

GOVERNMENT COLLEGE (AUTONOMOUS), BHAWANIPATNA

(College with potential for excellence)



COURSES OF STUDIES

FOR THREE YEAR DEGREE COURSE IN **SCIENCE** (UNDER CBCS)

SUB: PHYSICS

Semester-I	2017	Semester-II	2018
Semester-III	2018	Semester-IV	2019
Semester-V	2019	Semester-VI	2020

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COURSE STRUCTURE

		Paper Code	Credit Points
Semester-I	1	AECC-1	02
	2	GE-1	06
	3	CORE-1	06
	4	CORE-2	06
		TOTAL	20
Semester-II	1	AECC-2	02
	2	GE-2	06
	3	CORE-3	06
	4	CORE-4	06
		TOTAL	20
Semester-III	1	SEC-1	02
	2	GE-3	06
	3	CORE-5	06
	4	CORE-6	06
	4	CORE-7	06
		TOTAL	26
Semester-IV	1	SEC-2	02
	2	GE-4	06
	3	CORE-8	06
	4	CORE-9	06
	4	CORE-10	06
		TOTAL	26
Semester-V	1	CORE-11	06
	2	CORE-12	06
	3	DSE-1	06
	4	DSE-2	06
		TOTAL	24
Semester-VI	1	CORE-13	06
	2	CORE-14	06
	3	DSE-3	06
	4	DSE-4	06
		TOTAL	24
		GRAND TOTAL	140

C O N T E N T

	Paper Code	Page No.
1	AECC	03
2	SEC	07
3	GE	09
4	CORE	15
5	DSE	34

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

SEMESTER-I

AECC-I : ENVIRONMENTAL STUDIES (ENVS)

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: Introduction to environmental studies and Ecosystem [BOTANY Dept]

Multidisciplinary nature of environmental studies;

Scope and importance; Concept of sustainability and sustainable development.

Ecosystems : [ZOOLOGY Dept]

What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: Food chains, food webs and ecological succession. Case studies of the aquatic ecosystems (ponds) (8 lectures)

MODULE-2:

Natural Resources : Renewable and Non-renewable Resources [ZOOLOGY Dept]

- Land resources and land use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, Biodiversity and tribal populations.
- Water : Use and over---exploitation of surface and ground water, floods, droughts, conflicts Over water (international & inter-state).
- Energy resources : Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies. (8 lectures)

MODULE-3: Biodiversity and Conservation [BOTANY Dept]

- Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones Of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation; Endangered and endemic species of India
- Threats to biodiversity : Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions;
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. (8 lectures) [BOTANY Dept]

MODULE-4: Environmental Pollution [CHEMISTRY Dept]

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
- Nuclear hazards and human health risks
- Solid waste management: Control measures of urban and industrial waste.
- Global warming, ozone layer depletion. (8 lectures)

References:

1. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S.Chand Publishing, New Delhi.
2. Das and Mishra. *Man and Environment*.
3. S. Swain. *Environmental Studies*.
4. M C Dash. *Fundamental of Ecology*.
5. Shukla and Chandel. *A Text Book of Plant Ecology*.

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ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

SEMESTER-II

AECC-II : ENGLISH

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

This course aims at enhancing the English language proficiency of undergraduate students in humanity, science and commerce streams to prepare them for the academic, social and professional expectations during and after the course. The course will help develop academic and social English competencies in speaking, listening, pronunciation, reading and writing, grammar and usage, vocabulary, syntax, and rhetorical patterns.

Students, at the end of the course, should be able to use English appropriately and effectively for further studies or for work where English is used as the language of communication.

MODULE-1: Reading Comprehension [15]

- 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

MODULE-2: Writing [15]

Expanding an Idea	Writing a Memo	Report Writing
Creative Writing	News Story	Setting in Creative Writing
Writing a Business Letter	Letters to the Editor	Précis Writing
CV & Resume Writing	Dialog writing	Covering Letter
Writing Formal Email	Elements of Story Writing	Note Making
Information Transfer	Interviewing for news papers	

MODULE-3: Language functions in listening and conversation [06]

1. Discussion on a given topic in pairs
2. Speaking on a given topic individually

(Practice to be given using speaking activities from the prescribed textbooks)

Grammar and Usage [14]

Simple and Compound Sentences; Complex Sentences; Noun Clause; Adjective Clause; Adverb Clause; The Conditionals in English; The Second Conditional; The Third Conditional; Words and their features; Phrasal Verbs; Collocation; Using Modals; Use of Passives; Use of Prepositions; Subject-verb Agreement; Sentence as a system; Common Errors in English Usage

Examination pattern

Each reading and writing question will invite a 200 word response.

Language function questions set in context will carry 01 mark per response. There will be 15 bit questions.

Midterm test:	Writing : 1 question	04 x 01qn = 04 marks
	Speaking: 2 questions	03x02 qns = 06 marks
	Total	10 marks

Term End :	MODULE-1	Reading: 05 questions	03x 05 qns= 15 marks
		(3 prose and two poetry questions)	
	MODULE-2	Writing: 03 questions	05 x 03 qns= 15 marks
	MODULE-3	Grammar & usage: 10 qns	01x 10 qns = 10 marks
	Total		40 marks

Grammar questions must be set in contexts; not as isolated sentences as used for practice in the prescribed textbook.

