GOVERNMENT COLLEGE (AUTONOMOUS), BHAWANIPATNA

(College with potential for excellence)

COURSES OF STUDIES

FOR THREE YEAR DEGREE COURSE IN

S C I E N C E

(UNDER CBCS)

SUB: CHEMISTRY

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

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 (3 prose and two poetry questions)	03x 05 qns= 15 marks
	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

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AECC-II : ODIA
SEMESTER-II

ଆସ୍ଥାମୂଲ୍ୟାଂକ -୨, ମୋଟ୍ ଶ୍ରେଣୀ ପାଠଦାନ-୨୦ ଘଣ୍ଟା, ପୂର୍ଣ୍ଣସଂଖ୍ୟା -୫୦, ପରୀକ୍ଷା ସମୟ-୨ ଘଣ୍ଟା

<u>ପାଠ୍ୟରୁ କୌଣସି ଗୋଟିଏ ପାଠ୍ୟକୁ ବାଛିବାକୁ ହେବ।</u>

ପାଠ୍ୟ-୧ / Course-1 :

ଉପାଂଶ-୧: (ଗଳ୍ପବିଭାଗ) ଗଳ୍ପ ତରଂଗ-ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ
ଭଗବାନ ମଲାପରେ-ମହାପାତ୍ର ନୀଳମଣି ସାହୁ
ବିଷକନ୍ୟାର କାହାଣୀ-ମନୋଜ ଦାସ
ଦ୍ବିତୀୟ ଶ୍ମଶାନ-ରାମଚନ୍ଦ୍ର ବେହେରା
ଦୁଇଟି ପ୍ରଶ୍ନରୁ ଗୋଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁହେବ। (୧୦)

ଉପାଂଶ-୨: (କବିତାଶ୍ରୀ) ଅନୁଭବାଚ -ଗୁରୁପ୍ରସାଦ ମହାନ୍ତି
ଲଣ୍ଠନ-ରମାକାନ୍ତ ରଥ
କୁରୁପତିସଭାସ୍ଥଳେ -ପ୍ରତିଭା ଶତପଥୀ
ଦୁଇଟି ପ୍ରଶ୍ନରୁ ଗୋଟିଏ ପ୍ରଶ୍ନର ଉତ୍ତର ପାଞ୍ଚଶହ ଶବ୍ଦରେ ଲେଖିବାକୁ ହେବ। (୧୦)

ଉପାଂଶ-୩: (ଅବବୋଧ) ଏକଶହପଚାଶ ଶବ୍ଦର ଏକ ଅନୁଚ୍ଛେଦ ପ୍ରଦାନ କରାଯିବ।
୫ଟି ପ୍ରଶ୍ନ ପଡିବ ଏବଂ ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨। (୫X୨=୧୦)

ଉପାଂଶ-୪: (ଭାବ ସଂପ୍ରସାରଣ) କୌଣସି ଏକ ଚୂଡ଼ିକୁ ପ୍ରଶ୍ନଭାବରେ ପ୍ରଦାନ କରାଯିବ। (୧୦)

ଉପାଂଶ-୫: (ବିଭକ୍ତି) ବ୍ୟାକରଣ। ଆଠଟିରୁ ପାଞ୍ଚଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ। ପ୍ରତ୍ୟେକ ପ୍ରଶ୍ନର ମୂଲ୍ୟ ୨ ନମ୍ବର। (୫X୨=୧୦)

ପାଠ୍ୟ-୨ / Course-2 : ସଂପର୍କ ଅନୁବିଧି

ଉପାଂଶ-୧: ସଂପର୍କର ଭିତ୍ତି, ପରିଭାଷା, ଅନୁବିଧି ଓ ପରିସର

ଉପାଂଶ-୨: ସଂପର୍କର ପ୍ରକାରଭେଦ: କଥିତ-ଲିଖିତ, ବ୍ୟକ୍ତିଗତ-ସାମାଜିକ-ସାଂସ୍କୃତିକ-ବ୍ୟାବସାୟିକ-ସାହିତ୍ୟିକ

ଉପାଂଶ-୩: ସଂପର୍କର ବାଧକ ଓ ସଫଳସାଧନର ଦିଗ

ଉପାଂଶ-୪: ସଂପର୍କରେ ସାହିତ୍ୟର ଭୂମିକା

ଉପାଂଶ-୫: ସଫଳ ସଂପର୍କର ଭାଷା

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

ଉପାଂଶ-୧: ସ୍ବଗତକଥନ ଓ ସାଂଳାପିକ ଭଙ୍ଗୀ / ସାହିତ୍ୟ-ମାଧ୍ୟମ ଓ ଯୋଗାଯୋଗ

ଉପାଂଶ-୨: ଦଳଗତ ଆଲୋଚନା ଓ ବିତର୍କ

ଉପାଂଶ-୩: ସାକ୍ଷାତ୍‌କାର

ଉପାଂଶ-୪: ପତ୍ରଲିଖନ ପଦ୍ଧତି / ବିବରଣି ଲିଖନ

ଉପାଂଶ-୫: ବୈଦ୍ୟୁତିକ ପଦ୍ଧତି ଓ ସଂପର୍କର ଭାଷା (ଦୂରଭାଷ , ସଂକ୍ଷିପ୍ତ ସୂଚନା ପ୍ରେରଣ, ଦୃଶ୍ୟଶ୍ରାବ୍ୟ ସଂଚାର ବିଧାନ, ୱେବ୍‌ସାଇଟ୍, ଆନ୍ତର୍ଜାତିକ ପଦ୍ଧତି / ଇଣ୍ଟରନେଟ୍)

