FYUGP

CHEMISTRY HONOURS/ RESEARCH

FOR UNDER GRADUATE COURSES UNDER RANCHI UNIVERSITY

Implemented from
Academic Session 2022-2026

UNIVERSITY DEPARTMENT OF CHEMISTRY

Ranchi University, Ranchi-834008 (Jharkhand)

e-mail: chemistry@ranchiuniversity.ac.in, pgchemistryru2@gmail.com

Ref No. : ..... Date : .....

Members of Board of Studies for preparing Provisional Syllabus of the Four-Year Undergraduate Programme (FYUGP)

1. **Chairman –**

   Dr. A.K. Delta
   Associate Professor & Head,
   University Department of Chemistry, Ranchi University, Ranchi

2. **Internal Members-**

   i. **Dr. Hari Om Pandey**
   Associate Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   ii. **Dr. Smriti Singh**
   Assistant Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   iii. **Dr. Neeraj**
   Assistant Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   iv. **Dr. Guru Charan Sahu**
   Assistant Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   v. **Dr. Namrata Sinha**
   Assistant Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   vi. **Dr. Shilpi Singh**
   Assistant Professor,
   Department of Chemistry, Doranda College, R.U., Ranchi

   vii. **Dr. Anil Kumar Pandey**
   Assistant Professor,
   Department of Chemistry, J.N. College, Dhurwa, R.U., Ranchi

   viii. **Dr. S.K. Sengupta**
   Assistant Professor,
   Department of Chemistry, Gossner College, R.U., Ranchi

3. **External Member-**

   i. **Dr. Khurshid Akhtar**
   Associate Professor (SG),
   Department of Chemistry, D.S.P.M.U., Ranchi

DIRECTOR
IQAC, RANCHI UNIVERSITY,
RANCHI-834 001

Dr. A.K. Delta
H.O.D. Chemistry
CHAIRMAN
HEAD
Department of Chemistry
Ranchi University, Ranchi

Contents

S.No.		Page No.
	Members of Core Committee	i
	Contents	ii – iii
	COURSE STUCTURE FOR UNDERGRADUATE 'HONOURS' PROGRAMME	
1	Highlights of Regulations of FYUGP	1
2	Course Structure for FYUGP 'Honours/ Research (176 Credits)	3
3	Courses of Study for Four Year Undergraduate Programme	4
4	Semester Wise Courses of Study for Four Year Undergraduate Programme	5
5	Semester wise Examination Structure for SIE & ESUE	7
6	Introductory & Minor Courses	8
7	Aims of Bachelor's Degree Programme in Anthropology	9
8	Program Learning Outcomes	10
	SEMESTER I	
9	Major Course –MJ 1	11
10	MJ 1 LAB	13
	SEMESTER II	
11	Major Course- MJ 2	14
12	MJ 2 LAB	16
	SEMESTER III	
13	Major Course- MJ 3	17
14	MJ 3 LAB	19
	SEMESTER IV	
15	Major Course- MJ 4	20
16	MJ 4 LAB	22
17	Major Course- MJ 5	23
18	MJ 5 LAB	25
	SEMESTER V	
19	Major Course –MJ 6	26
20	MJ 6 LAB	28
21	Major Course- MJ 7	29
22	MJ 7 LAB	31
	SEMESTER VI	
23	Major Course- MJ 8	32
24	MJ 8 LAB	34

25	Major Course- MJ 9	35
26	MJ 9 LAB	37
	SEMESTER VII	
27	Advance Major Course –AMJ 1	38
28	AMJ 1 LAB	40
29	Advance Major Course- AMJ 2	41
30	AMJ 2 LAB	43
	SEMESTER VIII	
31	Advance Major Course- AMJ 3	44
32	AMJ 3 LAB	46
33	Advance Major Course- AMJ 4	47
34	AMJ 4 LAB	49
	INTRODUCTORY/ MINOR ELECTIVES	
35	Introductory Regular Course- IRC	50
36	IRC LAB	53
37	Minor Course- MN 1	54
38	MN 1 LAB	56
39	Minor Course- MN 2	57
40	MN 2 LAB	59
41	Minor Course- MN 3	60
42	MN 3 LAB	62
	FORMAT OF QUESTION PAPERS	
43	Format of Question Paper for Mid Sem Examination of 10 Marks	63
44	Format of Question Paper for Mid Sem Examination of 20 Marks	63
45	Format of Question Paper for End Sem Examination of 50 Marks	64
46	Format of Question Paper for End Sem Examination of 60 Marks	64
47	Format of Question Paper for End Sem Examination of 75 Marks	65
48	Format of Question Paper for End Sem Examination of 100 Marks	65

HIGHLIGHTS OF REGULATIONS OF FYUGP

PROGRAMME DURATION

- The Full-time, Regular UG programme for a regular student shall be for a period of four years with multiple entry and multiple exit options.
- The session shall commence from **1st of July**.

ELIGIBILITY

- The selection for admission will be primarily based on availability of seats in the Major subject and marks imposed by the institution. Merit point for selection will be based on marks obtained in Major subject at Class 12 (or equivalent level) or the aggregate marks of Class 12 (or equivalent level) if Marks of the Major subject is not available. Reservation norms of The Government of Jharkhand must be followed as amended in times.

ADMISSION PROCEDURE

- The reservation policy of the Government of Jharkhand shall apply in admission and the benefit of the same shall be given to the candidates belonging to the State of Jharkhand only. The candidates of other states in the reserved category shall be treated as General category candidates. Other relaxations or reservations shall be applicable as per the prevailing guidelines of the University for FYUGP.

ACADEMIC CALENDAR

- Each year the University shall draw out a calendar of academic and associated activities, which shall be strictly adhered to. The same is non-negotiable. Further, the Department will make all reasonable endeavors to deliver the programmes of study and other educational services as mentioned in its Information Brochure and website. However, circumstances may change prompting the Department to reserve the right to change the content and delivery of courses, discontinue or combine courses and introduce or withdraw areas of specialization.

PROGRAMME OVERVIEW/ SCHEME OF THE PROGRAMME

- Undergraduate degree programmes of either 3 or 4-year duration, with multiple entries and exit points and re-entry options within this period, with appropriate certifications such as:
  - a Certificate after completing 1 year (2 semesters) of study in the chosen fields of study,
  - a Diploma after 2 years (4 semesters) of study,
  - a Bachelor after a 3-year (6 semesters) programme of study,
  - a Bachelor (with Hons. / Research) after a 4-year (8 semesters) programme of study

VALIDITY OF REGISTRATION

- Validity of a registration for FYUGP will be for maximum for Seven years from the date of registration.

CALCULATION OF MARKS FOR THE PURPOSE OF RESULT

- Student's final marks and the result will be based on the marks obtained in Semester Internal Examination and End Semester Examination organized taken together.
- Passing in a subject will depend on the collective marks obtained in Semester internal and End Semester University Examination both. However, students must pass in Theory and Practical Examinations separately.

PROMOTION AND SPAN PERIOD

i. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.
ii. No student will be detained in odd Semesters (I, III, V & VII).
iii. To get promotion from Semester-II to Semester-III a student will be required to pass in at least 75% of Courses in an academic year (a student has to pass in minimum 9 papers out of the total 12 papers. However, it will be necessary to procure pass marks in each of the paper before completion of the course.
iv. To get promotion from Semester-IV to Semester-V (taken together of Semester I, II, III & IV) a student has to pass in minimum 16 papers out of the total 22 papers.
v. Eligibility to get entry in Semester VII is to secure a minimum of 7.5 CGPA up to semester VI along with other criteria imposed by the Institution.

PUBLICATION OF RESULT

- The result if the examination shall be notified by the Controller of Examinations of the University in different newspapers and also on University website.

- If a student is found indulged in any kind of malpractice/ unfair means during examination, the examination taken by the student for the semester will be cancelled. The candidate has to reappear in all the papers of the session with the students of next coming session and his one year will be detained. However, marks secured by the candidate in all previous semesters will remain unaffected.

- There shall be no Supplementary or Re-examination for any subject. Students who have failed in any subject in an even semester may appear in the subsequent even semester examination for clearing the backlog. Similarly, the students who have failed in any subject in an odd semester may appear in the subsequent odd semester examination for clearing the backlog.

Regulation related with any concern not mentioned above shall be guided by the Regulations of the University for FYUGP.

---*---

COURSE STUCTURE FOR FYUGP **'HONOURS/ RESEARCH'**

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jhark

	Common Courses (29)									**Introductory Courses (15)**				**Minor** (32)**	
Semester	Language and Communication Skills (Modern Indian Language including TRL) (6)	Language and Communication Skills (English) (6)	Environmental Studies (3)	Understanding India (2)	Health & Wellness, Yoga Education, Sports & Fitness (2)	Digital Education (3)	Mathematical & Computational Thinking and Analysis (2)	Value-Based Course/ Global Citizenship Education (2)	Community Engagement/ NCC/ NSS/ (3)	Introductory Courses [Natural Sc./ Humanities/ Social Sc./Commerce] (9)	Introductory Course [Vocational Studies] (6)	**Internship/ Project (4)**	**Major* (54) + Adv. Major (24)**	Natural Sc./ Humanities/ Social Sc./ Commerce (18)	Vocational Studies (14)
1	2	3	4	5	6	7	8			9	10	11	14	15	16
I	6			2	2					3	3		6		
II		6					2	2		3	3		6		
Exit Point: Undergraduate Certificate															
III			3			3			3	3		4	6		
IV													6+6	6	4
Exit Point: Undergraduate Diploma															
V													6+6	6	4
VI													6+6	6	4
Exit Point: Bachelor's Degree															
VII													6+6 (Adv. Topics)		
VIII													6+6 (Adv. Topics)		2
Exit Point: Bachelor's Degree with Hons. /Research															

*There will be four disciplinary areas: A-Natural Science, B-Humanities, C-Social Science, and D-Commerce, each having basket of co from any of the four disciplinary areas (out of A, B, C & D). The selection for admission will be primarily based on availability of seats institution.

**A student has to select three subjects for 'Introductory Regular Courses' from a pool of subjects associated with the Major offered by continue as 'Minor' from semester IV onwards, based on the academic interest and performance of the student.

Session 2022-26 onwards

COURSES OF STUDY FOR FOUR YEAR UNDERGRADUATE PROGRAMME

Table 2: Course structure for Undergraduate Certificate Programme *[May Exit after Sem.-II]*

Semester	Common Courses			Introductory Courses		Major	Total Credits
Sem.-I	LCS (MIL/TRL) (6 Credits)	Understanding India (2 Credits)	Health & Wellness, Yoga Education, Sports & Fitness (2 Credits)	IRC-1 (3 Credits)	IVS-1A (3 Credits)	MJ-1 (6 Credits)	**(22)**
Sem.-II	LCS (English) (6 Credits)	Global Citizenship Education (2 Credits)	Mathematical & Computational Thinking (2 Credits)	IRC-2 (3 Credits)	IVS-1B (3 Credits)	MJ-2 (6 Credits)	**(22)**

Total = 44 Credits

(LCS: Language and Communication Skills, MIL: Modern Indian Languages, TRL: Tribal Regional Languages, IRC: Introductory Regular Courses, IVS: Introductory Vocational Studies, MJ: Major)

Table 3: Course structure for Undergraduate Diploma Programme *[May Exit after Sem.-IV]*

Semester	Common Courses			Introductory Courses	Major	Minor	Internship/ Project	Vocational	Total Credits
Sem.-III	Environmental Studies (3 Credits)	Community Engagement/ NCC/ NSS (3 Credits)	Digital Education (3 Credits)	IRC-3 (3 Credits)	MJ-3 (6 Credits)		Internship/ Project (4 Credits)		**(22)**
Sem.-IV					MJ-4, MJ-5 (6+6=12 Credits)	MN-1 (6 Credits)		VS-1 (4 Credits)	**(22)**

Total = 88 Credits

(MN: Minor, VS: Vocational Studies)

Table 4: Course structure for Bachelor's Degree Programme *[May Exit after Sem.-VI]*

Semester	Major Courses	Minor Courses	Vocational	Total Credits
Sem.-V	MJ-6, MJ-7 (6+6 = 12 Credits)	MN-2 (6 Credits)	VS-2 (4 Credits)	**(22)**
Sem.-VI	MJ-8, MJ-9 (6+6= 12 Credits)	MN-3 (6 Credits)	VS-3 (4 Credits)	**(22)**

Total = 132 Credits

Table 5: Course structure for Bachelor's Degree with Hons./Research Programme

Semester	Advance Courses	Research Courses		Vocational	Total Credit
Sem.-VII	AMJ-1, AMJ-2	Research Methodology (6+6=12 Credits)	Research Proposal (6 Credits)	(4 Credits)	**(22)**
Sem.-VIII	AMJ-3, AMJ-4 (6+6=12 Credits)	Research Int./Field Work (4 Credits)	Research Report (4 Credits)	VSR (2 Credits)	**(22)**