Book Prescribed

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 (Decoding Newspapers, The Gold Frame, Of Truth, Lifestyle English)

Poetry (Lines Composed a few miles above Tintern Abbey; Sonnet 46 (Shakespeare); Pigeons)

All grammar and writing activities in the textbook



**AECC-II : ODIA
SEMESTER-II**

ଆସ୍ଥାମୂଲ୍ୟାଂକ - ୨, ମୋଟ୍ ଶ୍ରେଣୀ ପାଠଦାନ-୨୦ ଘଣ୍ଟା, ପୂର୍ଣ୍ଣସଂଖ୍ୟା - ୫୦, ପରୀକ୍ଷା ସମୟ- ୨ ଘଣ୍ଟା
ପାଠ୍ୟର କୌଣସି ଗୋଟିଏ ପାଠ୍ୟକୁ ବାଛିବାକୁ ହେବ।

ପାଠ୍ୟ-୧ / Course-1 :

- ଉପାଂଶ-୧: (ଗନ୍ଧବିଭାଗ) ଗନ୍ଧ ତରଂଗ-ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ
ଭଗବାନ ମଲାପରେ-ମହାପାତ୍ର ନୀଳମଣି ସାହୁ
ବିଷକନ୍ୟାର କାହାଣୀ-ମନୋଜ ଦାସ
ଦ୍ଵିତୀୟ ଶ୍ଵଶାନ-ରାମଚନ୍ଦ୍ର ବେହେରା
ଫୁଟି ପ୍ରଶ୍ନୋତ୍ତରାଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁ ହେବ। (୧୦)
- ଉପାଂଶ-୨: (କବିତାଶ୍ରୀ) ଅଦ୍ଭୁତବାଚ -କୁମ୍ଭସାସ ମହାନ୍ତି
ଲକ୍ଷନ-ରମାକାନ୍ତ ରଥ
କୁମ୍ଭପତିସଭାସଭେ -ପ୍ରତିଭା ଶତପଥୀ
ଫୁଟି ପ୍ରଶ୍ନର ଗୋଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁ ହେବ। (୧୦)
- ଉପାଂଶ-୩: (ଅବବୋଧ) ଏକଶହପଚାଶ ଶବ୍ଦର ଏକ ଅନୁଚ୍ଛଦ ପ୍ରଦାନ କରାଯିବ।
୫ଟି ପ୍ରଶ୍ନ ପଡିବ ଏବଂ ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨। (୫X୨=୧୦)
- ଉପାଂଶ-୪: (ଭାବ ସଂପ୍ରସାରଣ) କୌଣସି ଏକ ଭୂମିକୁ ପ୍ରଶ୍ନଭାବରେ ପ୍ରଦାନ କରାଯିବ। (୧୦)
- ଉପାଂଶ-୫: (ବିଭକ୍ତି) ବ୍ୟାକରଣ। ଆଠରୁର ପାଞ୍ଚଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ। ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨ ନମ୍ବର। (୫X୨=୧୦)

ପାଠ୍ୟ-୨ / Course-2 : ସଂପର୍କ ଅନୁକ୍ରମ

- ଉପାଂଶ-୧: ସଂପର୍କର ଭିତ୍ତି, ପରିଭାଷା, ଅନୁକ୍ରମ ଓ ପରିସର
- ଉପାଂଶ-୨: ସଂପର୍କର ପ୍ରକାରଭେଦ: କଥିତ-ଲିଖିତ, ବ୍ୟକ୍ତିଗତ-ସାମାଜିକ-ସାଂସ୍କୃତିକ-ବ୍ୟାବସାୟିକ-ସାହିତ୍ୟିକ
- ଉପାଂଶ-୩: ସଂପର୍କର ବାଧକ ଓ ସଫଳସାଧନର ବିଗ
- ଉପାଂଶ-୪: ସଂପର୍କରେ ସାହିତ୍ୟର ଭୂମିକା
- ଉପାଂଶ-୫: ସଫଳ ସଂପର୍କର ଭାଷା

ପାଠ୍ୟ-୩ / Course-3 : ସଂପର୍କର ରୀତି / ଭଙ୍ଗୀ ଓ ମାଧ୍ୟମ

- ଉପାଂଶ-୧: ସ୍ଵଗତକଥନ ଓ ସାଂଳାପିକ ଭଙ୍ଗୀ / ସାହିତ୍ୟ-ମାଧ୍ୟମ ଓ ଯୋଗାଯୋଗ
- ଉପାଂଶ-୨: ଦଳଗତ ଆଲୋଚନା ଓ ବିତର୍କ
- ଉପାଂଶ-୩: ସାକ୍ଷାତ୍‌କାର
- ଉପାଂଶ-୪: ପତ୍ରଲିଖନ ପଦ୍ଧତି / ବିବରଣୀ ଲିଖନ
- ଉପାଂଶ-୫: ବୈଷ୍ଟିକ ପଦ୍ଧତି ଓ ସଂପର୍କର ଭାଷା (ଫୁଲଭାଷ, ସଂକ୍ଷିପ୍ତ ଫୁନା ପ୍ରେରଣ, ଦୃଶ୍ୟଶ୍ରାବ୍ୟ ସଂଚାର ବିଧାନ, ଝେଦ୍‌ସାଇଟ୍, ଆନ୍ତର୍ଜାତିକ ପଦ୍ଧତି / ଇଣ୍ଟରନେଟ୍)

ଗୁଣ୍ଡ ତାଲିକା

- ୧- ଗନ୍ଧତରଂଗ- ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ।
- ୨- ସଂଯୋଗ ଅନୁକ୍ରମ/ବ୍ୟାବହାରିକ ଓଡିଆ ଭାଷା ଓ ପ୍ରୟୋଗାତ୍ମକ ବ୍ୟାକରଣ, ସନ୍ତୋଷ ତ୍ରିପାଠୀ, ନାଳନ୍ଦା, କଟକ।
- ୩- ପ୍ରାୟୋଗିକ ଓଡିଆ ଭାଷା- ଓଡିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା।
- ୪- ସମ୍ବାଦ ଓ ସାମ୍ବାଦିକତା- ଚନ୍ଦ୍ରଶେଖର ମହାପାତ୍ର, ଓଡିଶା ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା।
- ୫- ଆଧୁନିକ ଓଡିଆ ବ୍ୟାକରଣ – ଧନେଶ୍ଵର ମହାପାତ୍ର।