<u>ଗ୍ରନ୍ଥ ତାଲିକା</u>

୧- ଗଳ୍ପତରଂଗ- ପ୍ରକାଶକ ସମ୍ବଲପୁର ସାହିତ୍ୟ ସଂସଦ।

୨- ସଂଯୋଗ ଅନୁବିଧି /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 – ଧନେଶ୍ବର ମହାପାତ୍ର।

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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) बाक्य सुद्धि

(iii) पयायिवाची शब्द

(iv) विलोम शब्द

MODULE-4: **सामान्य ज्ञान**

(i) निबंध लेखन

अंक विभाजन:

विभाग - (क)	अपर्युक्त इकाइयो 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 ६६६ से अति संक्षीत्प 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, thrash, 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. Garteside (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)

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(Cartenary,Cycloid,Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quardrature, 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, Taylors theorem and Maclaurins theorem for functions of two variables. Maxima and Minima of functions of two and three variables, Implicit functions, Lagranges multipliers. Multiple integrals.

MODULE-4: Ordinary Differential Equations of 1^{st} order and 1^{st} degree (Variables separable, homogenous, exact and linear).Equations of 1^{st} 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 dfferential equations.

BooksRecommended:

1. Shantinarayan-Text Book of Calculus, Part-II, S.Chandand Co., Chapter-8 (Art. 24,25,26)
2. Shantinarayan-Text Book of Calculus, Part-III, S.Chandand Co., Chapter-1 (Art1,2), 3,4 (Art.10 to 12 ommitting Simpsons Rule), 5 (Art-13) and 6 (Art-15).
3. B.P.AcharyaandD.C.Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
4. SantoshK.Sengar-Advanced Calculus, Chapters: 2,4,5,6,7,11,12,13.
5. J.Sinharoy and S.Padhy-A Course of Ordinary and Partial Diferential Equations, Kalyani PuBlishers. Chapters: 2 (2.1to2.7), 3, 4 (4.1to4.7), 5,9 (9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13).

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MATHEMATICS

SMESTER-II

GE-2 : LINEAR ALGEBRAAND ADVANCEDALGEBRA

(CREDITS: 6, Theory=6)
(Total Marks: 100, Mid Sem=15, Tutorial=05, Term End=80: Duration: 3 hrs.)

MODULE-1: Vectorspace, Subspace, Spanofaset, 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, Quadraticforms.

MODULE-3: GroupTheory: Defnition and examples, Subgroups, Normal subgroups, Cyclicgroups, Cosets, Quotient groups, Permutation groups, Homomorphism. RingTheory: Defnition and examples, some special classes of Rings, Ideals, Quotientring, Ring homomorphism. Isomorphism theorems.

MODULE-4: Zerodivisors, Integraldomain, Finitefelds, Finitefeld Z / pZ, Field of quotients of an Integraldomain, Polynomialring, Divisionalgorithm, Remaindertheorem, Factorization of polynomials, irreducible and Reducible polynomials, Primitive polynomials, Irreducibility tests, Eisenstein Criterion.

BooksRecommended:

1. V.Krishnamurty, V.P.Mainra, J.L.Arora-Anintroduction to Linear Algebra, Afliated East-West Press Pvt. Ltd., New Delhi, Chapters: 3,4 (4.1to4.7), 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-III

GE-3: MECHANICS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.
Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.
MODULE-2: Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.
Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.
Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum.
MODULE-3: Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only).Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness.Physiological effects on astronauts.
MODULE-4: Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia - q, η and σ bySearles method.
MODULE-5: Oscillations: Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.
Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity.Length contraction.Time dilation. Relativistic addition of velocities.

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.

References:

- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
- Mechanics - J. C. Slater and N. H. Frank (McGraw-Hill) Theoretical Mechanics, M.R. Spiegel, 2006, 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 Poissions ratio of rubber
20 To determine the surface tension of mercury by Quien's method

Reference Books

- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, KitabMahal
- B.Sc. Practicle Physics by C.L.arora (S.Chand and Sons)
- 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, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, KitabMahal
- Engineering Practical Physics, S.Panigrahi& B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

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PHYSICS

SEMESTER – IV

GE-4: 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: (12 Lectures)

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor.

MODULE-2: (22 Lectures)

Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere.

Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

MODULE-3: (10 Lectures)

Magnetism: Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferromagnetic materials.

MODULE-4: (6 Lectures)

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

MODULE-5: (10 Lectures)

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.

Essential Readings:

- Electricity and magnetism –D.C.Tayal (Himalaya Publishing House)
- Elcricity 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.MishraM.DasP.K.JenaD.k.RoutB.k.dasD.C.PtraS.sahu (Shrikrishna Prakashan)
- Electricity and Magnetism –Brijlal and subramanyam
- Electricity and Magnetism-Khare and srivastava
- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw

References:

- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes&J.Yarwood.Vol.I, 1991, Oxford Univ. Press.
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes&J.Yarwood.Vol.I, 1991, Oxford Univ. Press.

