Four Year Under Graduate Programme (FYUGP)

As per provisions of NEP-2020

Vinoba Bhave University Hazaribag

Subject: **Chemistry**

To be implemented from the Academic Year **2022-23**

(From session 2022-26)

Syllabus for Semester -I

Members of Board of studies

Dr. S.K. Sahay HOD Chem. KBW College	Prof. S.K. Buxi HOD Chem. Annada College	Dr. R.K. Karn HOD Chem. Markham College of Commerce	Prof. Deepak Kumar HOD Chem. St. Columba's College	Dr. Pranita (P.G. Dept. of Chem.)	Dr. F. Rafat (P.G. Dept. of Chem.)	Dr. A.K. Saha (P.G. Dept. of Chem.)	Dr. K. Kumar (P.G. Dept. of Chem.)	Dr. S.S. Singh (P.G. Dept. of Chem.)	Dr. I. Kumar (HOD)	Dr. Rajnish Kumar Prof. & Proctor Patna Univ. (Ext. Expert)

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

Table 1: Credit Framework for Four Year Undergraduate Programme (FYUGP) under State Universities of Jharkhand [Total Credits = 176]

	Common Courses (29)									Introductory Courses (15)				Minor** (32)		Research Courses (18)				Total Credit
Semester	Language and Communication Skills (6)	LCS (English) (6)	Environmental Studies (3)	Understanding India (2)	Health & Wellness, Yoga Education, Sports & Fitness (2)	Digital Education (3)	Mathematical & Computational Thinking and Analysis (2)	VBC/ GCE (2)	Community Engagement/ NCC/ NSS/ (3)	Introductory Regular Courses [Natural Sc./ Humanities/ Soc. Sc./Commerce] (9)	Introductory Vocational Studies (6)	Internship/ Project (4)	Major* (54) + Adv. Major (24)	Nat. Sc./ Hum. / Soc. Sc./ Commerce (18)	Vocational Studies (14)	Research Methodology Courses (6)	Research proposal, Review of literature (4)	Research Internship/ Field Work (4)	Preparation of the RPR (4)	**176**
1	2	3	4	5	6	7	8	9	10	11	14	15	16	17	18	19	20	21	22	
I	6			2	2					3	3		6							**22**
II		6					2	2		3	3		6							**22**
Exit Point: Undergraduate Certificate																				
III			3			3			3	3		4	6							**22**
IV													6+6							**22**
Exit Point: Undergraduate Diploma																				
V													6+6	6	4					**22**
VI													6+6	6	4					**22**
Exit Point: Bachelor's Degree																				
VII													6+6 (Adv. Topics)			6	4			**22**
VIII													6+6 (Adv. Topics)		2			4	4	**22**
Exit Point: Bachelor's Degree with Hons. /Research																				

(LCS= Language & Communication skill, VBC = Value Based Course, GCE= Global Citizenship Education, RPR = Research Project Report,

*There will be four disciplinary areas: A-Natural Science, B-Humanities, C-Social Science, and D-Commerce; each having basket of courses. A student will have to select a 'Major' 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 in Major and cut-off marks imposed by the institution.

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

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			(6+6=12 Credits)	(6 Credits)	MJ-4, MJ-5 (4 Credits)	MN-1	VS-1 **(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 (6+6=12 Credits)	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	Advanced Major paper 1 (Disciplinary/Interdisciplinary Major)	6
	AMJ-2	Advanced Major paper 2 (Disciplinary/Interdisciplinary Major)	6
	RC-1	Research Methodology	6
	RC-2	Research Proposal	4
VIII	AMJ-3	Advanced Major paper 3 (Disciplinary/Interdisciplinary Major)	6
	AMJ-4	Advanced 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 Advanced Major Disciplinary/Interdisciplinary Courses
RC Research Courses
VSR Vocational Studies associated with Research

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.

Programme learning outcome

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

(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 use the evidence based comparative chemistry approach to explain the chemical synthesis and analysis.