AECC-II : HINDI
SEMESTER-II
(CREDITS: 2, Theory=2)
(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: कविता

- (i) कबीर - साखी : १ से १०
- (ii) तुलसी - विनयपत्रिका - पद १ और २
- (iii) प्रसाद - मधुमय देश
- (iv) निराला - भिक्षुक
- (v) अज्ञेय - हिरोशिमा

MODULE-2: गद्य

- (i) रामचन्द्र शुक्ल - उत्साह
- (ii) हजारी प्रसाद द्विवेदी - कुटज
- (iii) हरिशंकर परसाई - सदाचार का तावीज

MODULE-3: शब्द ज्ञान

- (i) शब्द सुद्धि
- (ii) वाक्य सुद्धि
- (iii) पययिवाची शब्द
- (iv) विलोम शब्द

MODULE-4: सामान्य ज्ञान

- (i) निबंध लेखन

अंक विभाजन:

विभाग - (क)	अपर्युक्त इकाइयों ६, ६६ और ६७ से ०३ प्रश्न पूछे जाएँगे। उनमें से ०२ के उत्तर लिखने होंगे। (प्रत्येक उत्तर ७००-१००० शब्दों के बिच)	10X2=20
विभाग - (ख)	अपर्युक्त इकाइयों ६ और ६६ से ०४ पद्यांश / गद्यांश पूछे जाएँगे। जिनमें से ०२ के उत्तर लिखने होंगे। (प्रत्येक उत्तर ४००-५०० शब्दों के बिच)	05X2=10
विभाग - (ग)	युनिट ६६ से अति संक्षीप्त प्रश्न पूछे जाएँगे।	02X5=10
	End Semester	40
	Internal	10
	Total	50

पाठ्य पुस्तक:

हिन्दी प्रसून - सं डॉ अंजुमन आरा, प्लानेट भी, कटक

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SKILL ENHANCEMENT COURSE (SEC)

SEMESTER-III

SEC-1: BASIC COMPUTER APPLICATION (BCA)

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: 4 classes

Introduction: Introduction to computer system: Computer, Hardware, Software, Types of software, Types of Computer, uses of computer.

MODULE-2: 6 Classes

Human Computer Interface: Operating system as user interface, utility programs, Input and output devices: Keyboard, Mouse, Joystick, Scanner (OCR, OBR, OMR, MICR), Digital Camera, Touch Screen. Monitor, Printer, Plotter,

Windows-Introduction, functions, properties and different versions, Working with Start Menu, Control Panel, Explorer, Desktop and Icons, My computer, Recycle bin, My Document, Good practices to make the windows run efficiently.

MODULE-3: 6 classes

Memory: Primary, secondary, auxiliary memory, RAM, ROM, cache memory, hard disks, optical disks, USB storage, Memory Card, C.P.U., registers, ALU, Control Unit, system bus, processors(only basic idea about function and type).

MODULE-4: 5 classes

VIRUS –Meaning, function, characteristics and types, Uses of Firewall and Antivirus.

Electronic mail and its features- inbox, composing mails, sending mail, trash, spam folder in email.

MODULE-5: 9 classes

Introduction to Ms.Office:

Ms.Word: Creating a file, Page formatting, editing, printing, saving a file, bullet and numbering, spell check, indenting, paragraph formatting, find and replace.

Ms. Excel: Spread sheet and its uses, Setting column and row, Inserting formula and uses of various functions (AND, IF, NOT, OR, SUM, MAX, COUNT, COUNTA, COUNTIF, AVERAGE), use of Auto sum, Formatting cell, printing, copying and saving.

Ms.Power Point: Features, Uses, Menus, Tool bar, template and wizard, creating animation and effects, saving, deleting and opening a presentations. characteristics of a good presentation.

Reference Book:

1. Computer Fundamental by PK Sinha – BPB publication.
2. Ms.Office 2007 by Rutkoshy, Seguin – BPB publication.
3. Goel, Computer Fundamentals, Pearson Education, 2010.

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SEMESTER-IV

SEC-2: COMMUNICATIVE ENGLISH AND WRITING SKILL (CEWS)

(CREDITS: 2, Theory=2)

(Total Marks: 50, Mid Sem=10, Term End=40, Duration: 2 hrs)

MODULE-1: Communication Process 10 Marks (1 long question / 2 short questions)

- Process of Communication, Characteristics of Business Communication, Inter-personal, Intra-personal and Group communication
- Definition, Objectives, Process, Channels and importance of Communication
- Principles of effective communication and Barriers to effective Communication.
- Types of Communication – Written, Verbal, Non-verbal, informal and Formal and Grape-vine
- Written Communication – Writing letters for inquiries, orders, complaints and claims, Condolence, Complement letters.

MODULE-2: Analytical Grammar 10 Marks (1 x 10 = 10)

- **Vocabulary** : Phrasal Verbs, Synonyms, Antonyms, Idioms, Commercial Terms, Countable and uncountable Nouns, Tense Patterns, Modal Verbs, Prepositions and Phrasal Verbs, The Imperatives, Interrogative, The Passive, Direct and Reported Speech.

MODULE-3: WRITING SKILL: 10 Marks (1 long question/ 2 short questions)

- Writing paragraph, developing ideas into paragraphs, writing personal letters and notes, writing applications, official letters and business letters, writing curriculum vitae/resume, writing e-mails, sms, advertisement and short notes.

MODULE-4: Creative Skills 10 Marks (1 long question)

- Reporting (on issues, events and business matters), Note making and summarising, Description of objects/events/process, Writing and designing pamphlet/brochure, Writing Review/ comment.