PRACTICAL: Mark 25 / Credit- 2

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. Ballistic Galvanometer: (i) Measurement of charge and current sensitivity, (ii) Measurement of CDR, (iii) Determine a high resistance by Leakage Method, (iv) To determine Self Inductance of a Coil by Rayleigh's Method.
3. To compare capacitances using De'Sauty's bridge.
4. Measurement of field strength B and its variation in a Solenoid (Determine dB/dx)
5. To study the Characteristics of a Series RC Circuit.
6. To study a series LCR circuit LCR circuit and determine its (a) Resonant frequency, (b) Quality factor
7. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q
8. To determine a Low Resistance by Carey Foster's Bridge.
9. To verify the Thevenin and Norton theorems
10. To verify the Superposition, and Maximum Power Transfer Theorems

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, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition.Khandelwal, 1985, Vani Pub.
- B.ScPracticle Physics –C.L.arora (S Chand & Sons)

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CHEMISTRY

SEMESTER-I

CORE-1: INORGANIC CHEMISTRY-I

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: ATOMIC STRUCTURE: Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: De- Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

MODULE-2: PERIODICITY OF ELEMENTS: Periodicity of Elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) (c) Ionic and crystal radii. (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. (f) Electron gain enthalpy, trends of electron gain enthalpy. (g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio.

MODULE-3: CHEMICAL BONDING-I

(a) Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(b) Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy,

(c) Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

MODULE-4: CHEMICAL BONDING:-II: (a) Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

(b) Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

MODULE-5: OXIDATION-REDUCTION: Redox equations, Standard electrode potential,Standard emf of the cell, Electrochemical series, Primary standards, secondary standards, Acid-base titration and way of locating the titration end point. Oxidation –reduction titration and way of locating the end point with oxidants KMnO4, K2Cr2O7,Iodimetry, Iodometric . Complexation titration and way of locating end point with EDTA.

PRACTICAL: Mark 25 / Credit- 2

Books Recommended: (Inorganic Chemistry)

1.Principle of Inorganic Chemistry :B. R. Puri, L.R. Sharma, K.C. Kalia, S. Chand & Company.
2.Concise Inorganic Chemistry, J. D. Lee. ELBS.

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CORE-2: PHYSICAL CHEMISTRY- II

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: GASEOUS STATE:

(a) Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.

(b) Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

(c) Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van 12 der Waals equation of state, its derivation and application in explaining real gas behaviour, calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

MODULE-2: LIQUID STATE:

Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

MODULE-3: SOLID STATE:

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

MODULE-4: IONIC EQUILIBRIA- I :

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; dissociation constants of mono-, di-and triprotic acids (exact treatment). Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts.

MODULE-5: IONIC EQUILIBRIA- II :

Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts – applications of solubility product principle. Qualitative treatment of acid – base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

PRACTICAL: Mark 25 / Credit- 2

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SEMESTER-II

CORE-3: ORGANIC CHEMISTRY-I

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: BASICS OF ORGANIC CHEMISTRY:

(a) Organic Compounds: Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties. Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

(b) Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocations, Carbanions, Free radicals and Carbenes.

(c) Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

MODULE-2: STEREOCHEMISTRY

Fischer Projection, Newmann and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis–trans and, syn-anti isomerism E/Z notations with C.I.P rule Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

MODULE-3: CYCLOALKANES AND CONFORMATIONAL ANALYSIS

(a)Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

(b) CARBON-**CARBON SIGMA BONDS**
Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

MODULE-4: CARBON-CARBON PI BONDS

(a) Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

(b) Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylicbromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. 1,5 Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds.

MODULE-5: AROMATIC HYDROCARBONS

Aromaticity: Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

PRACTICAL: Mark 25 / Credit- 2

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CORE-4: PHYSICAL CHEMISTRY- II

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: CHEMICAL THERMODYNAMICS:

(a) Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

(b) Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

MODULE-2:

(a) Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

(b) Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell 17 relations; thermodynamic equation of state.

MODULE-3: SYSTEMS OF VARIABLE COMPOSITION

(a) Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

(b) Partial molar quantities, dependence of thermodynamic parameters on composition; GibbsDuhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

MODULE-4: CHEMICAL EQUILIBRIUM

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Coupling of exoergic and endoergic reactions. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

MODULE-5: Solutions and Colligative Properties:

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

PRACTICAL: Mark 25 / Credit- 2

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SEMESTER-III

CORE-5: INORGANIC CHEMISTRY II: S- AND P-BLOCK ELEMENTS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: General Principles of Metallurgy (6 Lectures)

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic Kroll process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

MODULE-2: Acids and Bases (8 Lectures)

Brönsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle.

MODULE-3: Chemistry of *s* and *p* Block Elements: (30 Lectures)

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *s* and *p* block elements.; Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.; Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses.; Boric acid and borates, boron nitrides, borohydrides (diborane) carboranes and graphitic compounds, silanes, Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds.

MODULE-4: Noble Gases: (8 Lectures)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).

MODULE-5: Inorganic Polymers: (8 Lectures)

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes.

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models ofInorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. &Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
- Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
- Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.
- Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* 4th Ed., Pearson, 2010.
- Atkin, P. *Shriver & Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press (2010).

PRACTICAL: Mark 25 / Credit- 2

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and K2Cr2O7 using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of (i) arsenite and (ii) antimony in tartar-emetic iodimetrically
(iii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Cuprous Chloride, Cu2Cl2
(ii) Preparation of Manganese(III) phosphate, MnPO4.H2O
(iii) Preparation of Aluminium potassium sulphateKAl(SO4)2.12H2O (Potash alum) or Chrome alum.

Reference Books: Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.,* Pearson, 2009.