Total = 176 Credits

(AMJ: Advance Major, VSR: Vocational Studies associated with Research)

Table 6: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		
	Code	Papers	Credits
I	CC-1	Language and Communication Skills (Modern Indian language including TRL)	6
	CC-2	Understanding India	2
	CC-3	Health & Wellness, Yoga Education, Sports & Fitness	2
	IRC-1	Introductory Regular Course-1	3
	IVS-1A	Introductory Vocational Studies-1	3
	MJ-1	Major paper 1 (Disciplinary/Interdisciplinary Major)	6
II	CC-4	Language and Communication Skills (English)	6
	CC-5	Mathematical & Computation Thinking Analysis	2
	CC-6	Global Citizenship Education & Education for Sustainable Development	2
	IRC-2	Introductory Regular Course-2	3
	IVS-1B	Introductory Vocational Studies-2	3
	MJ-2	Major paper 2 (Disciplinary/Interdisciplinary Major)	6
III	CC-7	Environmental Studies	3
	CC-8	Digital Education (Elementary Computer Applications)	3
	CC-9	Community Engagement & Service (NSS/ NCC/ Adult Education)	3
	IRC-3	Introductory Regular Course-3	3
	IAP	Internship/Apprenticeship/ Project	4
	MJ-3	Major paper 3 (Disciplinary/Interdisciplinary Major)	6
IV	MJ-4	Major paper 4 (Disciplinary/Interdisciplinary Major)	6
	MJ-5	Major paper 5 (Disciplinary/Interdisciplinary Major)	6
	MN-1	Minor Paper 1 (Disciplinary/Interdisciplinary Minor)	6

	VS-1	Vocational Studies-1 (Minor)	4
V	MJ-6	Major paper 6 (Disciplinary/Interdisciplinary Major)	6
	MJ-7	Major paper 7 (Disciplinary/Interdisciplinary Major)	6
	MN-2	Minor Paper 2 (Disciplinary/Interdisciplinary Minor)	6
	VS-2	Vocational Studies 2 (Minor)	4
VI	MJ-8	Major paper 8 (Disciplinary/Interdisciplinary Major)	6
	MJ-9	Major paper 9 (Disciplinary/Interdisciplinary Major)	6
	MN-3	Minor Paper 3 (Disciplinary/Interdisciplinary Minor)	6
	VS-3	Vocational Studies 3 (Minor)	4
VII	AMJ-1	Advance Major paper 1 (Disciplinary/Interdisciplinary Major)	6
	AMJ-2	Advance Major paper 2 (Disciplinary/Interdisciplinary Major)	6
	RC-1	Research Methodology	6
	RC-2	Research Proposal	4
VIII	AMJ-3	Advance Major paper 3 (Disciplinary/Interdisciplinary Major)	6
	AMJ-4	Advance Major paper 4 (Disciplinary/Interdisciplinary Major)	6
	RC-3	Research Internship/Field Work	4
	RC-4	Research Report	4
	VSR	Vocational Studies (Associated with Research)	2
		Total Credit	**176**

Abbreviations:

CC Common Courses
IRC Introductory Regular Courses
IVS Introductory Vocational Studies
IAP Internship/Apprenticeship/ Project
VS Vocational Studies
MJ Major Disciplinary/Interdisciplinary Courses
MN Minor Disciplinary/Interdisciplinary Courses
AMJ Advance Major Disciplinary/Interdisciplinary Courses
RC Research Courses
VSR Vocational Studies associated with Research

Table 7: Semester wise Examination Structure in Discipline Courses:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I	MJ-1	Inorganic Chemistry - I	6	15	60	25
II	MJ-2	Organic Chemistry - I	6	15	60	25
III	MJ-3	Physical Chemistry - I	6	15	60	25
IV	MJ-4	Organic Chemistry - II	6	15	60	25
	MJ-5	Physical Chemistry - II	6	15	60	25
V	MJ-6	Inorganic Chemistry - II	6	15	60	25
	MJ-7	Molecular Spectroscopy & Photochemistry	6	15	60	25
VI	MJ-8	Organic Chemistry – III	6	15	60	25
	MJ-9	Physical Chemistry - III	6	15	60	25
VII	AMJ-1	Electro Chemistry, Nanochem.& applications	6	15	60	25
	AMJ-2	Polymer Chemistry & Materials Chemistry	6	15	60	25
	RC-1	Research Methodology	6	25	75	---
	RC-2	Research Proposal	4	25	75	---
VIII	AMJ-3	Advanced Analytical Chemistry	6	15	60	25
	AMJ-4	Organometallic and Bioinorganic Chemistry	6	15	60	25
	RC-3	Research Internship/Field Work	4	---	---	100
	RC-4	Research Report	4	---	---	100
	VSR	Vocational Studies (Associated with Research)	2	---	---	100
		Total Credit	**98**			

Table 8: Semester wise Course Code and Credit Points:

Semester	Common, Introductory, Major, Minor, Vocational & Internship Courses		Examination Structure			
	Code	Papers	Credits	Mid Semester Theory (F.M.)	End Semester Theory (F.M.)	End Semester Practical/ Viva (F.M.)
I/ II/ III	IRC	Introductory Chemistry	3	---	75	25
IV	MN-1	Chemistry in everyday life	6	15	60	25
V	MN-2	Environmental Chemistry	6	15	60	25
VI	MN-3	Chemistry of food, nutrition and preservation	6	15	60	25
		Total Credit	**21**			

AIMS OF BACHELOR'S DEGREE PROGRAMME IN CHEMISTRY

The broad aims of bachelor's degree programme in Chemistry are:

The aim of bachelor's degree programme in chemistry is intended to provide:

(i) Broad and balance knowledge in chemistry in addition to understanding of key chemical concepts, principles, and theories.

(ii) To develop students' ability and skill to acquire expertise over solving both theoretical and applied chemistry problems.

(iii) To provide knowledge and skill to the students' thus enabling them to undertake further studies in chemistry in related areas or multidisciplinary areas that can be helpful for self-employment/entrepreneurship.

(iv) To provide an environment that ensures cognitive development of students in a holistic manner. A complete dialogue about chemistry, chemical equations and its significance is fostered in this framework, rather than mere theoretical aspects

(v) To provide the latest subject matter, both theoretical as well as practical, such a way to foster their core competency and discovery learning. A chemistry graduate as envisioned in this framework would be sufficiently competent in the field to undertake further discipline-specific studies, as well as to begin domain-related employment.

(vi) To mold a responsible citizen who is aware of most basic domain-independent knowledge, including critical thinking and communication.

(vii) To enable the graduate, prepare for national as well as international competitive examinations, especially UGC-CSIR NET and UPSC Civil Services Examination.

PROGRAM LEARNING OUTCOMES

The broad aims of bachelor's degree programme in Chemistry are:

The student graduating with the Degree B.Sc. (Honours/Research) in Chemistry should be able to understand:

(i) **Core competency:** Students will acquire core competency in the subject Chemistry, and in allied subject areas.

(ii) Systematic and coherent understanding of the fundamental concepts in Physical chemistry, Organic Chemistry, Inorganic Chemistry, Analytical Chemistry, and all other related allied chemistry subjects.

(iii) Students will be able to understand use the evidence based comparative chemistry approach to explain the chemical synthesis and analysis.

(iv) The students will be able to understand understand the characterization of materials.

(v) Students will be able to understand understand the basic principle of equipment, instruments used in the chemistry laboratory.

(vi) Students will be able to understand demonstrate the experimental techniques and methods of their area of specialization in Chemistry.

(vii) **Disciplinary knowledge and skill:** A graduate student are expected to be capable of demonstrating comprehensive knowledge and understanding of both theoretical and experimental/applied chemistry knowledge in various fields of interest like Analytical Chemistry, Physical Chemistry, Inorganic Chemistry, Organic Chemistry, Material Chemistry, etc. Further, the student will be capable of using of advanced instruments and related soft-wares for in-depth characterization of materials/chemical analysis and separation technology.

(viii) **Skilled communicator:** The course curriculum incorporates basics and advanced training in order to make a graduate student capable of expressing the subject through technical writing as well as through oral presentation.

(ix) **Critical thinker and problem solver:** The course curriculum also includes components that can be helpful to graduate students to develop critical thinking ability by way of solving problems/numerical using basic chemistry knowledge and concepts.

(x) Sense of inquiry: It is expected that the course curriculum will develop an inquisitive characteristic among the students through appropriate questions, planning and reporting experimental investigation.

(xi) **Team player:** The course curriculum has been designed to provide opportunity to act as team player by contributing in laboratory, field-based situation and industry.

(xii) **Skilled project manager:** The course curriculum has been designed in such a manner as to enabling a graduate student to become a skilled project manager by acquiring knowledge about chemistry project management, writing, planning, study of ethical standards and rules and regulations pertaining to scientific project operation.

(xiii) **Digitally literate:** The course curriculum has been so designed to impart a good working knowledge in understanding and carrying out data analysis, use of library search tools, and use of chemical simulation software and related computational work.

(xiv) **Ethical awareness/reasoning:** A graduate student requires to understand and develop ethical awareness/reasoning which the course curriculum adequately provide.

(xv) **Lifelong learner:** The course curriculum is designed to inculcate a habit of learning continuously through use of advanced ICT technique and other available techniques/books/journals for personal academic growth as well as for increasing employability opportunity.

SEMESTER I

I. MAJOR COURSE –MJ 1: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

INORGANIC CHEMISTRY-I Theory: 60 Lectures

Course Objectives:
On completion of this course, the students will be able to understand understand

1. Atomic theory and its evolution.
2. Learning scientific theory of atoms, concept of wave function.
3. Elements in periodic table, physical and chemical characteristics, periodicity.
4. To predict the atomic structure, chemical bonding, and molecular geometry based on accepted models.
5. To understand atomic theory of matter, composition of atom.
6. Defining isotopes, isobar and isotone.
7. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
8. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.
9. Oxidation-Reductions and their use in metallurgy.
10. Inorganic polymers

Course Learning Outcomes:
On successful completion of this course the student should know:

1. Electronic configuration of various elements in periodic table
2. Predicting structure of molecules
3. How hydrogen bonding, metallic bonding is important in common materials' scientific applications to material fabrication

Course Content:

Atomic Structure: (10 classes each of 60 minutes duration)
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.

Periodicity of Elements: (10 classes each of 60 minutes duration)

s, *p*, *d*, *f* block elements, the long form of periodic table. Detailed discussion of the following properties of the elements.

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, Mullikan, Allred Rachow scales, electronegativity and bond order, partial charge, hybridization, group electronegativity.

Chemical Bonding:

(i) *Ionic bond:* **(5 classes each of 60 minutes duration)**

General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation with derivation, expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy.

(ii) *Covalent bond:* **(12 classes each of 60 minutes duration)**

Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions containing lone and bond pairs of electrons multiple bonding, sigma and pi-bond approach, Valence Bond theory, (Heitler-London approach). Hybridization containing s, p and s, p, d atomic orbitals, shapes of hybrid orbitals, Bents rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of simple homonuclear and heteronuclear diatomic molecules: N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions. Covalent character in ionic compounds, polarizing power and polarizability. Fajan rules, polarization. Ionic character in covalent compounds: Bond moment and dipole moment. ionic character from dipole moment and electronegativities.

(iii) *Metallic Bond:* **(6 classes each of 60 minutes duration)**

Qualitative idea of free electron model, Semiconductors, Insulators.

(iv) *Weak Chemical Forces:* **(2 classes each of 60 minutes duration)**

Van'der Waals, ion-dipole, dipole-dipole, induced dipole dipole- induced dipole interactions, hydrogen bond, effects of hydrogen bonding on melting and boiling points, solubility, dissolution.

Oxidation-Reduction and general principle of metallurgy: (7 classes each of 60 minutes duration)

Redox equations, Standard Electrode Potential and its application to inorganic reactions. Occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon or 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.

Inorganic Polymers: (8 classes each of 60 minutes duration)

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

Reference Books:

1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5th Edn.
2. Douglas, B.E., McDaniel, D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry,(Third Edition)* John Wiley & Sons,1999.
3. Atkins, P. W. and DePaula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press,2014.
4. Rodger, G. E. *Inorganic and Solid State Chemistry*, Cengage Learning, 2002.
5. Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.*, John Wiley Sons, N.Y. 1994.
6. Rodger, G.E. *Inorganic and Solid State Chemistry*, Cengage Learning India Edition, 2002.6 Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010

CHEMISTRY PRACTICAL- MJ 1 LAB

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

(A) **Titrimetric Analysis**
- (i) Calibration and use of apparatus.
- (ii) Preparation of solutions of different Molarity/Normality of titrants.
- (iii) Use of primary and secondary standard solutions.