Recommended reading:

1. Fluency in English – Part I & II, Oxford University Press.
2. A. J. Thomson & A. V. Matrinet, Practice English Grammar.
3. L. Gartside (ELBS) Modern Business Letters.
4. Business English, Pearson, 2008
5. Pradhan, Bhende and Thakur – Business Communication, Himalaya Publishing House.
6. U. S. Rai & M. S. Rai, Business Communication, Himalaya Publishing House, Bombay.
7. Language, Literature and Creativity, Orient Blackswan 2013

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GENERIC ELECTIVE (GE)

CHEMISTRY

SEMESTER-I

GE- 1: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

SECTION A (INORGANIC CHEMISTRY-1)

MODULE-1: Atomic Structure

(a) 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.

(b) 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 and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1s, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Radial and angular nodes and their significance. 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 m_l and m_s .

Shapes of s, p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s). 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.

MODULE-2: Chemical Bonding and Molecular Structure

(a) 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.

(b) 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, trigonalbipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.

(c) 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+.

SECTION B (ORGANIC CHEMISTRY-1)

MODULE-3: Fundamentals of Organic Chemistry

(a) 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.

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

MODULE-4: Stereochemistry

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).

MODULE-5: Aliphatic Hydrocarbons

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

(b) 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.

(c) 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 .

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CHEMISTRY

SEMESTER-II

GE-2: CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

Section A (Physical Chemistry-1)

MODULE-1: Chemical Energetics

(a) Review of thermodynamics and the Laws of Thermodynamics.

(b) 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.

(c) Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

MODULE-2:

(a) Chemical Equilibrium: 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 K_p , K_c and K_x for reactions involving ideal gases.

(b) Ionic Equilibria: 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)

MODULE-3: (Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure)

(a) Aromatic hydrocarbons (i) Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid

(ii) 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).

(b) Alkyl and Aryl Halides: Alkyl Halides (Upto 5 Carbons) (i) Types of Nucleophilic Substitution (SN_1 , SN_2 and SN_i) reactions. (ii) Preparation: from alkenes and alcohols. (iii) Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

(c) **Aryl Halides** (i) Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer & Gattermann reactions. (ii) Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by $-OH$ group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). (iii) Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

MODULE-4: Alcohols, Phenols and Ethers (Upto 5 Carbons)

(a) **Alcohols**: (i) Preparation: Preparation of 1° , 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

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

(b) **Phenols**: (Phenol case) Preparation: Cumenehydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten – Baumann Reaction.

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

MODULE-5: Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde);

(i) Preparation: from acid chlorides and from nitriles.

(ii) Reactions – Reaction with HCN , ROH , $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemmensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf-Verley reduction.

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CHEMISTRY

SEMESTER-III

GE-3: ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

SECTION A (INORGANIC CHEMISTRY-1)

MODULE-1: Atomic Structure

(a) 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.

(b) 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 and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for $1s$, $2s$, $2p$, $3s$, $3p$ and $3d$ orbitals (Only graphical representation). Radial and angular nodes and their significance. 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 m_l and m_s . Shapes of s , p and d atomic orbitals, nodal planes. Discovery of spin, spin quantum number (s) and magnetic spin quantum number (m_s). 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.

MODULE-2: Chemical Bonding and Molecular Structure

(a) 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.

(b) 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, trigonalbipyramidal and octahedral arrangements. Concept of resonance and resonating structures in various inorganic and organic compounds.

(c) 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⁺.

SECTION B (ORGANIC CHEMISTRY-1)

MODULE-3: Fundamentals of Organic Chemistry

(a) 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.

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

MODULE-4: Stereochemistry

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).

MODULE-5: Aliphatic Hydrocarbons

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

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

(b) **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. KMnO₄) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis.

(c) **Alkynes:** (Upto 5 Carbons) Preparation: Acetylene from CaC₂ 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 KMnO₄, ozonolysis and oxidation with hot alk. KMnO₄.

PRACTICAL: Mark 25 / Credit- 2

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CHEMISTRY

SEMESTER-IV

GE-4: CHEMICAL ENERGETICS, EQUILIBRIA& FUNCTIONAL ORGANIC CHEMISTRY-I

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

SECTION A (PHYSICAL CHEMISTRY-1)

MODULE-1: Chemical Energetics

(a) Review of thermodynamics and the Laws of Thermodynamics.

(b) 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.

(c) Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

MODULE-2: (a) Chemical Equilibrium: Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG° , Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases.

(b) Ionic Equilibria: 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)

MODULE-3: (Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure)

(a) Aromatic hydrocarbons (i) Preparation (Case benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. (ii) 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).

(b) Alkyl and Aryl Halides: Alkyl Halides (Upto 5 Carbons) (i) Types of Nucleophilic Substitution (SN_1 , SN_2 and SN_i) reactions. (ii) Preparation: from alkenes and alcohols. (iii) Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

(c) Aryl Halides: (i)Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer&Gattermann reactions. (ii) Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by $-OH$ group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). (iii) Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

MODULE-4: Alcohols, Phenols and Ethers (Upto 5 Carbons)

(a) Alcohols: (i) Preparation: Preparation of 1° , 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters. (ii) 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.

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

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

MODULE-5: Aldehydes and ketones (aliphatic and aromatic): (Formaldehyde, acetaldehyde, acetone and benzaldehyde) : (i) Preparation: from acid chlorides and from nitriles. (ii) Reactions – Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives. Iodoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf-Verley reduction.

PRACTICAL: Mark 25 / Credit- 2

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MATHEMATICS

SEMESTER-I

GE-1: CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Curvature, Asymptotes, Tracing of Curves (Cartesian, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quadrature, Volume and Surface area of solids of revolution.

MODULE-2: Sphere, Cones and Cylinders, Conicoid.

MODULE-3: Explicit and Implicit functions, Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylor's theorem and Maclaurin's theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagrange's multipliers. Multiple integrals.