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CORE-6: ORGANIC CHEMISTRY II: OXYGEN CONTAINING FUNCTIONAL GROUPS

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Chemistry of Halogenated Hydrocarbons: (16 Lectures)
Alkyl halides: Methods of preparation, nucleophilic substitution reactions – SN1, SN2 and SNimechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.
Aryl halides: Preparation, including preparation from diazonium salts. nucleophilic aromaticsubstitution; SNAr, Benzyne mechanism.
Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.
Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

MODULE-2: Alcohols, Phenols, Ethers and Epoxides: (14 Lectures)
Alcohols: preparation, properties and relative reactivity of 1˚, 2°, 3° alcohols, Bouvaelt-BlancReduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;
Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitutionreactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

MODULE-3: Carbonyl Compounds: (14 Lectures)
(a) Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH4, NaBH4); Addition reactions of unsaturated carbonyl compounds: Michael addition.
(b) Active methylene compounds: Keto-enoltautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

MODULE-4: Carboxylic Acids and their Derivatives: (10 Lectures)
Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic/phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids;
Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilicsustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

MODULE-5: Sulphur containing compounds: (6 Lectures)
Preparation and reactions of thiols, thioethers and sulphonic acids.
Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides withalcohols, ammonia derivatives and LiAlH4

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

PRACTICAL: Mark 25 / Credit- 2
1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:
   i. Acetylation of one of the following compounds: amines (aniline, *o*-, *m*-, *p*-toluidines and *o*-, *m*-, *p*-anisidine) and phenols (β-naphthol, vanillin, salicylic acid) by any one method:
      a. Using conventional method.
      b. Using green approach
   ii. Benzolyation of one of the following amines (aniline, *o*-, *m*-, *p*- toluidines and *o*-, *m*-,

p-anisidine) and one of the following phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.

iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).

iv. Bromination of any one of the following:
   a. Acetanilide by conventional methods
   b. Acetanilide using green approach (Bromate-bromide method)

v. Nitration of any one of the following:
   c. Acetanilide/nitrobenzene by conventional method
   d. Salicylic acid by green approach (using ceric ammonium nitrate).

vi. Selective reduction of *meta* dinitrobenzene to *m*-nitroaniline.

vii. Reduction of *p*-nitrobenzaldehyde by sodium borohydride.

viii. Hydrolysis of amides and esters.

ix. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.

x. *S*-Benzylisothiouronium salt of one each of water soluble and water insoluble acids(benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

xi. Aldol condensation using either conventional or green method.

xii. Benzil-Benzilic acid rearrangement.

The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization, melting point and TLC.

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S., Hannaford, A.J., Smith, P.W.G. &Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.* Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis,* University Press (2000).
- Ahluwalia, V.K. &Dhingra, S. *Comprehensive Practical Organic Chemistry: QualitativeAnalysis,* University Press (2000).

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CORE-7 : PHYSICAL CHEMISTRY-III

(PHASE EQUILIBRIA AND CHEMICAL KINETICS)

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Phase Equilibria: (14 Lectures)

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule,; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapourequilibria, phase diagram for one component systems, with applications to Water and Sulphur system.

Phase diagrams for two component systems ,systems of solid-liquid equilibria involving eutectic with Lead-silver system. Congruent M.P. with Ferric chloride-water system and incongruent melting points with Sodium sulphate- Water system.Solid solution.

MODULE-2: Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivative and application.

MODULE-3: Chemical Kinetics (18 Lectures)

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision

theory of reaction rates.Qualitative treatment of the theory of Absolute reaction rate.

MODULE-4: Catalysis: (8 Lectures)

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis,Michaelis-Menten mechanism, acid-base catalysis.

MODULE-5: Surface chemistry: (10 Lectures)

Physical adsorption, chemisorption, adsorption isotherms. nature of adsorbed state. Freundlich adsoption isotherm, Langmuir adsorption isotherm, Gibbs adsorption equation, CMC.

Reference Books:

- Peter Atkins & Julio De Paula, *Physical Chemistry* 10th Ed., Oxford University Press (2014).
- Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rdEd.,* Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
- Zundhal, S.S. *Chemistry concepts and applications*Cengage India (2011).
- Ball, D. W. *Physical Chemistry*Cengage India (2012).
- Mortimer, R. G. *Physical Chemistry 3rdEd.,* Elsevier: NOIDA, UP (2009).
- Levine, I. N. *Physical Chemistry 6thEd.,* Tata McGraw-Hill (2011).
- Metz, C. R. *Physical Chemistry 2ndEd.,* Tata McGraw-Hill (2009).

PRACTICAL: Mark 25 / Credit- 2

I. Determination of critical solution temperature and composition of the phenol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:
   a. simple eutectic and
   b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:
   (i) $I_2(aq) + I^- \rightarrow I_3^-(aq)^{2+}$
   (ii) $Cu^{2+}(aq) + nNH_3 \rightarrow Cu(NH_3)_n$

V. Study the kinetics of the following reactions.

1. Initial rate method: Iodide-persulphate reaction
2. Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.
b. Saponification of ethyl acetate.

3. Compare the strengths of HCl and H2SO4 by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption

I. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.*; McGraw-Hill: New York (2003).
- Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York (2003).

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SEMESTER-IV

CORE-8: INORGANIC CHEMISTRY III: COORDINATION CHEMISTRY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Coordination Chemistry I: IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes, Labile and inert complexes, Werner's theory of co-ordination compounds.