(B) **Acid-Base Titrations**
- (i) Estimation of carbonate and hydroxide present together in mixture.
- (ii) Estimation of carbonate and bicarbonate present together in a mixture.
- (iii) Estimation of free alkali present in different soaps/detergents

(C) **Oxidation-Reduction Titrimetry**
- (i) Estimation of Fe(II) using standardized $KMnO_4$ solution.
- (ii) Estimation of oxalic acid using standardized $KMnO_4$ solution
- (iii) Estimation of oxalic acid and sodium oxalate in a given mixture.
- (iv) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Mendham, J., A. I. Vogel's *Quantitative Chemical Analysis* Sixth Edition, Pearson, 2009.
2. Svehala G. and Sivasankar I. B, Vogel's Qualitative Inorganic Analysis, Pearson, India, 2012.

SEMESTER II

I. MAJOR COURSE- MJ 2: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ORGANIC CHEMISTRY I Theory: 60 Lectures

Course Objectives:
On successful completion of this course the student should be able to understand:

1. Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
2. Stereochemistry of organic molecules – conformation and configuration, asymmetric molecules and their nomenclature.
3. Aromatic compounds and aromaticity, mechanism of aromatic reactions.
4. Reactivity, stability of organic molecules, structure, stereochemistry.
5. Mechanism of organic reactions (effect of nucleophile/ leaving group, solvent), substitution *vs*. elimination.

Course Learning Outcomes:
On successful completion of this course the student should know:

1. Design and syntheses of organic molecules.
2. Structure identification through IR, NMR and Mass spectroscopic data.
3. Lab/ Instrumentation techniques used for analysing reaction mechanisms.

Course Content:

Basics of Organic Chemistry: (12 classes each of 60 minutes duration)
Organic Compounds: Classification and Nomenclature, Hybridization, shape of molecules, influence of hybridization on bond properties. Electron Displacement Effects: inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications, Dipole moment, Organic acids and bases, their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges, Electrophiles and Nucleophiles, Nucleophlicity and basicity, Types, shape and relative stability of reaction intermediates (Carbocations, Carbanions, Free radicals and Carbenes). Organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Stereochemistry: (10 classes each of 60 minutes duration)

Concept of asymmetry, Fischer Projection, Newmann and Sawhorse projection formulae and their interconversions, Geometrical isomerism: cis–trans & syn-anti isomerism and E/Z notations with C.I.P rules. Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-centres, Distereoisomers, Meso structures, Racemic mixtures, Relative and absolute configuration: D/L and R/S configurations.

Chemistry of Aliphatic Hydrocarbons:

A. Alkanes: (2 classes each of 60 minutes duration)

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz- Fittig Reactions, Free radical substitutions: Halogenation - relative reactivity and selectivity.

B. Alkenes & Alkynes: (10 classes each of 60 minutes duration)

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations. Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration- demercuration, hydroboration- oxidation, 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 benzylic bromination and mechanism, e.g. propene, 1-butene. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions.

C. Cycloalkanes and Conformational Analysis (4 classes each of 60 minutes duration)

Cycloalkanes and stability, Baeyer strain theory, Conformation analysis, Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

D. Aromatic Hydrocarbons (6 classes each of 60 minutes duration)

Aromaticity: Huckel'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 substituent groups.

E. Polynuclear Hydrocarbons: (6 classes each of 60 minutes duration)

Reactions of naphthalene, phenanthrene and anthracene: Structure, Preparation, structure elucidation and important derivatives of naphthalene and anthracene.

Chemistry of Halogenated Hydrocarbons: (10 classes each of 60 minutes duration)

Alkyl halides: Methods of preparation, nucleophilic substitution reactions – S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc. Nucleophilic substitution vs. elimination.

Aryl halides: Preparation from diazonium salts. nucleophilic aromatic substitution, S_NAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li and their use in synthesis.

Reference Books:

1. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
2. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, (2007)
3. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill (2008).
4. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., (2012), OxfordUniversitiy Press.
5. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure andmechanism, Kluwer Academic Publisher, (2000).

CHEMISTRY PRACTICAL- MJ 2 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

PRACTICALS: 60 Lectures

1. Purification of organic compounds by crystallization using the following solvents:
   a. Water b. Alcohol c. Alcohol-Water
2. Determination of the melting points of given organic compounds and unknown organic compounds (using Kjeldahl method and electrically heated melting point apparatus).
3. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds.
4. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
5. Chromatography
   a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   b. Separation of a mixture of two sugars by ascending paper chromatography

Reference Books

1. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. *Practical Organic Chemistry,5th Ed.,* Pearson (2012)

SEMESTER III

I. MAJOR COURSE- MJ 3: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

PHYSICAL CHEMISTRY I Theory: 60 Lectures

Course Objectives:
On completion of this course, the students will be able to understand understand:

1. Familiarization with various states of matter.
2. Physical properties of each state of matter and laws related to describe the states.
3. Calculation of lattice parameters.
4. Understanding Kinetic model of gas and its properties.
5. Maxwell distribution, mean-free path, kinetic energies.
6. Liquid state and its physical properties related to temperature and pressure variation.
7. Properties of liquid as solvent for various household and commercial use.
8. Solids, lattice parameters – its calculation, application of symmetry, solid characteristicsof simple salts.

Course Learning Outcomes:
On successful completion of this course the student shall know:

1. Determination of lattice parameters of given salt.
2. Study of X-Ray diffraction pattern and finding out reference from JCPDI file.
3. Numerical related to salt hydrolysis, ionic equilibria.

Course Content:

Behaviour of real gases: (20 classes each of 60 minutes duration)
Deviation from ideal gas behaviour, compressibility factor and its variation with pressure for different gases. Causes of deviation from ideal behaviour. van der Waals equation of state, its derivation and application in explaining real gas behaviour. Boyle's temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, critical and van der Waals constants, law of corresponding states.

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, 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. 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.

Liquid state: (5 classes each of 60 minutes duration)

Structure and physical properties of liquids, vapour pressure, surface tension, viscosity, and their dependence on temperature. Effect of addition of various solutes on surface tension, cleansing action of detergents.

Ionic equilibria: (20 classes each of 60 minutes duration)

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 tri-protic acids.

Salt hydrolysis, hydrolysis constants, degree of hydrolysis and pH of different salt solutions. Buffer solutions, Henderson equation, buffer capacity, buffer range, buffer action, applications of buffers in analytical chemistry, Solubility and solubility product.

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) and applications of HSAB principle.

Qualitative treatment of acid–base titration curves (calculation of pH at various stages). Theories of indicators, selection of indicators and their limitations. Multistage equilibria in polyelectrolytes.

Solid state: (15 classes each of 60 minutes duration)

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. Various types of defects in crystals, Glasses and liquid crystals.

Reference Books:

1. Atkins, P. W. & Paula, J. de *Atkin's Physical Chemistry* 8th Ed., Oxford University Press(2006).
2. Ball, D. W. *Physical Chemistry* Thomson Press, India (2007).
3. Castellan, G. W. *Physical Chemistry* 4th Ed. Narosa (2004).
4. Mortimer, R. G. *Physical Chemistry* 3rd Ed. Elsevier: NOIDA, UP (2009).5 G. M. Barrow, Tata McGraw Hill (Fifth Edition) (2007)
5. Roy, B. N. Fundamentals of Classical and Statistical Thermodynamics Wiley, 2001*6 Commonly Asked Questions in Thermodynamics.* CRC Press, 2011.

CHEMISTRY PRACTICAL- MJ 3 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

PRACTICALS: 60 Lectures

1. **Surface tension measurements.**
   a. Determine the surface tension by (i) drop number (ii) drop weight method.
   b. Study the variation of surface tension of detergent solutions with concentration.

2. **Viscosity measurements using Ostwald's viscometer**.
   a. Determination of viscosity of aqueous solution of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
   b. Viscosity of sucrose solution with the concentration of solute.

3. **pH metry**
   a. Effect on pH of addition of HCl/ NaOH to solutions of acetic acid, sodium acetate and their mixtures.
   b. Preparation of buffer solutions of different pH
      i. Sodium acetate-acetic acid
      ii. Ammonium chloride-ammonium hydroxide
   c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

Reference Books

1. Khosla, B. D., Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.:New Delhi (2011).
2. Garland, C. W., Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.,McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.,* W.H. Freeman &Co.: New York (2003).
4. Athawale V. D. amd Mathur P. Experimental Physical Chemistry, New Age Intenational(2001)

SEMESTER IV

I. MAJOR COURSE- MJ 4: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ORGANIC CHEMISTRY-II Theory: 60 Lectures

Course Objectives:
After completion of the course, the learner shall be able to understand understand:
1. Familiarization about classes of organic compounds and their methods of preparation.
2. Name reactions, uses of various reagents and the mechanism of their action.
3. Use of reagents in various organic transformation reactions.
4. Nitrogen containing functional groups and their reactions.
5. Heterocyclic compounds and their reactions.

Course Learning Outcomes:
On successful completion of this course the student should know:
1. Elucidating reaction mechanisms for organic reactions.
2. Organometallic compounds and their uses.
3. Use of benzene diazonium salt in organic synthesis.
4. Applications of heterocyclic compounds in pharmaceutics/drugs and the mechanism of actions.
5. Pharmaceutics/Biomedical applications of alkaloids and terpenes.

Course Content:

Alcohols, Phenols, Ethers and Epoxides: (10 classes each of 60 minutes duration)
Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3°- alcohols, Bouvaelt-Blanc Reduction, 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 substitution reactions, Reimer–Tiemann and Kolbe's–Schmidt Reactions, Fries and Claisen rearrangements with mechanism.
Ethers and Epoxides: Preparation and reaction with acids. Reaction of epoxides with alcohols, ammonia derivatives and $LiAlH_4$

Carbonyl Compounds: (15 classes each of 60 minutes duration)

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, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC),

Addition reactions of unsaturated carbonyl compounds: Michael addition.

Carboxylic Acids and their Derivatives: (10 classes each of 60 minutes duration)

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 nucleophilic substitution at acyl group, Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.

Sulphur containing compounds: (4 classes each of 60 minutes duration)

Preparation and reactions of thiols, thioethers and sulphonic acids.

Nitrogen Containing Functional Groups (9 classes each of 60 minutes duration).

Preparation and important reactions of compounds of nitro, nitrile and isonitrile groups. 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 synthetic applications.

Heterocyclic Compounds: (12 classes each of 60 minutes duration)

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom, Synthesis, reactions and mechanism of substitution reactions of Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Structure elucidation of indole, Fischer indole synthesis and Madelung synthesis), Structure elucidation of quinoline and isoquinoline, Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner-Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction Derivatives of furan: Furfural and furoic acid.

Reference Books:

1. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
2. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
3. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons(1976).
4. Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc (2009).
5. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.
6. Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science (2010).
7. Clayden, J., Greeves, N., Warren, S., Wothers, P., *Organic Chemistry,* Oxford University PressInc., New York (2001).

CHEMISTRY PRACTICAL- MJ 4 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for
End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Identification of elements (N, S, and halogen) and Functional group tests for alcohols, phenols, carbonyl, carboxylic acid and amine group of compounds.
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: (Using conventional method and using green chemistry approach)
   ii. Benzolyation of one of the amines (aniline, o-, m-, p-toluidines and o-, m-, p-anisidine) and one of the phenols (β-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
   iii. Nitration: (any one)
      a. Acetanilide/nitrobenzene by conventional method
      b. Salicylic acid by green approach (using ceric ammonium nitrate).
   iv. Hydrolysis of amides and esters.
   v. Semicarbazone of any one of the following compounds: acetone, ethyl methyl ketone, cyclohexanone, benzaldehyde.
3. Collected solid samples may be used for recrystallization, melting point and TLC.
4. Qualitative analysis of unknown organic compounds containing monofunctional groups (carbohydrates, nitro compounds, amines and amides).
5. Preparation of methyl orange.

Reference Books

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

II. MAJOR COURSE- MJ 5: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

PHYSICAL CHEMISTRY II Theory: 60 Lectures

Course Objectives:
After completion of the course, the learner shall be able to understand understand:

1. First & second laws of thermodynamics.
2. Concept of enthalpy & resonance energy.
3. Understanding the use of thermochemistry to calculate Bond energy.
4. Development of Quantum Chemistry.
5. Schrodinger equation.
6. Spherical polar coordinate.
7. LCAO-MO and VB treatments.

Course Learning Outcomes:
On successful completion of this course the student should know the:

1. use of thermochemistry to calculate Bond energy
2. use of quantum chemistry in elucidation of atomic structure.
3. Concept of molecular orbitals and their interaction to form bonds.

Course Content:

Introduction to thermodynamics: (8 classes each of 60 minutes duration)
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.

Thermochemistry: (10 classes each of 60 minutes duration)
Heat 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.

Second Law: (7 classes each of 60 minutes duration)

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.