MODULE-4: Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogeneous, exact and linear). Equations of 1st order but higher degree.

MODULE-5: Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters. Laplace transforms and its applications to solutions of differential equations.

Books Recommended:

1. Shantinayyan-Text Book of Calculus, Part-II, S.Chand and Co., Chapter-8 (Art. 24,25,26)
2. Shantinayyan-Text Book of Calculus, Part-III, S.Chand and Co., Chapter-1 (Art.1,2), 3,4 (Art.10 to 12 omitting Simpson's Rule), 5 (Art-13) and 6 (Art-15).
3. B.P.Acharya and D.C.Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
4. Santosh K.Sengar-Advanced Calculus, Chapters: 2,4,5,6,7,11,12,13.
5. J.Sinha and S.Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Publishers. Chapters: 2 (2.1 to 2.7), 3, 4 (4.1 to 4.7), 5,9 (9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13).

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MATHEMATICS

SEMESTER-II

GE-2 : LINEAR ALGEBRA AND ADVANCED ALGEBRA

(CREDITS: 6, Theory=6)

(Total Marks: 100, Mid Sem=15, Tutorial=05, Term End=80: Duration: 3 hrs.)

MODULE-1: Vector space, Subspace, Span, Basis, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

MODULE-2: 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, Eigenvalues, Eigenvectors, Quadratic forms.

MODULE-3: Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism. Ring Theory: Definition and examples, some special classes of Rings, Ideals, Quotient ring, Ring homomorphism. Isomorphism theorems.

MODULE-4: Zero divisors, Integral domain, Finite fields, Field of quotients of an integral domain, Polynomial ring, Division algorithm, Remainder theorem, Factorization of polynomials, irreducible and reducible polynomials, Primitive polynomials, Irreducibility tests, Eisenstein Criterion.

Books Recommended:

1. V.Krishnamurthy, V.P.Mainra, J.L.Arora-An Introduction to Linear Algebra, Allied East-West Press Pvt. Ltd., New Delhi, Chapters: 3,4 (4.1 to 4.7), 5 (except 5.3), 6 (6.1, 6.2, 6.5, 6.6, 6.8), 7 (7.4 only).
2. I.H.Seth-Abstract Algebra, Prentice Hall of India Pvt. Ltd., New Delhi. Chapters: 13,14,15,16, 17,18,19,20.

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PHYSICS

SEMESTER-I

CORE-1: MATHEMATICAL PHYSICS-I

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Vector Calculus: 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.

Vector Differentiation: Vector Differentiation: 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.

MODULE-2: Vector Integration: 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).

MODULE-3: Orthogonal Curvilinear Coordinates: 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.

Dirac Delta function and its properties: Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

MODULE-4: First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.

MODULE-5: Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

Referred Books:

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

PRACTICAL: Mark 25 / Credit- 2

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CORE-2: MECHANICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable mass system: motion of rocket. Motion of a projectile in Uniform gravitational field. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

Work and Energy: Work and Kinetic Energy Theorem. Conservative and nonconservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

MODULE-2: Rotational Dynamics: 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.

Elasticity: Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

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

MODULE-3: Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. 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).

MODULE-4: Oscillations: 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.

Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

MODULE-5: Special Theory of Relativity: 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.

Essential Readings:

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- Physics for Degree Students-I Das Jena and others (SrikrishnaPrakashan)
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
- University Physics. F.W. Sears, M.W. Zemansky, H.D. Young 13/e, 1986, Addison Wesley
- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- Mechanics, Berkeley Physics, vol. 1, C. Kittel, W. Knight, et. al. 2007, Tata McGraw-Hill.

PRACTICAL: Mark 25 / Credit- 2

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
- 12 To determine the Young's Modulus by bending of beam
- 13 To determine the Modulus of Rigidity by Torsion Pendulum
- 14 To determine the surface tension by soap bubble
- 15 To determine the thermal conductivity by Lee's method
- 16 To determine the Viscosity by capillary flow method
- 17 To determine the unknown frequency of given tuning fork
- 18 To verify the laws of Transverse vibration of strings by using a sono meter
- 19 To determine the Poissons ratio of rubber
- 20 To determine the surface tension of mercury by Quien's method

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SEMESTER-II

CORE-3: ELECTRICITY AND MAGNETISM

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Electric field: Electric field lines, Electric intensity, calculation of electric intensity due to: an electric dipole, charged rod, charged loop and charged disc. Electric flux. Gauss' Law with applications to charge distributions with spherical (for both conducting and non-conducting), cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential, calculation of electric potential due to a charged sphere (for both conducting and non-conducting), due to a dipole at any point, an infinite line charge, uniformly charged disc. Dipole approximation for an arbitrary distribution of charge, multipole expansion due to a charge distribution. Laplace's and Poisson Equations (in Cartesian, spherical and cylindrical co-ordinate), solution of Laplace equation in Cartesian, spherical and cylindrical coordinates in 3-dimension, conducting sphere in a uniform electric field. The Uniqueness Theorem. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor.

MODULE-2: Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor, capacity of a spherical conductor enclosed by an earthen concentric spherical shell, capacity of an earthed sphere enclosed by a concentric spherical shell, capacity of a cylindrical capacitor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Dielectric in an atomic view (Polar and non-polar) examples of HCl , H_2O , CO_2 . Potential and field outside of a dielectric, Gauss law in dielectrics, Boundary conditions at the dielectric surface, Dielectric sphere in a uniform electric field. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

MODULE-3: Magnetic Field: Basic concepts of magnetism, Magnetic force between current elements and definition of Magnetic Field **B**. Magnetic effect of electric current, Biot-Savart's Law and its simple applications: straight wire and circular loop (at center of loop and at a point on the axis passing through center of loop) magnetic field on the axis of solenoid, Helmholtz galvanometer: its description and calculation of **B**. 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. (Long cylindrical wire, (4) long solenoid, infinitely long co-axial transmission line Properties of **B**: curl and divergence. Scalar and 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.