MODULE-2: Coordination Chemistry II: Valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. Crystal field theory, measurement of 10 Dq(o), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of 10 Dq (o, t). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar geometry. Qualitative aspect of Ligand field Theory.

MODULE-3: Transition Elements: General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer &Bsworth diagrams). Difference between the first, second and third transition series. Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy)

MODULE-4: Lanthanoids and Actinoids: Electronic configuration, oxidation states, colour, spectral and magnetic properties of Lanthanoids and Actinoids, lanthanide contraction, separation of lanthanides (ion-exchange method only). Chemistry of Uranium, Cerium, Thorium.

MODULE-5: Bioinorganic Chemistry: Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of Iron.

Reference Books:

- Purcell, K.F &Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977.
- Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
- Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry*Panima Publishing Company 1994.
- Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. &Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997.

PRACTICAL: Mark 25 / Credit- 2

Gravimetric Analysis:

i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN
iii. Estimation of iron as Fe2O3 by precipitating iron as Fe(OH)3.
iv. Estimation of Al (III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate).

Inorganic Preparations:

i. Tetraamminecopper (II) sulphate, [Cu(NH3)4]SO4.H2O
ii. *Cis*and *trans* K[Cr(C2O4)2. (H2O)2] Potassium dioxalatodi-aquachromate (III)
iii. Tetraamminecarbonatocobalt (III) ion
iv. Potassium tris(oxalate)ferrate(III)

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni (II) and Co (II)
ii. Fe (III) and Al (III)

Reference Book:

Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6thEd.,* Pearson, 2009.

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CORE-9: ORGANIC CHEMISTRY III: HETEROCYCLIC CHEMISTRY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Nitrogen Containing Functional Groups: Preparation and important reactions of nitro and compounds, nitriles and isonitriles Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid. Diazonium Salts: Preparation and their synthetic applications.

MODULE-2: Polynuclear Hydrocarbons (8 Lectures)

Reactions of naphthalene, phenanthrene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene; Polynuclear hydrocarbons.

MODULE-3: Heterocyclic Compounds (10 Lectures)

Classification and structure of five membered heterocyclics: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene. Derivatives of furan: Furfural and furoic acid Six membered heterocyclics : Pyridine (Hantzsch synthesis), Pyrimidine; Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis),

MODULE-4: Alkaloids (6 Lectures)

Natural occurrence, General structural features, Isolation and their physiological action Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

MODULE-5: Terpenes (6 Lectures)

Occurrence, Isolation, classification, isoprene rule; Elucidation of stucture and synthesis of Citral, Neral ,α-terpineol and Camphor.

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry ofNatural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons (1976).
- Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Kalsi, P. S. *Textbook of Organic Chemistry 1stEd.*, New Age International (P) Ltd. Pub.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, PrajatiParakashan (2010).

PRACTICAL: Mark 25 / Credit- 2

1. Detection of extra elements.
2. Functional group test for nitro, amine and amide groups.
3. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols and carbonyl compounds)

Reference Books

- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.,* Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis,* University Press (2000).
- Ahluwalia, V.K. &Dhingra, S. *Comprehensive Practical Organic Chemistry:Qualitative Analysis,* University Press (2000).

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CORE-10: PHYSICAL CHEMISTRY IV: ELECTROCHEMISTRY
(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Conductance I (10 Lectures)

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions and application. Debye-Hückel-Onsager equation.

MODULE-2: Conductance II (10 Lectures)

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

MODULE-3: Electrochemistry I

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry.

Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

MODULE-4: Electrochemistry II

Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb2O3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

MODULE-5: Electrical & Magnetic Properties of Atoms and Molecules(12 Lectures)

Basic ideas of electrostatics, Electrostatics of dielectric media, Clausius-Mosotti equation, Lorenz-Laurentz equation, Dipole moment and molecular polarizabilities and their measurements. Diamagnetism, paramagnetism, magnetic susceptibility and its measurement.

Reference Books:

- Atkins, P.W & Paula, J.D. *Physical Chemistry*, 10th Ed., Oxford University Press (2014).
- Castellan, G. W. *Physical Chemistry 4thEd.,*Narosa (2004).
- Mortimer, R. G. *Physical Chemistry 3rdEd.,* Elsevier: NOIDA, UP (2009).
- Barrow, G. M., *Physical Chemistry 5thEd.,* Tata McGraw Hill: New Delhi (2006).
- Engel, T. & Reid, P. *Physical Chemistry 3rdEd.,* Prentice-Hall (2012).
- Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
- Silbey, R. J.; Alberty, R. A. &Bawendi, M. G. *Physical Chemistry 4thEd.,* John Wiley & Sons, Inc. (2005).

PRACTICAL: Mark 25 / Credit- 2

Conductometry

I. Determination of cell constant
II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
III. Perform the following conductometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base
   iii. Mixture of strong acid and weak acid vs. strong base
   iv. Strong acid vs. weak base

Potentiometry

I Perform the following potentiometric titrations:
   i. Strong acid vs. strong base
   ii. Weak acid vs. strong base
   iii. Dibasic acid vs. strong base
   iv. Potassium dichromate vs. Mohr's salt

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SEMESTER-V

CORE-11: ORGANIC CHEMISTRY-IV

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: (a) Nucleic Acids : Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides. **(9 Lectures)**

(b) Lipids : Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity. **(8 Lectures)**

MODULE-2: Amino Acids, Peptides and Proteins

Amino acids, Peptides and their classification. α-Amino Acids - Synthesis, ionic properties and reactions. Zwitterions, p*K*a values, isoelectric point and electrophoresis; Study of peptides: determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis **(16 Lectures)**