Introduction to Quantum Chemistry (25 classes each of 60 minutes duration)

Introduction to black-body radiation and distribution of energy, photo-electric effect, concept of quantization, wave particle duality (de-Broglie's hypothesis), The uncertainty principle, The wave function: wave function and its interpretation, conditions of normalization and Orthogonality and its significance. Basic idea about operators, Eigen function and values, Schrodinger equation and application to free-particle and particle in a box, boundary conditions, wave functions and energies, degeneracy, hydrogen atom, Schrodinger equation in polar coordinates, radial and angular parts of the hydrogenic orbitals, degeneracies, spherical harmonics, representations of hydrogenic orbitals.

Quantitative treatment of simple harmonic oscillator model, setting up of Schrodinger equation and discussion of solution of wave functions. Rigid rotator model and discussion of application of Schrodinger equation: idea about transformation to spherical polar co-ordinate, discussion on solution, Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus. Chemical bonding: Valence bond and Molecular orbital approaches, LCAO-MO treatment of H_2, H_2^+, bonding and anti-bonding orbitals, Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations.

Reference Books:

1. Laideler K. J. and Meiser J. M. Physical Chemistry Third Edition (International)1999
2. Levine I. N., Physical Chemistry, Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. Physical Chemistry- A Molecular Approach, University Science Books, 1998.
4. Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
5. House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA (2004).

CHEMISTRY PRACTICAL- MJ 5 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Determination of water equivalent of calorimeter.
2. Determination of heat of neutralization of HCl and NaOH.
3. Determination of heat of neutralization of acetic acid and NaOH.
4. Determination of heat of solution of ammonium chloride.
5. Determination of critical solution temperature (CST of phenol-water system).
6. Determination of effect of impurity (NaCl) on critical solution temperature of phenol-water system.
7. Determination of molecular weight of volatile compound by Victor Meyer method.

Reference Books

1. Khosla, B. D., Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.:New Delhi (2011).
2. Garland, C. W., Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed*.,McGraw-Hill: New York (2003).
3. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.,* W.H. Freeman &Co.: New York (2003).
4. Athawale V. D. amd Mathur P. Experimental Physical Chemistry, New Age Intenational(2001)

SEMESTER V

I. MAJOR COURSE- MJ 6: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

INORGANIC CHEMISTRY-II **Theory: 60 Lectures**

Course Objectives:
After completion of the course, the learner shall be able to understand understand:

1. Chemistry of s and p-block elements.
2. Chemistry of noble gases.
3. Structure, bonding of s and p block materials and their oxides/compounds.
4. Understanding chemistry of boron compounds and their structures.
5. Chemistry of noble gases and their compounds, application of VSEPR theory inexplaining structure and bonding.
6. Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.
7. Lanthanides, Actinides – separation, colour, spectra and magnetic behaviour
8. Understanding the nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
9. Understanding the transition metals stability in reactions, origin of colour and magnetic properties.
10. Understanding the separation of Lanthanoids and Actinoids, its colour, spectra and magnetic behaviour.

Course Learning Outcomes:
On successful completion of this course the student should know:

1. Extraction of metals through metallurgical operations and their uses.
2. Bonding of various s and p block elements.
3. Chemistry of inorganic polymers and their uses.
4. IUPAC nomenclature of coordination compounds/complexes.
5. Prediction of structure of complexes using various theories, colour and magneticproperties of different complexes.
6. Use of lanthanide/actinide compounds in industries.

Course Content:

Chemistry of *s* and *p* Block Elements: (20 classes each of 60 minutes duration)

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.

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. Per-oxo acids of Sulphur inter-halogen compounds, poly- halide ions, pseudo-halogens.

Noble Gases: (8 classes each of 60 minutes duration)

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6, Bonding in noble gas compounds (Valence bond and MO treatment for XeF_2), Shape of noble gas compounds (VSEPR theory).

Transition Elements: (10 classes each of 60 minutes duration)

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and 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)

Coordination Chemistry: (12 classes each of 60 minutes duration)

Werner's theory, EAN rule, valence bond theory (inner and outer orbital complexes), Crystal field theory, d-orbital splitting in weak and strong fields, pairing energies, factors affecting the magnitude of (Δ). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn-Teller theorem, square planar complexes, d-orbital splitting in trigonal bipyramidal, square pyramidal and cubic ligand field environments, CFSE, Variation of lattice energies, enthalpies of hydration and crystal radii variations in halides of firstand second row transition metal series, Qualitative aspect of Ligand field theory, IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with the coordination number 4 and 6, Chelate effect.

Lanthanides and Actinides: (10 classes each of 60 minutes duration)

Electronic configuration, oxidation states, colour, spectra and magnetic behaviour, lanthanide contraction, separation of lanthanides (ion-exchange method only).

Reference Books:

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E, Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.* John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N., Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010
6. Atkins, P. W and Shriver D. N. *Atkins' Inorganic Chemistry* 5th Ed. Oxford University Press(2010).
7. Purcell, K.F & Kotz, J.C. *Inorganic Chemistry* W.B. Saunders Co, 1977. Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
8. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.

CHEMISTRY PRACTICAL- MJ 6 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment = 15 marks
Practical record notebook = 05 marks
Viva-voce = 05 marks

PRACTICALS: 60 Lectures

(A) Iodo / Iodimetric Titrations

(i) Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodimetrically).
(ii) Estimation of available chlorine in bleaching powder iodometrically.

(B) Inorganic preparations

(i) Cuprous Chloride, Cu_2Cl_2
(ii) Preparation of Aluminium potassium sulphate (Potash alum) or Chrome alum.

(C) Qualitative semimicro analysis of mixtures

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given on the understanding of chemistry of different reactions.
Following radicals may be analyzed:

CO_3^{2-}, NO_2^-, S^{2-}, SO_4^{2-}, SO_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:

i. one interfering anion, **or**
ii. insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) **or**
iii. combination of anions e.g. $CO_3^{2-}$and SO_3^{2-}, NO_2^- and NO_3^-.

Note: Spot analyses/tests should be done wherever possible.

(D) Controlled synthesis of two copper oxalate hydrate complexes.
(E) Preparation of acetylacetanato complexes of Cu^{2+}/Fe^{3+}.
(F) 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

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis* Sixth Edition Pearson, 2009.
2. Vogel's *Qualitative Inorganic Analysis,* Revised by G. Svehla. Pearson Education, 2002.
3. Marr & Rockett *Practical Inorganic Chemistry.* John Wiley & Sons 1972.

II. MAJOR COURSE- MJ 7: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

MOLECULAR SPECTROSCOPY & PHOTOCHEMISTRY

Theory: 60 Lectures

Course Objectives:
This course is designed:
1. To expose the students to the basic principles of spectroscopic theory.
2. Application of spectroscopic techniques in organic chemistry
3. Interaction of electromagnetic radiations and matter
4. Applications of spectroscopic analysis to elucidate structure of organic compounds.

Course Learning Outcomes:
On successful completion of this course the student should be able to understand:
1. Correlate theory and experimental findings in order to explore structural features of organic compounds.
2. Apply the concept to establish structures of unknown compounds.

Course Content:

Organic Spectroscopy (5 classes each of 60 minutes duration)

General principles: Introduction to absorption and emission spectroscopy. Interaction of electromagnetic radiation with molecules & various types of spectra and Born- Oppenheimer approximation.

UV Spectroscopy: (7 classes each of 60 minutes duration)

Types of electronic transitions, λ_{max}, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption, Application of Woodward - Fieser rules for calculation of λ_{max} for the following systems: α, β-unsaturated aldehydes, ketones, carboxylic acids and esters, Conjugated dienes: alicyclic, homoannular and heteroannular and extended conjugated systems (aldehydes, ketones and dienes). Distinction between cis and trans isomers.

IR Spectroscopy: (10 classes each of 60 minutes duration)

Fundamental and non-fundamental molecular vibrations, Infrared radiation and types of molecular vibrations. IR spectra of alkanes, alkenes and simple alcohols (inter and intramolecular hydrogen bonding), aldehydes, ketones, carboxylic acids and their derivatives (effect of substitution on >C=O

stretching absorptions). Effect of H-bonding, conjugation, resonance and ring size on IR absorptions, Fingerprint region and its significance, application in functional group analysis.

NMR Spectroscopy: **(12 classes each of 60 minutes duration)**

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.

Mass Spectroscopy: **(8 classes each of 60 minutes duration)**

Application of fragmentation rule in characterization of organic compounds. Problems on structure elucidation of organic compounds based on spectral data. Applications of IR, UV, NMR and Mass spectra for identification of simple organic molecules.

Electronic Spectroscopy: **(8 classes each of 60 minutes duration)**

Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

Photophysical and photochemical processes: **(10 classes each of 60 minutes duration)**

Laws of photochemistry, quantum yield. Jablonski diagrams: Law of photochemical equivalence, quantum efficiency, low and high quantum efficiency. kinetics of photochemical reactions ($H_2 + Br_2 \rightarrow 2HBr$, $2HI \rightarrow H_2 + I_2$), energy transfer in photochemical reactions (photosensitization and quenching), fluorescence, phosphorescence, chemiluminescence, Discussion of Electronic spectra and photochemistry (Lambert-Beer law and its applications).

Reference Books:

1. Laideler K. J. and Meiser J. M. *Physical Chemistry* Third Edition (International)1999
2. Levine I. N., *Physical Chemistry,* Fourth Edition), McGraw-Hill (International), 1995.
3. McQuarrie D. A. and Simon J. D. *Physical Chemistry- A Molecular Approach,* UniversityScience Books, 1998
4. Rohatgi-Mukherjee K. K. Fundamentals of Photochemistry, New age (revised secondedition).
5. Banwell C.N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. TataMcGraw-Hill: New Delhi (2006).
6. R.M. Silverstein, G.C. Bassler & T.C. Morrill*: Spectroscopic Identification of OrganicCompounds*, John Wiley & Sons.
7. John R. Dyer, Applications of absorption spectroscopy of organic compounds, Prentice Hall India (2012).

CHEMISTRY PRACTICAL- MJ 7 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Purification method for liquid, solid organic substance (distillation, recrystallization, chromatorgrapy)
2. Determination of indicator constant - colourimetry. (instructor may vary indicators available in the lab).
3. Verification of Beer's Law - Determination of concentration of solution by colourimetry. (Instructor may explain the principle of using colourimeter, its handling drawing standard calibration curve, and its application in finding unknown concentration of dyes, concentration of metal solutions (*e.g*. Ni, Cu using appropriate reagent) from standard calibration curve.
4. Identification of functional groups of simple organic compounds by IR spectroscopy and NMR spectroscopy
   (Sample spectra may be provided for simple organic compounds like Ethanol, Aniline, Phenol, acetic acid, other simple aldehydes, carboxylic acid, etc., for identification of functional groups. References from standard spectroscopy books may also be taken for such purpose for enhancing students understanding and skill).
5. **Project:** Collect IR, NMR, UV-VIS spectra from available sources and make a Project on "Spectroscopic identification of Organic Compounds"

Reference Books

1. Practicals in physical chemistry – a modern approach, P.S. Sindhu, Macmillan,
2. Experiments in Physical Chemistry, J. M. Wilson, R.J. Newcomb, A.R. Denaro, 2nd Edn.,Elsevier.

SEMESTER VI

I. MAJOR COURSE- MJ 8: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ORGANIC III Theory: 60 Lectures

Course Objectives:
After completion of the course, the learner shall be able to understand understand:

1. Understanding reactions and reaction mechanism of compounds containing active methylene groups.
2. Understanding the reactions and mechanisms of diazonium compounds.
3. Understanding the structure, mechanism of reactions of selected heterocyclic compounds.
4. Classification, structure, mechanism of reactions of few selected alkaloids and terpenes.

Course Learning Outcomes:
On successful completion of this course the student should know:

1. Elucidating reaction mechanisms for organic reactions.
2. Use of active methylene groups in organic mechanism and preparation of new organiccompounds.
3. Use of benzene diazonium salt in organic synthesis.
4. Applications of heterocyclic compounds in pharmaceutics/drugs and the mechanism of actions.

Course Content:

Chemistry of Active methylene groups: (6 classes each of 60 minutes duration)

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

Chemistry of Carbohydrates: (20 classes each of 60 minutes duration)

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 excluding their structure elucidation.

Unit 2: Chemistry of Amino Acids, Peptides and Proteins (10 classes)

Classification of Amino Acids, Zwitterion structure and Isoelectric point. Overview of Primary, Secondary, Tertiary and Quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme).

Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis.

Unit 3: Chemistry of Enzymes and correlation with drug action (8 classes)

Mechanism of enzyme action, factors affecting enzyme action, Coenzymes and cofactors and their role in biological reactions, Specificity of enzyme action (including stereospecifity).

Enzyme inhibitors and their importance, phenomenon of inhibition (competitive and non- competitive inhibition including allosteric inhibition).

