators:

Van-de Graff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

UNIT-V **10 Lectures**

Particle physics:

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm. Elementary ideas of quarks and gluons.

***Reference Books**:*

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub. Inc., 1991)
- Atomic and Nuclear Physics -A. B. Gupta, Dipak Ghosh (Books and Allied Publishers)
- Physics of Atoms and Molecules – Bransden (Pearson India) 2003
- Subatomic Physics - Henley and Gracia (World Scientific) 2012
- Introduction to Nuclear and Particle Physics-A. Das and T. Ferbel (World Scientific)
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

SEMESTER-VI

C-6.1: ELECTROMAGNETIC THEORY

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I **7 Lectures**

Maxwell Equations:

Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density.

UNIT-II **8 Lectures**

EM Wave Propagation in Unbounded Media:

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance.

Propagation through conducting media, relaxation time, skin depth. Electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

UNIT-III **8 Lectures**

EM Wave in Bounded Media:

Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

UNIT-IV

Optical Fibres: **3 Lectures**

Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Polarization of Electromagnetic Waves-I **3 Lectures**

Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula.

UNIT-V **11 Lectures**

Polarization of Electromagnetic Wave-II

Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light.

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter.

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
- Electricity and Magnetism ---D C Tayal (Himalaya Publication)2014
- Introduction to Electrodynamics-A.Z. Capri & P.V. Panat (Alpha Science) 2002
- Optics E. Hecht, (Pearson India)

Additional Books for Reference

- Electromagnetic Fields & Waves, P. Lorrain & D. Corson, 1970, W.H. Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press
- Electromagnetic Theory-A. Murthy (S. Chand Publication) 2014
- Classical Electrodynamics, J. D. Jackson (Wiley India)

PRACTICAL

End Sem Practical – 30/3 hrs

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan`s law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

C-6.2: STATISTICAL MECHANICS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem Theory – 50/3 hrs

UNIT-I : Classical Statistics-I **8 Lectures**

Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical, Canonical and grand canonical ensemble. Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function

UNIT-II : Classical Statistics-II **8 Lectures**

Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

UNIT-III : Radiation: **8 Lectures**

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law.

UNIT-IV **8 Lectures**

Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

UNIT-V : Quantum Statistics: **8 Lectures**

Identical particles, macrostates and micro states. Fermions and Bosons, Bose Einstein distribution function and Fermi-Dirac Distribution function. Bose-Einstein Condensation, Bose deviation from Planck's law, Effect of temperature on F-D distribution function, degenarate Fermigas, Density of States, Fermi energy

Reference Books:

- Statistical Mechanics-R.K. Pathria & Paul D. Beale (Academic Press) 3rd Edition (2011)
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
- An introduction to Equilibrium Statistical Mechanics: Palash Das (I.K. International Publication) 2012
- Statistical Physics -- F. Mandl (CBS) 2012
- Statistical Physics of Particles-M. Kardar (CUP 2007)

PRACTICAL

End Sem Practical – 30/3 hrs

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

- Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M. Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

DSE-6.3 : NANO MATERIALS AND APPLICATIONS

Full Marks - 100
Mid Sem – 20/1 hr
End Sem – 80/3 hrs

UNIT-I : Nanoscale Systems: 10 Lectures

Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

UNIT-II : Synthesis Of Nanostructure Materials: 10 Lectures

Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.

UNIT-III : Characterization: 10 Lectures

X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

UNIT-IV : Applications: 10 Lectures

Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage.

UNIT-V 10 Lectures

Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
6. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).
7. Nanotechnology- Rakesh Rathi (S Chand & Company, New Delhi)

DSE-6.4 : PROJECT

Full Marks - 100
End Sem Project – 100

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