MODULE-3: Enzymes : Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition). **(8 Lectures)**

MODULE-4: Concept of Energy in Biosystems : Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism). ATP: The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems: NAD+, FAD. Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle. Overview of catabolic pathways of fat and protein. Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types. **(7 Lectures)**

MODULE-5: Pharmaceutical Compounds: Structure and Importance :

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine). **(12 Lectures)**

Reference Books:

- Berg, J.M., Tymoczko, J.L. & Stryer, L. (2006) *Biochemistry*. 6th Ed. W.H. Freeman and Co.
- Nelson, D.L., Cox, M.M. & Lehninger, A.L. (2009) *Principles of Biochemistry. IV Edition.* W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. (2009) *Harper's Illustrated Biochemistry*. XXVIII edition. Lange Medical Books/ McGraw-Hill.

PRACTICAL: Mark 25 / Credit- 2

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion/ cauliflower/peas.

Reference Books:

- Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
- Arthur, I. V. *Quantitative Organic Analysis,* Pearson.

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CORE-12: PHYSICAL CHEMISTRY V

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: (a) Quantum Chemistry
Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy. Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.
(b) Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.
MODULE-2: Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H2+. Bonding and antibonding orbitals. Qualitative extension to H2.; Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH2, H2O) molecules. Qualitative MO theory and its application to AH2 type molecules. **(14 Lectures)**
MODULE-3: (a) Molecular Spectroscopy:
Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.; Rotation spectroscopy: Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.; Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration, concept of group frequencies. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.
(b) Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.
MODULE-4: Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triple states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of polyenes using free electron model.
Nuclear Magnetic Resonance (NMR) spectroscopy: Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales, spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules. Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.
(14 Lectures)
MODULE-5: Photochemistry
Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical Significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence. **(12 Lectures)**

Reference Books:

- Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006).
- Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
- House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).
- Kakkar, R. *Atomic & Molecular Spectroscopy*: *Concepts & Applications*, Cambridge University Press (2015).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).

PRACTICAL: Mark 25 / Credit- 2

UV/Visible spectroscopy

I. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λmax values. Calculate the energies of the two transitions in different units (J molecule-1, kJ mol-1, cMODULE-1, eV).
II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

Colourimetry

I. Verify Lambert-Beer's law and determine the concentration of $CuSO_4$/$KMnO_4$/$K_2Cr_2O_7$ in a solution of unknown concentration
II. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
III. Study the kinetics of iodination of propanone in acidic medium.
IV. Determine the amount of iron present in a sample using 1,10-phenathroline.
V. Determine the dissociation constant of an indicator (phenolphthalein).
VI. Study the kinetics of interaction of crystal violet/ phenolphthalein with sodium hydroxide.
VII. Analysis of the given vibration-rotation spectrum of HCl(g)

Reference Books

- Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R.Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.;* McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.;* W.H.Freeman & Co.: New York (2003).

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SEMESTER-VI

CORE-13: INORGANIC CHEMISTRY-IV

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Theoretical Principles in Qualitative Analysis (H2S Scheme)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II. **(10 Lectures)**

MODULE-2: Organometallic Compounds

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

MODULE-3: Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present inether solution of Grignard reagent and their structures, Schlenk equilibrium. Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene. **(14 Lectures)**

MODULE-4: Reaction Kinetics and Mechanism: Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes,

Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes. **(18 Lectures)**

MODULE-5: Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes **(10 Lectures)**

Reference Books:

- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, 1996.
- Cotton, F.A.G.; Wilkinson & Gaus, P.L. *Basic Inorganic Chemistry 3rd Ed.;* Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed.,* Harper Collins 1993, Pearson,2006.
- Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry3rd Ed.,* John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements*, *Elsevier 2nd Ed*, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. *Concise Inorganic Chemistry 5th Ed.,* John Wiley and sons 2008.
- Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
- Shriver, D.D. & P. Atkins, *Inorganic Chemistry 2nd Ed.,* Oxford University Press, 1994.
- Basolo, F. & Pearson, R. *Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed.,* John Wiley & Sons Inc; NY.
- Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
- Miessler, G. L. & Tarr, D.A. *Inorganic Chemistry 4th Ed.,* Pearson, 2010.
- Collman, J. P. *et al. Principles and Applications of Organotransition Metal Chemistry*. Mill Valley, CA: University Science Books, 1987.
- Crabtree, R. H. *The Organometallic Chemistry of the Transition Metals. j* New York, NY: John Wiley, 2000.
- Spessard, G. O. & Miessler, G.L. *Organometallic Chemistry*. Upper Saddle River, NJ: Prentice-Hall, 1996.

PRACTICAL: Mark 25 / Credit- 2

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-},$S_2O_3^{2-}$, CH_3COO^-, F^-,Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+},, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+},Sr^{2+}, Ca^{2+}, Mg^{2+}

Mixtures should preferably contain one interfering anion, **or** insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) **or** combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, $Br^-$and I^-, NO_3^- and Br^-, NO_3^- and I^-. Spot tests should be done whenever possible.

i. Measurement of 10 Dq by spectrophotometric method

ii. Verification of spectrochemical series.

iii. Controlled synthesis of two copper oxalate hydrate complexes: kinetic vs thermodynamic factors.

iv. Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}. Find the λ_{max} of the complex.

v. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetone, DMG, glycine) by substitution method.