Unit 5: Chemistry of Lipids (8 classes each of 60 minutes duration)

Introduction to lipids, classification. Oils and fats: Common fatty acids present in oils and fats, Omega fatty acids, Trans fats, Hydrogenation, Saponification value, Iodine number.

Biological importance of triglycerides, phospholipids, glycolipids, and steroids (cholesterol).

Chemistry of Dyes (8 classes each of 60 minutes duration)

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.

Reference Books:

1. P Sykes, A Guide Book to Mechanism in Organic Chemistry, 6th Edition (1997), Orient Longman, New Delhi.
2. Morrison, R. T., Boyd, R. N., Bhatterjee, S.K., Organic Chemistry, 7th Edn., Pearson.
3. Acheson, R.M. *Introduction to the Chemistry of Heterocyclic compounds,* John Welly & Sons(1976).
4. Solomons, T.W., Fryhle Craig, *Organic Chemistry,* John Wiley & Sons, Inc (2009).
5. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition,2013.
6. Kalsi, P. S. *Organic reacations and their mechanisms*, New Age Science (2010).
7. Clayden, J., Greeves, N., Warren, S., Wothers, P., *Organic Chemistry,* Oxford University PressInc., New York (2001).
8. Singh, J., Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Parakashan (2010).
9. Bansal R. K. *Heterocyclic Chemistry: Syntheses, Reactions and Mechanisms*, New Age, ThirdEdition (1999).
10. J. C. Kotz, P. M. Treichel & J. R. Townsend: *General Chemistry*, Cengage Lening India Pvt. Ltd., New Delhi (2009).
11. B. H. Mahan: *University Chemistry* 3rd Ed. Narosa (1998).
12. R. H. Petrucci: *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
13. J. D. Lee: *A New Concise Inorganic Chemistry,* E.L.B.S.
14. F.A. Cotton & G. Wilkinson: *Basic Inorganic Chemistry,* John Wiley.
15. Gary Wulfsberg: *Inorganic Chemistry,* Viva Books Pvt. Ltd.

16. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
17. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
18. Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
19. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
20. Berg, J. M., Tymoczko, J. L. & Stryer, L. *Biochemistry 7th Ed.,* W. H. Freeman.

CHEMISTRY PRACTICAL- MJ 8 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **60 Lectures**

1. Analysis of Carbohydrate: aldoses and ketoses, reducing and non-reducing sugars using simple lab procedures.
2. Separation of amino acids by paper chromatography
3. To determine the concentration of glycine solution by formylation method.
4. Study of titration curve of glycine
5. To determine the saponification value of an oil/fat.
6. To determine the iodine value of an oil/fat
7. Differentiate between a reducing/ nonreducing sugar.

Reference Books:

1. A.I. Vogel, Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
2. A.I. Vogel, Quantitative Chemical Analysis, Prentice Hall, 6th Edn.
3. B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.
4. Furniss, B.S., Hannaford, A.J., Rogers, V., Smith, P.W.G., Tatchell, A.R.
5. *Vogel's Textbook of Practical Organic Chemistry*, ELBS.
6. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* Universities Press.

II. MAJOR COURSE- MJ 9: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):

*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

PHYSICAL CHEMISTRY - III

Theory: 60 Lectures

Course Objectives:

After completion of the course, the learner shall be able to understand understand:

1. Third Law of thermodynamics and concepts.
2. Understanding the concept of entropy, reversible, irreversible processes. Calculation ofentropy using 3nd law of thermodynamics.
3. Phases, components, Gibbs phase rule, Phase diagrams and applications.
4. Chemical kinetics: type of reactions, determination of rate, theories of reaction rate, steady state approximation.
5. Catalyst – mechanism, acid base catalysis, enzyme catalysis.
6. Adsorption isotherms.
7. Understanding phases, components, Gibb's phase rule and its applications, construction of phase diagram of different systems, the application of phase diagram.
8. Understanding the basics of chemical kinetics: determination of order, molecularity, and understanding theories of reaction rates, determination of rate of opposing/parallel/chain reactions with suitable examples, application of steady state kinetics, Steady-state approximation.
9. Catalyst – mechanism of catalytic action, enzyme catalysis.
10. Langmuir, Freundlich – adsorption isotherms, significance, multilayer adsorption – theory and significance.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Application of course objectives stated above.

Course Content:

Third law of thermodynamics: (4 classes each of 60 minutes duration)

Third Law of thermodynamics, residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: (6 classes each of 60 minutes duration)

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 relations, thermodynamic equations of state.

Partial molar quantities: (6 classes each of 60 minutes duration)
Partial molar quantities, dependence of thermodynamic parameters on composition, Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Dilute solutions: (8 classes each of 60 minutes duration)
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 solutesin solution.

Phase Equilibria: (12 classes each of 60 minutes duration)
Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems, Clausius-Clapeyron equation and its applications to solid- liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points, solid solutions. 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 derivation and applications.

Chemical Kinetics: (12 classes each of 60 minutes duration)
Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated rate laws for first, second and fractional order reactions, pseudo-unimolecular reactions, determination of the order, kinetics of complex reactions (limitedto first order): (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, Lindemann mechanism, qualitative treatment of the theory ofabsolute reaction rates.

Catalysis: (6 classes each of 60 minutes duration)
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.

Surface chemistry: (6 classes each of 60 minutes duration)
Physical adsorption, chemisorption, adsorption isotherms (Freundlich, Temkin, derivation of Langumuir adsorption isotherms, surface area determination), BET theory of multilayer adsorption (no derivation), Adsorption in solution.

Reference Books:

1. Atkins P. and De Paula, J. *Physical Chemistry* Tenth Ed., OUP, 2014.
2. Castellan, G. W. *Physical Chemistry* 4th Ed., Narosa, 2004.
3. Engel, T. and Reid, P. *Physical Chemistry* 3rd Ed., Prentice Hall, 2012.

4. McQuarrie, D. A. and Simon, J. D. *Molecular Thermodynamics* Viva Books, 2004.
5. Roy, B. N. *Fundamentals of Classical and Statistical Thermodynamics* Wiley, 2001
6. *Commonly Asked Questions in Thermodynamics*. CRC Press, 2011.
7. Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill, 2010.
8. Metz, C.R. *2000 Solved Problems in Chemistry*, Schaum Series, 2006.
9. Zundhal, S.S. *Chemistry concepts and applications* Cengage India, 2011 6 Ball, D. W. *Physical Chemistry* Cengage India, 2012.
10. Mortimer, R. G. *Physical Chemistry 3rd Ed.,* Elsevier: NOIDA, UP, 2009.
11. Levine, I. N. *Physical Chemistry 6th Ed.,* Tata McGraw-Hill, 2011.

CHEMISTRY PRACTICAL- MJ 9 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):

There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

Kinetics

1. Study the kinetics of the following reactions.
    a. Acid hydrolysis of methyl acetate with hydrochloric acid.
    b. Saponification of ethyl acetate.

Adsorption

2. Verification of Freundlich and Langmuir isotherms for adsorption of acetic acid and selected organic dye(s) on activated charcoal.
3. Preparation of $Fe(OH)_3$ sols.
4. Study of adsorption of acetic acid on charcoal.

Conductometry

5. Determination of cell constant
6. Equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
7. Conductometric titrations of: Strong acid Vs. strong base (ii) Weak acid vs. strong base, (iii) Mixture of strong acid and (iv)weak acid vs. strong base, Strong acid vs. weak base.

Potentiometry

8. Potentiometric titrations of: (i) Strong acid vs. strong base (ii) Weak acid vs. strong base

(ii) Dibasic acid vs. strong base (iv) Potassium dichromate vs. Mohr's salt.

Reference Books

1. Khosla, B. D., Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand, N. Delhi, 2011.
2. Garland, C. W., Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry*, Eighth Edition, McGraw-Hill (2003).
3. Halpern, A. M. and Mc Bane, G. C. *Experimental Physical Chemistry,* Third Edition, W, H.Freeman (2003).

SEMESTER VII

I. ADVANCE MAJOR COURSE- AMJ 1: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):

*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ELECTRO CHEMISTRY, NANOCHEMISTRY & APPLICATIONS

Theory: 60 Lectures

Course Objectives:

After completion of the course, the learner can be able to understand understand:

1. Basic principle of laws of electrochemistry.
2. Understanding about chemical cells and their function
3. Understanding about electrodes, EMF measurement.
4. Understanding about potentiometric titrations and theirapplications.

Course Learning Outcomes:

1. Application of course objectives stated above.

Course Content:

Electrolytic Theories: (12 classes each of 60 minutes duration)

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. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. 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.

Quantitative aspects of Faraday's laws of electrolysis: (8 classes each of 60 minutes duration)

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 of different kind of half-cells.

Application of EMF measurements: (10 classes each of 60 minutes duration)
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/Sb_2O_3 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).

Electroanalytical methods: (5 classes each of 60 minutes duration)
Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Electrical & Magnetic Properties of Atoms and Molecules: (5 classes each of 60 minutes duration)
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, molecular interpretation.

Introduction to nanoscience, nanostructure and nanotechnology: (10 classes each of 60 minutes duration)
Basic idea; Overview of nanostructures and nano-materials, classification, (cluster, colloid, nanoparticles, and nanostructures -Spheroid, Wire, Rod, Tube, and Quantum Dot), Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures, control of nano-architecture- one dimensional control. Carbon nanotubes and inorganic nanowires. Calculation of percentage of surface atom and surface to volume ratio of spherical, wire, rod and disc shapes nanoparticles.

Size dependent properties of nanomaterials: (3 classes each of 60 minutes duration)
Basic idea with few examples only: Quantum confinement, Electrical, Optical (Surface Plasmon resonance), variation in colours (Blueshift & Red shift), Magnetic, thermal and catalytic properties.

Synthesis of Nanomaterials: (7 classes each of 60 minutes duration)
Brief introduction about Top-down and Bottom-up approaches & self-assembly techniques of nanoparticles synthesis, Solvothermal process, Examples of preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires.

Reference Books:

1. 1.Atkins, P.W & Paula, J.D. *Physical Chemistry*, 10th Ed., Oxford University Press (2014).
2. Castellan, G. W. *Physical Chemistry* 4th Ed., Narosa (2004).
3. Mortimer, R. G. *Physical Chemistry* 3rd Ed., Elsevier: NOIDA, UP (2009).
4. Barrow, G. M., *Physical Chemistry* 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. *Physical Chemistry* 3rd Ed., Prentice-Hall (2012).
6. Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).
7. Silbey, R. J., Alberty, R. A. & Bawendi, M. G. *Physical Chemistry* 4th Ed., John Wiley &Sons, Inc. (2005).
8. Zhen Guo and Li Tan, *Fundamentals and Applications of Nanomaterials*.2009, Artech House,London

Publication.
9. 1.C. N. R. Rao, A. Muller, A. K. Cheetam, The Chemistry of Nanomaterials: Synthesis,Properties and Applications, Willey-VCH Verlag, Germany, 2005.
10. 2.G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Appications, ImperialCollege Press, London, 2004
11. 3.R. W. Kelsall, I. W. Hameley, M. Geoghegan, Nanoscale Science and Technology, JohnWiley & Sons, England, 2005
12. Charles P. Poole and Frank J Owens, *Introduction to nano technology*, Wiley Interscience, 2003.
13. Pradeep, T., A text of book of nanoscience and nanotechnology, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2012.

CHEMISTRY PRACTICAL- AMJ 1 LAB:

Marks : Pr (ESE: 3Hrs) =25	**Pass Marks: Pr (ESE) = 10**

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: **60 Lectures**

1. Determination of pH of a given solution using glass electrode.
2. Determination of cell constant.
3. Determination of equivalent conductance, degree of dissociation, and dissociation constant of weak acid.
4. Conductometric titration: strong acid vs. strong base, weak acid vs. strong base.
5. Potentiometric titration: strong acid vs. strong base, weak acid vs. strong base, potassium dichromate vs. Mohr's salt.
6. Synthesis of ZnO nanoparticles.

Reference Books

1. Khosla, B. D., Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.:New Delhi (2011).
2. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry,* UniversitiesPress.
3. Garland, C. W., Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry 8th Ed.,*
4. McGraw-Hill: New York (2003).
5. Halpern, A. M. & McBane, G. C. *Experimental Physical Chemistry 3rd Ed.,* W.H. Freeman &Co.: New York (2003).
6. Fahlman, B.D. *Materials Chemistry,* Springer, 2004.

II. ADVANCE MAJOR COURSE- AMJ 2: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):

*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

POLYMER CHEMISTRY & MATERIALS CHEMISTRY

Theory: 60 Lectures

Course Objectives:

After completion of the course, the learner can be able to understand understand:

1. The mechanism of polymer material formation.
2. Molecular weight and structure property relationship
3. Polymerization procedure and Zigler-Natta catalysis.
4. Characterization of polymers

Course Learning Outcomes:

On successful completion of this course the student should be able to understand:

1. Student will explore various aspects of Polymerisation.

Course Content:

Introduction: (4 classes each of 60 minutes duration)

Introduction and classification of Polymers, Biopolymers, Synthetics polymers. polymerization process, degree of polymerization, condensation and addition polymers, kinetics of addition polymerization process.