MODULE-4: Magnetic Properties of Matter: Magnetization vector (**M**). Magnetic Intensity (**H**). Magnetic Susceptibility and permeability. Relation between **B**, **H**, **M**. Ferromagnetism. B-H curve and hysteresis. Types of magnetic substances Dia, Para and Ferro magnetic, explanation in terms of Langevin's theory.

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Induced electric field due to a solenoid, motional electromotive force: (1) moving conducting rod in a constant magnetic field, conducting rod sliding along a stationary U-shaped conductor placed in a uniform magnetic field, rectangular loop of wire moving through a non-uniform magnetic field, stationary loop in time varying magnetic field, moving loop in time varying magnetic field. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

MODULE-5: Electrical Circuits: 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: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

Essential Readings:

- Electricity and magnetism –D.C.Tayal (Himalaya Publishing House)
- Electricity and Magnetism By K.K.Tiwari
- Introduction to Electrodynamics, D.J. Griffiths,(Low Price Edition)
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Physics for degree students –II B.BhunyaS. Mishra M.Das P.K.Jena D.k.Rout B.k.das D.C.Ptra S.sahu (ShrikrishnaPrakashan)
- Electricity and Magnetism –Brijlal and subramanyam
- Electricity and Magnetism-Khare and srivastava
- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

PRACTICAL: Mark 25 / Credit- 2

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.

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CORE-4: WAVES AND OPTICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Geometrical optics: Fermat's principle,deduction of Laws of reflection and refraction at plane interface, Lens system: cardinal points ,Abbe's condition, Cardinal points of (1) Co-axial Lens system(2)Co-incidence of Principal Points and nodal Points(3)relation between formulae of thin lenses and co-axial lens system, lateral longitudinal and angular magnifications of a lens system equivalent focal length of two thin lenses when air is in-between them, Thick lens focal length of thick lens variation of focal length of a thick biconvex lens with thickness ,cardinal points of thick lensMatrix formulation of geometrical Optics.Abberation: Chromatic aberration, spherical aberration, astigmatism and coma, distortion achromatism and reduction of aberrations.Idea of dispersion, Ramsden and Huygens eyepiece.Rainbow primary and secondary rainbow.

MODULE-2: Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods.Lissajous Figures with equal an unequal frequency and their uses. **Superposition of two perpendicular Harmonic Oscillations:** Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

MODULE-3: Wave Motion: 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.

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe.Newton's Formula for Velocity of Sound.

Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment.

Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves. Laplace's Correction.

MODULE-4: Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Interference: 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.

Interferometer: 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.

MODULE-5: Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only)

Fresnel Diffraction: 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.

Fraunhofer diffraction: Single slit, Double slit. Multiple slits. or Diffraction grating. Circular aperture, Resolving Power of a telescope, microscope. Diffraction grating.

Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Essentials readings:

- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- A Text Book of Optics By Brijlala and subramanyam (S.Chand publication)
- Optics by satya Prakash (Pragati Prakashan)
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.
- Physics for degree students by B. Bhunya, S. Mishra, M. Das, P.K. Jena, D.K. Rout, B.K. Dash, D.C. Patra, S. Sahu
- Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

PRACTICAL: Mark 25 / Credit- 2

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify $\lambda = vT$ 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.

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SEMESTER-III

CORE-5: MATHEMATICAL PHYSICS-II

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Fourier Series: 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.

MODULE-2: Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equation by Series Solution of Legendre, Bessel, Hermite and Laguerre Differential Equations to find out their polynomials. Integral representation of Legendre Bessel, Hermite and Laguerre polynomials. Generating Function Simple recurrence relations and Identities of Legendre, Bessel, Hermite and Laguerre Polynomials.

MODULE-3: Properties: Rodrigues Formula, Orthogonality, Orthonormality of Legendre, Bessel, Hermite and Laguerre Polynomials. Expansion of function in a series of Legendre Polynomials. Associated Legendre and Laguerre differential equations and their properties like Rodrigues Formula, Orthogonality, Orthonormality also their Generating Function Simple recurrence relations and Identities. Spherical Bessel's function. Spherical harmonics.

MODULE-4: Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line.

MODULE-4: Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation

Essential Readings:

- Mathematical Physics and Special Relativity --M. Das, P.K. Jena and B.K. Dash (SrikrishnaPrakashan)
- Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics)
- Mathematical Physics—SatyaPrakash (S.Chand&Sons)
- Mathematical physics --B.S.Rajput
- Mathematical Physics—B.D.Gupta
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- 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

References:

- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.9
- 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

PRACTICAL: Mark 25 / Credit- 2

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem

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CORE-6: THERMAL PHYSICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Introduction to Thermodynamics

Zeroth and First Law & Second Law of Thermodynamics:

Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient. 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:

MODULE-2: Thermodynamics & Entropy:

Kelvin-Planck and Clausius Statements and their Equivalence. Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. 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 Universe. Entropy Changes in Reversible and Irreversible Processes. Principle of Increase of Entropy. Temperature-Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics. Unattainability of Absolute Zero.

MODULE-3: Thermodynamic Potentials & Maxwell's Thermodynamic Relations:

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

MODULE-4: Kinetic Theory of Gases

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

MODULE-5: Real Gases: 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.

Essential Readings:

- Physics for Degree students I- M. Das, P. K. Jena, M. Bhunyan, D. K. Rout
- Heat and Thermodynamics- Brijlal and N Subrahmanyam; S. Chand publication
- Heat and Thermodynamics- Satyaprakash; Pragati Prakashan
- Thermal and statistical physics O.K. Sharma and B.S. Talyal; Kalyani Publishers
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

References:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
- Thermal Physics--C. Kittel and H. Kroemer (McMillan Education India) 2010

PRACTICAL: Mark 25 / Credit- 2

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.