Reference Books

- Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education, 2002.
- Marr & Rockett *Practical Inorganic Chemistry*. John Wiley & Sons 1972.

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CORE-14: ORGANIC CHEMISTRY-V

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: (a) Organic Spectroscopy
General principles Introduction to absorption and emission spectroscopy.
UV Spectroscopy*:* Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.
(b) IR Spectroscopy*:* Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.
MODULE-2: ***(a)NMR Spectroscopy****:* Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds.
(b) Applications of IR, UV and NMR for identification of simple organic molecules. **(24 Lectures)**
MODULE-3: Carbohydrates
Occurrence, classification and their biological importance.
Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation; Disaccharides – Structure elucidation of maltose, lactose and sucrose. Polysaccharides – Elementary treatment of starch, cellulose and glycogen. **(16 Lectures)**
MODULE-4: Dyes : Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes – Methyl Orange and Congo Red (mechanism of Diazo Coupling); Triphenyl Methane Dyes -Malachite Green, Rosaniline and Crystal Violet; Phthalein Dyes – Phenolphthalein and Fluorescein; Natural dyes –structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples. **(8 Lectures)**
MODULE-5: Polymers : Introduction and classification including di-block, tri-block and amphiphilic polymers; Number average molecular weight, Weight average molecular weight, Degree of polymerization, Polydispersity Index. Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics – thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Fabrics – natural and synthetic (acrylic, polyamido, polyester); Rubbers – natural and synthetic: Buna-S, Chloroprene and Neoprene; Vulcanization; Polymer additives; Introduction to liquid crystal polymers; Biodegradable and conducting polymers with examples.
(12 Lectures)

Reference Books:

- Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed*., New Age International (P)Ltd. Pub.
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.
- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.
- Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. *Organic Chemistry,* John Wiley & Sons, Inc.
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry,* Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Prakashan (2010).
- Kemp, W. *Organic Spectroscopy*, Palgrave.
- Pavia, D. L. *et al. Introduction to Spectroscopy* 5th Ed. Cengage Learning IndiaEd. (2015).

PRACTICAL: Mark 25 / Credit- 2

1. Extraction of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, aryl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols, etc.
6. Identification of simple organic compounds by IR spectroscopy and NMR spectroscopy (Spectra to be provided).
7. Preparation of methyl orange.

Reference Books:

- Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson (2012).
- Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical Organic Chemistry, 5th Ed.,* Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis,* University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: Qualitative Analysis,* University Press (2000).

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DISCIPLINE SPECIFIC ELECTIVE (DSE)

CHEMISTRY

SEMESTER-V

DSE-1: GREEN CHEMISTRY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Introduction to Green Chemistry
What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.
Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.
Principles of Green Chemistry and Designing a Chemical synthesis
Twelve principles of Green Chemistry with their explanations and examples and Special emphasis on the following: Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products; Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions.
MODULE-2:
Prevention/ minimization of hazardous/ toxic products reducing toxicity.
risk = (function) hazard × exposure; waste or pollution prevention hierarchy,
Green solvents– supercritical fluids, water as a solvent for organic reactions,
Ionic liquids, fluorous biphasic solvent, PEG, solventless processes, immobilized
Solvents and how to compare greenness of solvents.
Energy requirements for reactions – alternative sources of energy: use of
Microwaves and ultrasonic energy.
Selection of starting materials; avoidance of unnecessary derivatization – careful use of blocking/protecting groups.
MODULE-3:
Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; catalysis and green chemistry, comparison of heterogeneous and homogeneous catalysis, biocatalysis, asymmetric catalysis and photocatalysis.
Prevention of chemical accidents designing greener processes, inherent safer design, principle of ISD "What you don't have cannot harm you", greener alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol) subdivision of ISD, minimization, simplification, substitution, moderation and limitation.
Strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.
MODULE-4:
(a) Examples of Green Synthesis/ Reactions and some real world cases
Green Synthesis of the following compounds: adipic acid, catechol, disodium iminodiacetate (alternative to Strecker synthesis)
Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents Diels-Alder reaction and Decarboxylation reaction
Ultrasound assisted reactions: sonochemical Simmons-Smith Reaction (Ultrasonic alternative to Iodine)
Surfactants for carbon dioxide – replacing smog producing and ozone depleting solvents with CO2 for precision cleaning and dry cleaning of garments.
(b) Designing of Environmentally safe marine antifoulant.
Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments.
An efficient, green synthesis of a compostable and widely applicable plastic (polylactic acid) made from corn.
Healthier Fats and oil by Green Chemistry: Enzymatic Inter esterification for production of no Trans-Fats and Oils
Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

MODULE-5: Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; co crystal controlled solid state synthesis (C2S3); Green chemistry in sustainable development.

Reference Books:

- Ahluwalia, V.K. & Kidwai, M.R. *New Trends in Green Chemistry*, Anamalaya Publishers (2005).
- Anastas, P.T. & Warner, J.K.: *Green Chemistry - Theory and Practical*, Oxford University Press (1998).
- Matlack, A.S. *Introduction to Green Chemistry*, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. *Real-World cases in Green Chemistry*, American Chemical Society, Washington (2000).
- Ryan, M.A. & Tinnesand, M. *Introduction to Green Chemistry*, American Chemical Society, Washington (2002).
- Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.

PRACTICAL: Mark 25 / Credit- 2

1. Safer starting materials

Preparation and characterization of nanoparticles of gold using tea leaves.