Polymeric Structure and Property Relationship: (8 classes each of 60 minutes duration)

Structure of polymers - Linear, branched, cross linked, and network polymers, molecular weight (number average and weight average) and distribution of molecular weight, polydispersity index, crystallinity in polymer, melting temperature and glass transition temperature, Volumetric properties - molar volume, density, Van der Waals volume, Coefficient of linear thermal expansion and volumetric thermal expansion - Pressure volume temperature (PVT) relationship.

Polymerization Chemistry: (4 classes each of 60 minutes duration)

Industrial methods of polymerization such as a bulk, solution, emulsion, suspension. Stereochemistry of polymers and stereo-specific polymerization, Catalysts-their utility in polymers and stereo-specific polymerizations, Catalysts their utility in polymer manufacture, Zieglar-Natta, Metallocene and others.

Characterization of Polymers: (8 classes each of 60 minutes duration)
Molecular Weight Determination by Light scattering, End-group analysis, Viscosity, Applications of FTIR, UV-visible, NMR and Mass Spectroscopy for identification of polymers.

Crystal structure of solids: (8 classes each of 60 minutes duration)
Fundamental of lattices, unit cell, atomic coordinates, Bravais lattices, crystal direction and planes, types of close packing, packing efficiency, radius ratios, few important crystal structures. Synthesis of Inorganic solids, solid state, solution phase and vapor phase synthesis, precipitation, hydrothermal, sol-gel, surfactant based synthesis. Growth of single crystals.

Properties of Polymers: **(12 classes each of 60 minutes duration)**
(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, polyurethanes, silicone polymers, polydienes, Polycarbonates.

Frontier areas of polymer science and technology: (16 classes each of 60 minutes duration)
Conducting polymers: Basic principles of conducting polymers, delocalized electronic states of conjugated polymers, polyanilines, polyacetylenes, polythiophene, applications of conducting polymers.

Biodegradable polymers: Definition classification of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soya protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers, polyhydroxy alkanoates, polycarpolactone, polyvinyl alcohol, polyacetic acid, application of biodegradable and biomedical polymers, contact lens, dental polymers, artificial heart, kidney, skin, and blood cells.

Fibers: Natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA.
Rubber: Compounding and elastomeric properties, vulcanization, reinforcement.

Reference Books:

1. D.W. Van Krevelen and P.J. Hoftyzen, "Properties Of Polymer, 3rd Edition Elsevier Scientific, Publishing Company Amsterdam - Oxford - Newyork. 1990.
2. J.E. Mark Ed.AIP, Physical Properties Of Polymers Hand Book, Williston, Vt, 1996.
3. Reaction Engineering of Step Growth Polymerization, S K Gupta and Anil Kumar, PlenumPress, 1987
4. Odian, George, Principles of Polymerization, McGraw-Hill Book Co., New York (1970).
5. W. Billmeyer, Text book of polymer science, 3rd Edn., 2007, Wiley.
6. J.R.Fried, Polymer Science and Technology, (2005), PHI publication.
7. Billmeyer Jr., Fred W., Textbook of Polymer Science, Wiley- Interscience Publishers, NewYork (1962).
8. Physical methods for chemistry: R. S. Drago, 1992, Saunders college publication.
9. P. J. Flory, Principle of polymer chemistry, Cornell University Press.
10. Polymer Science and technology, Plastics, Rubber and composites, P. Ghosh, Tata McGraw Hill.
11. V. Gowriker, N. V. Viswanathan, J. Sreedhar, Polymer Science, New Age Int. Publication, 2019.

CHEMISTRY PRACTICAL- AMJ 2 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Free radical solution polymerization of any one: Styrene, methylmethacrylate, methyl acrylate, methacrylic acid (using free radical initiators). (purification of monomer should be taught)
2. Preparation of phenol-formaldehyde resins
3. Emulsion polymerization of polymethylmethacrylate.
4. Use of viscometer for molecular weight determination – (any known polymer, example: polyvinyl pyrrolidone in water/polyacrylamide in $NaNO_2$ solution) by viscometry. (students should be explained regarding principles and use of Ubblohde/Ostwald viscometer).
5. Estimation of amount of HCHO in a given solution by sodium bisulphite method.
6. Determination of exchange capacity of cation exchange resins and anion exchange resins.
7. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (IPC) and phenolphthalein
8. Determination of composition of dolomite (by complexometric titration).

Reference Books

1. P. Munk & T.M. Aminabhavi, *Introduction to Macromolecular Science*, 2nd ed. John Wiley &Sons (2002).
2. 2.M.P. Stevens, *Polymer Chemistry: An Introduction* 3rd ed. Oxford University Press (2005).
3. L. H. Sperling, *Introduction to Physical Polymer Science*, 4th ed. John Wiley & Sons (2005)

SEMESTER VIII

I. ADVANCE MAJOR COURSE- AMJ 3: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for
Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ADVANCED ANALYTICAL CHEMISTRY

Theory: 60 Lectures

Course Objectives:
After completion of the course, the learner can be able to understand understand:
1. To expose the students to the basic techniques of Analytical chemistry.

Course Learning Outcomes:
On successful completion of this course the student should be able to understand:
1. Decide appropriate methods for different analytical needs.

Course Content:

Qualitative aspects of analysis: (4 classes each of 60 minutes duration)
Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors.

Statistical methods in chemical analysis: (14 classes each of 60 minutes duration)
Theory of error and treatment of quantitative data, accuracy and precision, ways of expressing accuracy and precision, Normal error curve and its equation. Useful statistical tests with equation, test of significance, the F-test, Q-test, the students t-test, the Chi-test, the correlation coefficient, confidence limit of the mean, comparison of two standard values, comparison of two standard values, comparison of standard deviation with average deviation, comparison of mean with true values, regression analysis (least square method).

Separation techniques: (16 classes each of 60 minutes duration)
Solvent extraction: Classification, principle and efficiency of the technique. Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current

extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique. Paper, column and thin layer chromatography, Gas-liquid chromatography, HPLC.

Mechanism of separation: adsorption, partition & ion exchange. Development of chromatograms: frontal, elution and displacement methods. Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Stereoisomeric separation and analysis: Measurement of optical rotation, calculation of Enantiomeric excess (ee)/diastereomeric excess (de) ratios and determination of enantiomeric composition using NMR, Chiral solvents and chiral shift reagents. Chiral chromatographic techniques using chiral columns (GC and HPLC). Role of computers in instrumental methods of analysis.

Polarography: (4 classes each of 60 minutes duration)
Current-voltage relationship, theory of polarographic waves, instrumentation, qualitative and quantitative applications.

Atomic spectroscopy (6 classes each of 60 minutes duration)
Atomic absorption spectroscopy, theory and application (with some examples).

Thermal analysis: (6 classes each of 60 minutes duration)
Theory, methodology, instruments and applications of theromogravimetric analysis (TGA/DTA),and differential scanning calorimetry (DSC).

Analysis of fuel and drugs: (10 classes each of 60 minutes duration)
Fuel analysis: Solid, liquid and gaseous fuels, general properties of fuels, ultimate and proximate analysis of solid fuel, Determination of calorific value of solid, liquid and gaseous fuels, Flash point and fire point.
Drug analysis: Classification of drugs, Analysis of some standard drug using various chromatographic techniques.

Reference Books:

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth PublishingCalifornia, USA, 1988.
3. Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.
5. Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*
6. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles HarwoodJohn Wiley 1979.
7. Ditts, R.V. Analytical Chemistry, Methods of separation, van Nostrand, 1974.
8. Khopkar, S. M., Basic Concepts of Analytical Chemistry, New Age (Second edition) 1998
9. Ditts, R.V. Analytical Chemistry – Methods of separation.

CHEMISTRY PRACTICAL- AMJ 3 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
2. Preparation of buffer solutions of different pH (i. Sodium acetate-acetic acid, ii. Ammonium chloride-ammonium hydroxide)
3. Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:
    a. Ni (II) and Co (II)
    b. Fe (III) and Al (III)
4. Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.
5. Determination of flash point & fire point of given fuel sample.
6. Determination of viscosity index, cloud point, pour point of given fuel sample.
7. Determination of calorific value of given fuel sample/coal sample using bomb calorimeter.
8. Proximate analysis of given coal sample.
9. Determination of the iodine number of oil.
10. Determination of the saponification number of oil.

Reference Books

1. Mendham, J., *A. I. Vogel's Quantitative Chemical Analysis 6th Ed.,* Pearson, 2009.
2. Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
3. Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age International Publisher, 2009
4. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Edition.
5. Willard, H.H. *et al.*: *Instrumental Methods of Analysis*, 7th Ed. Wardsworth PublishingCalifornia, USA, 1988.
6. Christian, G.D, *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004. 4 Harris, D.C.: *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016.5 Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*
7. Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles HarwoodJohn Wiley 1979.
8. Ditts, R.V. Analytical Chemistry, Methods of separation, van Nostrand, 1974.

II. ADVANCE MAJOR COURSE- AMJ 4: (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ORGANOMETALLIC AND BIOINORGANIC CHEMISTRY

Theory: 60 Lectures

Course Objectives:
After completion of the course, the learner can be able to understand understand: Coordination compounds – its nomenclature, theories, d-orbital splitting in complexes, chelate.

1. Transition metals, its stability, colour, oxidation states and complexes.
2. Lanthanides, Actinides – separation, colour, spectra and magnetic behaviour
3. Bioinorganic chemistry – metal ions in biological system, its toxicity, haemoglobin.
4. Understanding the nomenclature of coordination compounds/complexes, Molecular orbital theory, d-orbital splitting in tetrahedral, octahedral, square planar complexes, chelate effects.
5. Understanding the transition metals stability in reactions, origin of colour and magnetic properties.
6. Understanding the separation of Lanthanides and Actinides, its colour, spectra and magnetic behaviour.
7. Understanding the bioinorganic chemistry of metals in biological systems.
8. Haemoglobin and its importance in biological systems.

Course Learning Outcomes:
1. Application of course objectives stated above.

Course Content:

Chemistry of 3d metals: (8 classes each of 60 minutes duration)

Oxidation states displayed by Cr, Fe, Co, Ni and Co. A study of the following compounds (including preparation and important properties), Peroxo compounds of Cr, $K_2Cr_2O_7$, $KMnO_4$, $K_4[Fe(CN)_6]$, sodium nitroprusside, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(NO_2)_6]$.

Organometallic Compounds: (10 classes each of 60 minutes duration)

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.

Synergic effects: (14 classes each of 60 minutes duration)
EAN rule as applied to carbonyls. Preparation, structure, bonding and properties of mononuclear and polynuclear carbonyls of 3d metals. p-acceptor behaviour of carbon monoxide. Synergic effects (VB approach)- (MO diagram of CO can be referred to for synergic effect to IR frequencies).

Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. pi-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Definition and Classification with appropriate examples based on nature of metal-carbon bond (ionic, s, p and multicentre bonds). Structures of methyl lithium, Zeise's salt and ferrocene. Organometallic compounds of Mg and Li – Use in synthesis of organic compounds.

Zeise's salt: (4 classes each of 60 minutes duration)
Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: (6 classes each of 60 minutes duration)
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 in ether solution of Grignardreagent and their structures, Schlenk equilibrium.

Ferrocene: (6 classes each of 60 minutes duration)
Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Bioinorganic chemistry: (12 classes each of 60 minutes duration)
A brief introduction to bio-inorganic chemistry. Geochemical effect on distribution of metals. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions: Na/K pump, Role of Mg^{2+} ions in energy production and chlorophyll. Iron and its application in bio- systems, Haemoglobin, Storage and transfer of iron. Role of Ca^{2+} in blood clotting, stabilization of protein structures and structural role (bones).