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

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CORE-7: DIGITAL SYSTEMS AND APPLICATIONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Introduction to CRO: 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.

Integrated Circuits (Qualitative treatment only): 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.

MODULE-2: Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. 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.

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

MODULE-3: Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.

MODULE-4: Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Shift registers: 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): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

MODULE-5: Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.

Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.

Essential Readings:

- Principle of electronics- V.K.Mehta and Rohit Mehta: S.Chand Publication
- Handbook of electronics –Gupta, Kumar & Sharma
- Digital electronics and microcomputers-R.K.Gaur: DhanpatRai Publication
- Foundation of electronics-D.C.Chattopadhyaya, P.C. rakhshit, B saha&N.N.Purohit
- Bsc Physics –K N Sharma: Kalyani Publishers
- Physics for Degree Students- M Das P K Jenas M Bhunyan D K Rout
- Basic Principle of electronics- B.L. Thareja
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

PRACTICAL: Mark 25 / Credit- 2

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 astablemultivibrator of given specifications using 555 Timer.
15. To design a monostablemultivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor
 - a) Addition and subtraction of numbers using direct addressing mode
 - b) Addition and subtraction of numbers using indirect addressing mode
 - c) Multiplication by repeated addition.
 - d) Division by repeated subtraction.
 - e) Handling of 16-bit Numbers.
 - f) Use of CALL and RETURN Instruction.
 - g) Block data handling.
 - h) Other programs (e.g. Parity Check, using interrupts, etc.).

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.



SEMESTER-IV

CORE-8: MATHEMATICAL PHYSICS–III

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

MODULE-1: Complex Analysis-I: 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 in both Cartesian and polar condition. Examples of analytic functions. Laplace's equation. Line integral of complex function. Properties of complex line integral

MODULE-2: Complex Analysis: Singular functions: poles and branch points, order of singularity, branch cuts. Evolution of line integral by indefinite integration. Cauchy's Inequality. Cauchy's Integral theorem. Cauchy's Integral formula. Simply and multiply connected region. Derivatives of analytic functions. Morera's theorem, Liouville's theorem.

MODULE-3: Complex Analysis: Laurent and Taylor's expansion. Singularities of analytic function. Residues and their evolution. Cauchy's Residue Theorem. Application in solving Definite Integrals of following forms (a) Define integrals of Trigonometric Functions of $\cos\theta$, $\sin\theta$, integration round the unit circle (b) Evolution of certain improper real integrals (c) Evolution of infinite integrals by Jordan's Lemma. (d) Evolution of integrals when integrand has pole on real axis. (e) Evolution of integrals involving many-valued functions. (f) Use of contour integration for deducing integrals from known integrals.

MODULE-4: Integrals Transforms: 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.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

MODULE-5: Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT.

Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform.

Essential Readings:

- Mathematical Physics and Special Relativity --M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan)
- Mathematical Physics--H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics)
- Mathematical Physics—SatyaPrakash (S.Chand&Sons)
- Mathematical physics –B.S.Rajput
- Mathematical Physics—B.D.Gupta
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7thEdn., Elsevier.
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- 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

References:

- 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

PRACTICAL: Mark 25 / Credit- 2

Scilab/C++ based simulations experiments based on Mathematical Physics problems

like

1. Solve differential equations:

$$dy/dx = e-x \text{ with } y = 0 \text{ for } x = 0$$

$$dy/dx + e-xy = x^2$$

$$d^2y/dt^2 + 2 dy/dt = -y$$

$$d^2y/dt^2 + e-tdy/dt = -y$$

2. Dirac Delta Function: Evaluate

$$\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\frac{(x-2)^2}{2\sigma^2}} (x+3) dx, \text{ for } \sigma = 1, 0.1, 0.01 \text{ and show it tends to } 5.$$

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:

$$\int_{-1}^{+1} P_n(\mu) P_m(\mu) d\mu = \delta_{n,m}$$

$$\text{Plot } P_n(x), J_\nu(x)$$

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. $\sin \theta$, 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. Compute the nth roots of unity for $n = 2, 3,$ and $4.$

9. Find the two square roots of $-5+12j.$

10. Integral transform: FFT of e^{-x^2}

11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.

12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.

13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

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. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- 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
- https://web.stanford.edu/~boyd/ee102/laplace_ckts.pdf
- ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

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CORE-9: ELEMENTS OF MODERN PHYSICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. DeBroglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

MODULE-2: Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude;

MODULE-3: Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

MODULE-4: 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. Fission - 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).

MODULE-5: 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.

Lasers: Basic concepts of LASER. Principles of Laser Spontaneous and Stimulated Emissions and absorption Metastable states. Pumping and various methods of pumping. Population Inversion. Basic lasing, Einstein's A and B coefficients Three-Level and Four-Level, Lasers. Ruby Laser and He-Ne Laser. Application of Laser.

Essential Readings:

- Physics for Degree Students IV- M Das P K Jenas M Bhunyan D K Rout
- Introduction to Quantum mechanics- M Das P K Jena
- Quantum Mechanics- Gupta, Kumar Sharma
- Atomic Physics: J B Rajam
- BSc Physics –K N Sharma
- Atomic Physics-S N Ghosal
- Nuclear Physics-Satya Prakash
- Nuclear Physics-S N Ghosal
- Modern Physics- S P Khare
- Nuclear Physics- Irving Kaplan
- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
- Modern Physics-C L Arora
- Fynmen Lectures-III by Sir Richard P Fynmen

Reference Books:

- 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.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.

- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- 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

PRACTICAL: Mark 25 / Credit- 2

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.Prasadh & Ramakrishna, 11th Edn, 2011, KitabMaha

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CORE-10: ANALOG SYSTEMS AND APPLICATIONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Semiconductor Diodes: 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. Current Flow Mechanism in Forward and Reverse Biased Diode.