2. Using renewable resources: Preparation of biodiesel from vegetable/ waste cooking oil.

3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

(I) Triethylamine ion + OH- → propene + trimethylpropene + water

(II) 1-propanol

H2SO4/

propene + water

Other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

4. Use of enzymes as catalysts

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide.

5. Alternative Green solvents

Extraction of D-limonene from orange peel using liquid CO2 prepared form dry ice.

Mechanochemical solvent free synthesis of azomethines

6. Alternative sources of energy

Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

Reference Books:

- Anastas, P.T & Warner, J.C. *Green Chemistry: Theory and Practice,* Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistry experiment*. American Chemical Society, Washington DC (2002).
- Ryan, M.A. *Introduction to Green Chemistry*, Tinnesand; (Ed), American Chemical Society, Washington DC (2002).
- Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi*. Bangalore CISBN 978-93-81141-55-7 (2013).
- Cann, M.C. & Connelly, M. E. *Real world cases in Green Chemistry*, American Chemical Society (2008).
- Cann, M. C. & Thomas, P. *Real world cases in Green Chemistry,* American Chemical Society (2008).
- Lancaster, M. *Green Chemistry: An Introductory Text* RSC Publishing, 2nd Edition, 2010.
- Pavia, D.L., Lampman, G.M., Kriz, G.S. & Engel, R.G. *Introduction to Organic Laboratory Techniques: A Microscale and Macro Scale Approach,* W.B.Saunders, 1995.

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DSE 2: POLYMER CHEMISTRY

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: Introduction and history of polymeric materials:
Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.
Functionality and its importance**:** Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.
MODULE-2: Kinetics of Polymerization:
Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques .
Crystallization and crystallinity**:** Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point. (12 lecturer)
MODULE-3: Nature and structure of polymers : Structure Property relationships. Determination of molecular weight of polymers (*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index. **(10 Lectures)**
MODULE-4: (a) Glass transition temperature (Tg) and determination of Tg, Free volume theory, WLF equation, Factors affecting glass transition temperature (Tg).
(b) Polymer Solution – Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures. **(16 Lectures)**
MODULE-5: Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).
Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly (p-phenylene sulphide polypyrrole, polythiophene)]. **(10 Lectures)**

Reference Books:

- R.B. Seymour & C.E. Carraher: *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
- G. Odian: *Principles of Polymerization*, 4th Ed. Wiley, 2004.
- F.W. Billmeyer: *Textbook of Polymer Science*, 2nd Ed. Wiley Interscience, 1971.
- P. Ghosh: Polymer Science & Technology, Tata McGraw-Hill Education, 1991.
- R.W. Lenz: *Organic Chemistry of Synthetic High Polymers.* Interscience Publishers, New York, 1967.

PRACTICAL: Mark 25 / Credit- 2

1. **Polymer synthesis:** Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).: a. Purification of monomer, b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)
2. Preparation of nylon 66/6 : Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein: a. Preparation of IPC, b. Purification of IPC

c. Interfacial polymerization

3. Redox polymerization of acrylamide
4. Precipitation polymerization of acrylonitrile
5. Preparation of urea-formaldehyde resin
6. Preparations of novalac resin/ resold resin.
7. Microscale Emulsion Polymerization of Poly(methylacrylate).

Polymer characterization

1. Determination of molecular weight by viscometry: (a) Polyacrylamide-aq.NaNO2 solution, (b) (Poly vinyl proplylidine (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol): (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.

3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

Polymer analysis

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis *at least 7 experiments to be carried out.

Reference Books:

- M.P. Stevens, *Polymer Chemistry: An Introduction*, 3rd Ed., Oxford University Press, 1999.
- H.R. Allcock, F.W. Lampe & J.E. Mark, *Contemporary Polymer Chemistry*, 3rd ed. Prentice-Hall (2003)
- F.W. Billmeyer, *Textbook of Polymer Science*, 3rd ed. Wiley-Interscience (1984)
- J.R. Fried, *Polymer Science and Technology*, 2nd ed. Prentice-Hall (2003)
- P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley & Sons (2002)
- L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)
- M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
- Seymour*l* Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).

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SEMESTER-VI

DSE-3 : INDUSTRIAL CHEMICALS AND ENVIRONMENT

(CREDITS: 6, Theory=4 + Practical=2)
(Total Marks: 100, Mid Sem=15, Practical=25, Term End=60: Duration: 3 hrs.)

MODULE-1: (a)Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

(b) Inorganic Chemicals: Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate. **(10 Lectures)**

MODULE-2: Environment and its segments

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.

Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx and control procedures. Effects of air pollution on living organisms and vegetation. Greenhouse effect and Global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and Halogens, removal of sulphur from coal. Control of particulates.

MODULE-3: (a) *Water Pollution*: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal.

(b) Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water. **(15 Lectures)**

MODULE-4: Energy & Environment

(a) Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

(b) Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management. **(10 Lectures)**

MODULE-5: Biocatalysis

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology. **(10 Lectures)**

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
- S.E. Manahan, *Environmental Chemistry*, CRC Press (2005).
- G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

PRACTICAL: Mark 25 / Credit- 2

1. Determination of dissolved oxygen in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.
5. Measurement of chloride, sulphate and salinity of water samples by simple titration method (AgNO3 and potassium chromate).
6. Estimation of total alkalinity of water samples (CO32-, HCO3-) using double titration method.
7. Measurement of dissolved CO2.
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.

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SEMESTER-VI

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

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