Reference Books:

1. Lippard, S.J. & Berg, J.M. *Principles of Bioinorganic Chemistry* Panima Publishing Company1994.
2. Cotton, F.A. & Wilkinson, G, *Advanced Inorganic Chemistry* Wiley-VCH, 1999
3. Basolo, F, and Pearson, R.C. *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY,1967.
4. Greenwood, N.N. & Earnshaw A. *Chemistry of the Elements*, Butterworth-Heinemann, 1997

CHEMISTRY PRACTICAL- AMJ 4 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Reaction of metal with halide – preparation of Grignard reagent. (only demonstration purpose)
2. Grignard preparation of dye (malachite green (using methylbenoate)/crystal violet (using diethylcarbonate) (starting material as p-bromo N, N-dimethyl aniline) (only demonstration purpose)
3. Preparation of various Schiff base-metal complexes and their identification using spectroscopy.
4. Preparation of any two of the following complexes and measurement of their conductivitymeasurement:
   a. tetraamminecarbonatocobalt (III) nitrate
   b. tetraamminecopper (II) sulphate
   c. potassium trioxalatoferrate (III) trihydrate

Reference Books

1. Synthesis of organometallic compounds: A practical guide, S. Komiya, Wiley.
2. A.I. Vogel: Qualitative Inorganic Analysis, Prentice Hall, 7th Edn.
3. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., *Textbook of Practical Organic Chemistry*, Prentice-Hall,

---

COURSES OF STUDY FOR **INTRODUCTORY/ MINOR ELECTIVE** FYUGP IN **"CHEMISTRY"**

SEMESTER I/ II/ III INTRODUCTORY REGULAR COURSE 1 Paper

I. INTRODUCTORY REGULAR COURSE (IRC)

(Credits: Theory-02, Practicals-01)

- All Four Introductory & Minor Papers of Chemistry to be studied by the Students of **Other than Chemistry Honours.**

- Students of **Chemistry Honours** must Refer Content from the **Syllabus of Opted Introductory & Minor Elective Subject**.

Marks: 75 (ESE: 3Hrs) = 75	**Pass Marks: Th (ESE) = 30**

Instruction to Question Setter for

End Semester Examination (ESE 75 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** six questions of fifteen marks each, out of which any four are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

INTRODUCTORY CHEMISTRY Theory: 60 Lectures

Course Objectives:
After completion of the course, the learner can be able to understand understand:

1. To expose the students to the basic principles of Chemistry.
2. Exposure of all three major branches of Chemistry.
3. Concept of molecular framework and chemical bonding
4. Representative elements and their chemistry.
5. Atomic theory and its evolution.
6. Learning scientific theory of atoms, concept of wave function.
7. Elements in periodic table, physical and chemical characteristics, periodicity.
8. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
9. Valence bond theory incorporating concepts of hybridization predicting geometry of molecules.
10. Basic of organic molecules, structure, bonding, reactivity and reaction mechanisms.
11. Stereochemistry of organic molecules – conformation and configuration, asymmetricmolecules and nomenclature.
12. Aromatic compounds and aromaticity, mechanism of aromatic reactions.
13. Reactivity, stability of organic molecules, structure, stereochemistry.
14. Mechanism of organic reactions (effect of nucleophile/leaving group, solvent),substitution *vs*. elimination.

Course Learning Outcomes:

1. Application of course objectives stated above.

Course Content:

Section A: Inorganic Chemistry

Atomic Structure: (2 classes each of 60 minutes duration)

Bohr's theory and its limitations. Need of a new approach to Atomic structure. Shape of *s*, *p* and *d* atomic orbitals, nodal planes. Rules for filling electrons in various orbitals, Electronic configuration

of atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energy of atomic orbitals, Anomalous electronic configurations.

Chemical Bonding and Molecular Structure: (7 classes each of 60 minutes duration)
Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage ionic character.
Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

***s*- and *p*-Block Elements: (1 class of 60 minutes duration each)**
Periodicity in *s*- and *p*-block elements with respect to electronic configuration, atomic and ionic size, ionization enthalpy, electronegativity. Inert pair effect, diagonal relationship and anomalous behaviour of first member of each group.

Compounds of *s*- and *p*-Block Elements: (2 classes each of 60 minutes duration)
Hydrides and their classification (ionic, covalent and interstitial), structure and properties with respect to stability of hydrides of p- block elements. Concept of multicentre bonding (diborane).

Transition Elements (3d series): (2 classes each of 60 minutes duration)
General group trends with special reference to electronic configuration, variable valency, colour, magnetic and catalytic properties, ability to form complexes.

Coordination Chemistry: (3 classes each of 60 minutes duration)
Valence Bond Theory (VBT): Inner and outer orbital complexes of Cr, Fe, Co, and Ni (coordination numbers 4 and 6). Structural and stereoisomerism in complexes with coordination numbers 4 and 6. Drawbacks of VBT. IUPAC system of nomenclature.

Crystal Field Theory: (3 classes each of 60 minutes duration)
Crystal field effect, octahedral symmetry. Crystal field stabilization energy (CFSE), Crystal field effects for weak and strong fields. Tetrahedral symmetry. Factors affecting the magnitude of Δ_o. Spectrochemical series. Comparison of CFSE for O_h and T_d complexes.

Section B: Organic Chemistry
Fundamentals of Organic Chemistry: (3 classes each of 60 minutes duration)
Inductive Effect, Electromeric Effect, Resonance and Hyperconjugation. Cleavage of Bonds: Homolysis and Heterolysis. Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.
Aromaticity: Benzenoids and Hückel's rule.

Alkanes: (2 classes each of 60 minutes duration) (Upto 5 Carbons)
Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent.
Reactions: Free radical Substitution: Halogenation

Alkenes: (4 classes each of 60 minutes duration) (Upto 5 Carbons)
Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule),

Reactions: cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymecuration-demercuration, Hydroboration-oxidation.

Alkynes: (2 classes each of 60 minutes duration) (Upto 5 Carbons)
Preparation: Acetylene from CaC_2 and conversion into higher alkynes, by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.
Reactions: Formation of metal acetylides, addition of bromine and alkaline $KMnO_4$, ozonolysis and oxidation with hot alk. $KMnO_4$.

Aromatic hydrocarbons: (4 classes each of 60 minutes duration)
Preparation of benzene: from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid.
Reactions of benzene: Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation).

Alkyl Halides: (5 classes each of 60 minutes duration)
Types of Nucleophilic Substitution (S_N1, S_N2 and S_Ni) reactions.
Preparation: from alkenes *and* alcohols.
Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Section C: Physical Chemistry
Chemical Energetics: (6 classes each of 60 minutes duration)
Review of thermodynamics and the Laws of Thermodynamics.
Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations. Calculation of bond energy, bond dissociation energy from thermochemical data.

Chemical Equilibrium: (4 classes each of 60 minutes duration)
Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and ΔG^o, Le Chatelier's principle.

Kinetic Theory of Gases: (4 classes each of 60 minutes duration)
Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation. Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation. van der Waals equation of state for real gases. Critical phenomena.

Chemical Kinetics: (6 classes each of 60 minutes duration)
The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation.

CHEMISTRY PRACTICAL-IRC LAB: 30 Lectures

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

Section A: Inorganic Chemistry - Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of Fe (II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
4. Estimation of Cu (II) ions iodometrically using $Na_2S_2O_3$.

Section B: Organic Chemistry

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
    a. Benzoylation of amines/phenols
    b. Oxime and 2,4 dinitrophenyl hydrazone of aldehyde/ketone

Section C: Physical Chemistry

Thermochemistry

1. Determination of heat capacity of calorimeter.
2. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
3. Determination of enthalpy of hydration of copper sulphate.

Ionic equilibria pH measurements

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

Reference Books:

- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

SEMESTER IV MINOR ELECTIVE-1 1 Paper

I. MINOR ELECTIVE (MN 1) (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (SIE + ESE) = 30

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

CHEMISTRY IN EVERYDAY LIFE Theory: 60 Lectures

Course Objectives:
This course is designed:

1. Chemical aspects of some common health hazards.
2. Chemistry of some common useful materials

Course Learning Outcomes:
On successful completion of this course the student should be able to understand:

1. Explore significance of chemistry in daily life.
2. Explore common chemicals of daily use.
3. Learn about food

Course Content:

Respiration and energy production in human body: (12 classes each of 60 minutes duration)
Respiration, Respiratory enzymes, brief outline of hemoglobin and myoglobin, oxygen transport mechanism in body, co-operativity, Respiration in lower animals, hemocyanine, hemerythrine. Energy production in body, ATP, enzyme responsible for food digestion, mechanism of food digestion, active site of cytochrome c-oxidase.

Chemical aspects of some common health hazards: (8 classes each of 60 minutes duration)
Anemia, sickle cell anemia, leukemia, blood pressure irregulation, blood sugar, arthritis, carbon monoxide poisoning in mines, cyanide poisoning, fluorosis etc.

Vitamins and minerals: (4 classes each of 60 minutes duration)
Need for vitamin in body, types of vitamins, water soluble and fat-soluble vitamins, Vitamin B 12, vitamin C (Cyanocobalamine), vitamin D, Vitamin K. Role of minerals in body, iodine deficiency and remedy.

Significance of Radical chemistry in living system: (8 classes each of 60 minutes duration)
Radical production in environment, superoxide and peroxide, health impact, action of radicals, cell mutation, diseases caused by free radical, cancer, radical quencher, anti-oxidants, natural anti-oxidants like vegetables, beverages like tea and coffee, fruits.
Radical destroying enzymes: superoxide dismutase, catalase, peroxidase, mechanism of action.

Chemistry of Materials: (12 classes each of 60 minutes duration)
Soaps and Detergents – their action, Biofuels – production of biofuels and its utility as alternative fuel source, Fibers: natural fibers, cotton, wool, silk, rayon, artificial fibers, polyamides, acrylic acid, PVC, PVA, Examples of natural biodegradable polymers, cellulose, cellulose acetate, cellophane, soya protein, corn, zein protein, wheat gluten protein, synthetic biodegradable polymers. Use of polymeric materials in daily life.

Organic farming: (10 classes each of 60 minutes duration)
Green manuring and organic fertilizers, Recycling of bio- degradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

Fermentation technology: (6 classes each of 60 minutes duration)
Scope and opportunities of fermentation technology. Principles of fermentation: Submerged, solid state, batch, fed-batch and continuous culture. Fermentative production of vinegar, alcohol (ethanol, wine, beer), acids (citric acid and gluconic acid), amino acids (lysine and glutamic acid) and antibiotics (penicillin and streptomycin).

Reference Books:

1. Srilakshmi B (2017): Nutrition Science,6th Multicolour Ed. New Age International (P) Ltd.
2. Roday S (2012): Food Science and Nutrition, 2nd Ed. Oxford University Press.
3. Mann J and Truswell S (2017): Essentials of Human Nutrition, 5th Ed. Oxford UniversityPress.
4. Wilson K and Walker J (2000): Principles and Techniques of Practical Biochemistry, 5th Ed.Oxford University Press.
5. Sadasivan S and Manikam K (2007): Biochemical Methods, 3rd Ed. New Age International (P)Ltd.
6. Oser B L (1965). Hawk's Physiological Chemistry, 14th Ed. McGraw-Hill Book
7. Gopalan C , Rama Sastri BV and Balasubramanian SC(2016): Nutritive value of Indian Foods,Indian Council of Medical Research.
8. Subalakshmi, G and Udipi, SA (2006): Food processing and preservation, 1st Ed. New Age International (P)Ltd.
9. Srilakshmi B (2018): Food Science, 7th Colour Ed. New Age International (P) Lt
10. Potter NN and Hotchkiss JH (1999): Food science,5th Ed, Spinger.
11. Kaim W, Bioinorganic Chemistry, Vol 4, Brigitte Scwederski, Wiley, 1994.
12. Crichton R. H. Biological Inorganic Chemistry – An Introduction, Elsevier, 2008.
13. Berg J. M., Tymoczeko J. L., Stryer l. Biochemistry, W. H. Freeman, 2008.
14. Bertini, I., Gray, H. B., Lippard, S. J. and Valentine, J. S. (1994) *BioinorganicChemistry.* University Science Books (1994)
15. Lippard S., Berg J. M. Principles of Bioinorganic Chemistry, University Science Books1994.
16. Polymer science, V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, New AgeInternational.
17. NIIR Board. (2012). The complete Technology Book on Biofertilizer and organic farming. 2nd Edition. NIIR Project Consultancy Services.
18. Sathe, T.V. (2004) Vermiculture and Organic Farming. Daya publishers.
19. Subba Rao N.S. (2017). Biofertilizers in Agriculture and Forestry. Fourth Edition. Medtech.
20. Vayas, S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

CHEMISTRY PRACTICAL- MN 1 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Identification of Mono, Di and polysaccharides, Identification of Proteins, Identification of glycerol., Determination of moisture content in food, ash content and determination of calcium, iron, vitamin-C.
2. Comparison with norms and interpretation of the nutritional assessment data and its significance. Weight for age, height for age, weight for height, body Mass Index (BMI) Waist - Hip Ratio (WHR). Skin fold thickness.
3. Quantitative estimation of Sugars (Glucose, lactose, starch), Estimation of acid value, iodine value, Saponification value of fats, Estimation of blood Glucose, Estimation of serum cholesterol
4. Analysis of soaps and detergents.
5. Analysis of Biofuels - flash point, pour point, cloud point
6. Preparation of Nylon-6, Nylon-66
7. Testing of adulterant in food, oil and vegetable
8. Vitamin-C preparation.