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

MODULE-2: Bipolar Junction transistors: 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.

MODULE-3: Amplifiers: 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: Two stage RC-coupled amplifier and its frequency response.

MODULE-4: Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

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

MODULE-5: Operational Amplifiers (Black Box approach): 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: (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.

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation)

Essential Readings:

- Principle of electronics- V.K.Mehta and Rohit Mehta: S.Chand Publication
- Handbook of electronics –Gupta, Kumar & Sharma
- Foundation of electronics-D.C.Chattopadhyaya, P.C. rakhshit, B saha&N.N.Purohit
- Bsc Physics –K N Sharma: Kalyani Publishers
- Physics for Degree Students- M Das P K Jenas M Bhunyan D K Rout
- Basic Principle of electronics- B.L. Thareja
- 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

Reference Books:

- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- 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
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

PRACTICAL: Mark 25 / Credit- 2

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 converter (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.

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SEMESTER-V

CORE-11: QUANTUM MECHANICS AND APPLICATIONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Schrodinger equation & the operators: 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. **(8 Lectures)**

MODULE-2: Time independent Schrodinger equation-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. (8 Lectures)

MODULE-3: General discussion of bound states in an arbitrary potential- 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. (8 Lectures)

MODULE-4: One Dimensional Problem: 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.

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern- Gerlach Experiment. (8 Lectures)

MODULE-5: 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). (8 Lectures)

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. Aruldas, 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,(SriKrishna 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
- Cohen-Tannoudji, B Diu and F Laloë, Quantum Mechanics (2 vols) Wiley-VCH 1977

PRACTICAL: Mark 25 / Credit- 2

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 eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take $e = 3.795$ (eVÅ)^{1/2}, $\hbar c = 1973$ (eVÅ) and $m = 0.511 \times 10^6$ 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 wavefunction. Take $e = 3.795$ (eVÅ)^{1/2}, $m = 0.511 \times 10^6$ eV/c², and $a = 3$ Å, 5 Å, 7 Å. In these units $\hbar c = 1973$ (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, $\hbar c = 197.3$ MeV fm. The ground state energy E is 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: $m = 940 \times 106 \text{ eV}/C^2$, $D = 0.755501 \text{ eV}$, $\alpha = 1.44$, $r_0 = 0.131349 \text{ \AA}$

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. Press et al., 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. Saugez, 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

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CORE-12: SOLID STATE PHYSICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Crystal Structure: 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. (8 Lectures)

MODULE-2: Elementary Lattice Dynamics: 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 (6 Lectures)

MODULE-3: Magnetic Properties of Matter: 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. (6 Lectures)

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. (4 Lectures)

MODULE-3: Lasers: 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. (4 Lectures)

MODULE-5: Elementary band theory: 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. (8 Lectures)

Superconductivity: 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) (4 Lectures)

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.

PRACTICAL: Mark 25 / Credit- 2

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 oC) 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.

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**SEMESTER-VI
CORE-13: ELECTROMAGNETIC THEORY**

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: 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. **(8 Lectures)**

MODULE-2: 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. **(8 Lectures)**

MODULE-3: 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)

MODULE-4: Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only)

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. **(8 Lectures)**

MODULE-5: 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. **(8 Lectures)**

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: Mark 25 / Credit- 2

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

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CORE-14: STATISTICAL MECHANICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Microcanonical, Canonical and grand canonical ensemble. Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function. **(8 Lectures)**

MODULE-2: 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. **(8 Lectures)**

MODULE-3: Radiation: 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. **(8 Lectures)**

MODULE-4: 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. **(8 Lectures)**

MODULE-5: Quantum Statistics: 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, degenerate Fermigas, Density of States, Fermi energy. **(8 Lectures)**

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: Mark 25 / Credit- 2

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, 3rd 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

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DISCIPLINE SPECIFIC ELECTIVE (DSE)

PHYSICS

SEMESTER-V

DSE-1: CLASSICAL DYNAMICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

MODULE-1: Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. (12 Lectures)

MODULE-2: 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. (12 Lectures)

MODULE-3: Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Spacetime diagrams. Time-dilation, length contraction and twin paradox. (12 Lectures)

MODULE-4: Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. (12 Lectures)

MODULE-5: Doppler effect from a fourvector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. (12 Lectures)

PRACTICAL: Mark 25 / Credit- 2

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 (Srikrishna Prakashan)

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DSE-2 : NUCLEAR AND PARTICLE PHYSICS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: General Properties of Nuclei: 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 excited states. (12 Lectures)

MODULE-2: 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, (12 Lectures)

MODULE-3: Radioactivity decay: (a) Alpha decay: basics of α -decay processes, theory of α -mission, 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, (12 Lectures)

MODULE-4: Detector for Nuclear Radiations: 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.

(12 Lectures)

MODULE-5: Particle Accelerators: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

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.

(12 Lectures)

PRACTICAL: Mark 25 / Credit- 2

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

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SEMESTER-VI

DSE-3 : NANO MATERIALS AND APPLICATIONS

(CREDITS: 6, Theory=4 + Practical=2)

(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: NANOSCALE SYSTEMS: 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- quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

(8 Lectures)

MODULE-2: SYNTHESIS OF NANOSTRUCTURE MATERIALS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapour 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.

(8 Lectures)

MODULE-3: CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

(8 Lectures)

MODULE-4: OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals, Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostructures and nanostructures.

(8 Lectures)

MODULE-5: ELECTRON TRANSPORT: Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, tunneling and hopping conductivity.

APPLICATIONS: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells).

(8 Lectures)

PRACTICAL: Mark 25 / Credit- 2

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)

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DSE-4: PROJECT (CREDIT=6 / MARKS=100) (End Semester Evaluation)

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