Reference Books

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
3. Waites M.J. (2008). Industrial Microbiology: An Introduction, 7th Edition, Blackwell Science, London, UK.
4. Prescott S.C., Dunn C.G., Reed G. (1982). Prescott & Dunn's Industrial Microbiology, 4th Edition, AVI Pub. Co., USA.
5. Reed G. (2004). Prescott & Dunn's industrial microbiology, 4th Edition, AVI Pub. Co., USA.
6. JR Casida L.E. (2015). Industrial Microbiology, 3rd Edition, New Age International (P) Limited Publishers, New Delhi, India.
7. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001) Industrial Microbiology: An Introduction. 1st Edition, Blackwell Science, London, UK.
8. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5th Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi.

SEMESTER V **MINOR ELECTIVE-2** **1 Paper**

I. MINOR ELECTIVE (MN 2)

(Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):

*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

ENVIRONMENTAL CHEMISTRY

Theory: 60 Lectures

Course Objectives:

After completion of the course, the learner can be able to understand understand:

1. Composition of atmosphere
2. Biogeochemical cycles
3. Hydrological cycle
4. Water quality parameters
5. Atmospheric chemical phenomena and environmental pollution
6. Water pollution, parameters of water pollution, treatment of polluted water.

Course Learning Outcomes:

On successful completion of this course the student should know:

1. Heat Budget of Earth
2. Quality parameters for water
3. Environmental pollution
4. Water pollution, parameters and treatment of polluted water.

Course Content:

Environment: (10 classes each of 60 minutes duration)

Composition of atmosphere, temperature variation of earth atmospheric system (temperature vs. altitude curve), biogeochemical cycles of C, N, P, S and O system.

Hydrosphere: (12 classes each of 60 minutes duration)

Hydrological cycle, aquatic pollution and water quality parameters – Dissolve oxygen, biochemical oxygen demand, chemical oxygen demand, Analytical methods for the determination fluoride, chromium and arsenic, residual chlorine, purification and treatment of municipal water and waste water.

Soils: (5 classes each of 60 minutes duration)
Composition, micro and macro nutrients, Pollution - fertilizers, pesticides, plastics and metals. Waste treatment.

Atmosphere: (12 classes each of 60 minutes duration)
Chemical composition of atmosphere – particle, ions, and radicals in their formation, chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, and O and their effect, pollution by chemicals, CFC, Green House effect, acid rain, air pollution and control.

Industrial Pollution: (8 classes each of 60 minutes duration)
Cement, sugar, distillery, drug, paper and pulp, thermal power plants and nuclear power plants. Polymers, drugs etc. Radionuclide analysis. Disposal of wastes and their management.

Environmental Toxicology: (7 classes each of 60 minutes duration)
Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes. Bhopal gas tragedy, Chernobyl, Three-mile island, Sewozo and Minamata disasters.

Aquatic chemistry: (6 classes each of 60 minutes duration)
Water and its necessities, various water quality parameters (DO, BOD, COD, conductivity, pH, alkalinity, hardness) and its determination, Industrial, municipal water treatment processes,Waste water treatment procedure (primary, secondary and tertiary), Solid waste treatment. Soil pollution and Noise pollution.

Reference Books:

1. De. A.K. Environmental Chemistry, Wiley Eastern Ltd, 1990.
2. Miller T.G. Jr., Environmental Science, Wadsworth publishing House, Meerut, Odum. E.P.1971.
3. Odum, E.P. (1971) Fundamentals of Ecology. Third Edition, W.B. Saunders Co.,Philadelphia
4. S. E. Manahan, Environmental chemistry, 1993, Boca Raton, Lewis publisher
5. Environmental chemistry, Sharma and Kaur, 2016, Krishna publishers
6. Environmental Pollution, Monitoring and control, S.M. Khopker, 2007, New AgeInternational.
7. Environmental chemistry, C. Baird, M. Cann, 5th Edn, 2012, W.H. Freeman publication.
8. G. S. Sodhi Fundamental Concepts of Environmental Chemistry (Third Ed) Narosa (2009).
9. Principles of instrumental analysis: D. A. Skoog, Fifth Edition, Sauns College Publishing(London)
10. Basic concepts of analytical chemistry: S. M. Khopkar, Wiley Eastern (1995)

CHEMISTRY PRACTICAL- MN 2 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Determination of water quality parameters in following aspect:
2. Determination of dissolved oxygen in given water (chemical method/instrumentation method).
3. Determination of Biological Oxygen Demand (BOD).
4. Determination of Chemical Oxygen Demand (COD).
5. Finding out percentage of available chlorine in bleaching powder.
6. Measurement of chloride, sulphate and salinity of water samples by titration method ($AgNO_3$ and potassium chromate).
7. Estimation of total alkalinity of water samples (carbonate, bicarbonate) by titration method.
8. Estimation of SPM in air samples.

Reference Books

1. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, John Wiley &Sons, Inc. Publishers, New Delhi. (2005 edition).
2. J. A. Kent: Riegel's *Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
3. S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
4. A. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
5. S. M. Khopkar, *Environmental Pollution Analysis*: New Age Int. Publisher, New Delhi.

SEMESTER VI **MINOR ELECTIVE-3** **1 Paper**

I. MINOR ELECTIVE (MN 3)) (Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attd. + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	**Pass Marks: Th (SIE + ESE) = 30**

Instruction to Question Setter for

Semester Internal Examination (SIE 10+5=15 marks):
*There will be **two** group of questions. Question No.1 will be **very short answer type in Group A** consisting of five questions of 1 mark each. **Group B will contain descriptive type** two questions of five marks each, out of which any one to answer.*

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Test (SIA) of 10 Marks, (b) Class Attendance Score (CAS) of 5 marks. Conversion of Attendance into score may be as follows: (Attendance Upto 45%, 1mark, 45<Attd.<55, 2 marks, 55<Attd.<65, 3 marks, 65<Attd.<75, 4 marks, 75<Attd, 5 marks)

End Semester Examination (ESE 60 marks):
*There will be **two** group of questions. **Group A is compulsory** which will contain three questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks. **Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to answer.*

***Note:** There may be subdivisions in each question asked in Theory Examinations.*

CHEMISTRY OF FOOD, NUTRITION AND PRESERVATION

Theory: 60 Lectures

Course Objectives:
After completion of the course, the learner shall be able to understand understand:

1. Basic human physiology
2. About the basic of human physiological system and food science
3. To learn about the nutrition and its importance
4. To learn about the food preservation and its utility.
5. Important component of healthy food
6. Excess and deficiency of nutrition
7. Food preservatives
8. Preserved products
9. Food standards

Course Learning Outcomes:
On successful completion of this course the student should know:

1. To know about the basic of human physiological system and food science
2. To learn about the nutrition and its importance
3. To learn about the food preservation and its utility.

Course Content:

Basic of human physiological system and food science: **(15 classes each of 60 minutes duration)**
Digestive System: Structure and functions of G.I. tract, Process of digestion and absorption of food, Structure and functions of liver, gallbladder and pancreas. Basic concept on Food, Nutrition and Nutrients (Nutrition, Malnutrition and Health: Scope of Nutrition.), Classification of Food, Classification of Nutrients.

Concept of Energy in Bio-systems: (10 classes each of 60 minutes duration)

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.

Nutrition: (10 classes each of 60 minutes duration)

Dietary fibers (composition, properties and Minerals and trace elements (biochemical and physiological role, bioavailability and requirement with examples), Vitamins (examples, biochemical and physiological requirements, deficiency and excesses), Water (requirement, water balance), basic idea about community nutrition (objective, importance of various programmes).

Microbial culture: (10 classes each of 60 minutes duration)

Preparation of microbial culture, Preparation and sterilization of fermentation medium. Isolation and improvement of industrially important microorganisms.

Maintenance and preservation of microorganisms, Metabolic regulations and overproduction of metabolites. Kinetics of microbial growth and product formation.

Food preservation: (12 classes each of 60 minutes duration)

Food preservation: definition, objectives and principles of food preservation. Different methods of food preservation. Preserved Products: Jam, Jelly, Sauces, Pickles, Squashes, Syrups - types, composition and manufacture, selection, cost, storage, uses and nutritional aspects.

Food Standards: ISI, Agmark, FPO, MPO, PFA, FSSAI.

Analysis of food products: (3 classes each of 60 minutes duration)

Nutritional value of foods, idea about food processing, food preservations and adulteration.

Reference Books:

1. Berg, J.M., Tymoczko, J.L. & Stryer, L. (2006) *Biochemistr*y. 6th Ed. W.H. Freeman and Co.
2. Nelson, D.L., Cox, M.M. & Lehninger, A.L. (2009) *Principles of Biochemistry. IV Edition.* W.H. Freeman and Co.
3. Murray, R.K., Granner, D.K., Mayes, P.A. & Rodwell, V.W. (2009) *Harper's*
4. *Illustrated Biochemistry.* XXVIII edition. Lange Medical Books/ McGraw-Hill.
5. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
6. Srilakshmi B (2017): Nutrition Science,6th Multicolour Ed. New Age International (P) Ltd.
7. Roday S (2012): Food Science and Nutrition, 2nd Ed. Oxford University Press.
8. Mann J and Truswell S (2017): Essentials of Human Nutrition, 5th Ed. Oxford University Press.
9. Gopalan C, Rama Sastri BV and Balasubramanian SC (2016): Nutritive value of Indian Foods, Indian Council of Medical Research.
10. Subalakshmi, G and Udipi, SA (2006): Food processing and preservation, 1st Ed. New Age International (P)Ltd.
11. Srilakshmi B (2018): Food Science, 7th Colour Ed. New Age International (P) Lt
12. Potter NN and Hotchkiss JH (1999): Food science,5th Ed, Spinger.

CHEMISTRY PRACTICAL- MN 3 LAB:

Marks : Pr (ESE: 3Hrs) =25	Pass Marks: Pr (ESE) = 10

Instruction to Question Setter for

End Semester Examination (ESE):
There will be one Practical Examination of 3Hrs duration. Evaluation of Practical Examination may be as per the following guidelines:

Experiment	*= 15 marks*
Practical record notebook	*= 05 marks*
Viva-voce	*= 05 marks*

PRACTICALS: 60 Lectures

1. Identification of Mono, Di and polysaccharides, Identification of Proteins, Identification of glycerol., Determination of moisture content in food, ash content and determination of calcium, iron, vitamin-C.
2. Comparison with norms and interpretation of the nutritional assessment data and its significance. Weight for age, height for age, weight for height, Body Mass Index (BMI), Waist - Hip Ratio (WHR), Skin fold thickness.
3. Quantitative estimation of Sugars (Glucose, lactose, starch), Estimation of acid value, iodine value, Saponification value of fats, Estimation of blood Glucose, Estimation of serum cholesterol

Reference Books

1. Srilakshmi B (2017): Nutrition Science, 6th Multicolour Ed. New Age International (P) Ltd.
2. Roday S (2012): Food Science and Nutrition, 2nd Ed. Oxford University Press.
3. Mann J and Truswell S (2017): Essentials of Human Nutrition, 5th Ed. Oxford UniversityPress.
4. Wilson K and Walker J (2000): Principles and Techniques of Practical Biochemistry, 5th Ed.Oxford University Press.
5. Sadasivan S and Manikam K (2007): Biochemical Methods, 3rd Ed. New Age International (P)Ltd.
6. Oser B L (1965). Hawk's Physiological Chemistry, 14th Ed. McGraw-Hill Book
7. GopalanC , Rama Sastri BV and Balasubramanian SC (2016): Nutritive value of Indian Foods,Indian Council of Medical Research.
8. Subalakshmi, G and Udipi, SA (2006) Food processing and preservation, 1st Ed. New Age International (P) Ltd.
9. Srilakshmi B (2018): Food Science, 7th Colour Ed. New Age International (P) Lt
10. Potter NN and Hotchkiss JH (1999): Food science,5th Ed, Spinger.

FORMAT OF QUESTION PAPER FOR SEMESTER INTERNAL EXAMINATION

Question format for **10 Marks**:

Subject/ Code

F.M. =10 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [5]
3. ..... [5]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

FORMAT OF QUESTION PAPER FOR END SEMESTER UNIVERSITY EXAMINATION

Question format for **50 Marks**:

Subject/ Code

F.M. =50 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....

Group B

2. ..... [15]
3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **60 Marks**:

Subject/ Code

F.M. =60 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **75 Marks**:

Subject/ Code

F.M. = 75 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]
9. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **100 Marks**:

Subject/ Code

F.M. = 100 **Time**=3Hrs. Exam Year

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [10x1=10]
   i. ..... vi. .....
   ii. ..... vii. .....
   iii. ..... viii. .....
   iv. ..... ix. .....
   v. ..... x .....
2. ..... [5]
3. ..... [5]

Group B

4. ..... [20]
5. ..... [20]
6. ..... [20]
7. ..... [20]
8. ..... [20]
9. ..... [20]

Note: There may be subdivisions in each question asked in Theory Examination.