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

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

(vi) Students will be able to 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 include 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/ II/ III INTRODUCTORY REGULAR COURSE 1 Paper

I. INTRODUCTORY REGULAR COURSE (IRC)

(Credits: Theory-03, Practicals-0)

- The INTRODUCTORY REGULAR COURSE (IRC) of Chemistry is to be studied by the Students opting major subject other than **Chemistry.**

- Students opting **Chemistry as major subject have to select** a subject associated with **Chemistry** (such as Physics, Mathematics, Botany, Zoology, Geology, Statistics, etc.) **as INTRODUCTORY REGULAR COURSE.**

Marks: 25 (5 Attendance & others + 20 SIE: 1.5Hr) + 75 (ESE: 3Hrs) = 100	**Pass Marks: Th (MSE + ESE) = 40**

Instruction to Question Setter

Semester Internal Examination (SIE 20+5=25 marks):

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 20 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE 75 marks):

*There will be **two** group of questions. **Group A** will contain three questions in which all are to be answered. **Question No.1** will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks each. **Group B will contain descriptive type (Long answer type)** seven questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question of **group B**.*

INTRODUCTORY CHEMISTRY Theory: 45 Lectures

Course Objectives:

This course is designed:

- To expose the students to the basic principles of chemistry
- To introduce the first course

Course Learning Outcomes:

On successful completion of this course, the student will be able to understand other subjects such as Botany, Zoology, Geology, etc more easily.

Course Outlines:

Atomic Structure, Periodicity, Chemical Bonding and Molecular Structure, Gaseous state, Solutions, Introduction to Organic Chemistry, Organic reaction mechanism

Course Content:

1. **Atomic structure:**
   Bohr's atomic theory, Calculation of radius of orbits of atom and calculation of energy of electron in hydrogen-like atoms, Electromagnetic radiation and electromagnetic spectrum, hydrogen spectrum and its origin, Limitations of Bohr's atomic theory, de-Broglie theory, Heisenberg's uncertainty principle, quantum numbers, Aufbau principle, Hund's rule, Pauli's exclusion principle, electronic configuration of atoms and ions.

   (8 Lectures)

2. **Periodicity:**
   Modern periodic law and modern periodic table, Classification of elements into blocks, Atomic radius, Ionisation energy, Electron affinity, Electronegativity and their variation in the periodic table, Diagonal relationship.

   (6 Lectures)

3. **Chemical bonding:**
   General idea about chemical bonds and their types- ionic bond, covalent bond and coordinate bond, Valence bond theory of covalency, Explanation of shapes of molecules/ions: VSPER theory and hybridisation, Covalent character in ionic bond, Ionic character in covalent bond, Intermolecular forces.

   (6 Lectures)

4. **Gaseous state:**
   Ideal gas and ideal gas equation, Kinetic theory of gases, Real gases and their deviation from ideal gas behaviour, van der Waals equation and its derivation, Significance & units of van der Waals constants.

   (6 Lectures)

5. **Solutions:**
   Solutions and their classifications, Concentration of solution and various terms used to express the strength of solution, Calculations related to strength of solution, Idea of colligative properties and vapour pressure of solution, Ideal and non-ideal solutions,

   (6 Lectures)

6. **Introduction to organic chemistry:**
   Organic compounds and their classification, Functional group, Homologous series, Types of carbon chains, carbon atoms & hydrogen atoms, IUPAC nomenclature of organic compounds, Hybridisation and shapes of organic molecules, General idea about structural isomerism and stereoisomerism in organic compounds, Aromaticity and its implications.

   (8 Lectures)

7. **Organic reaction mechanism:**
   Fission of covalent bonds, Electrophiles and nucleophiles, Electronic displacements in organic molecules-Inductive effect, electromeric effect & Mesomeric effect, Resonance, Basic ideas of organic reaction intermediates- carbocation, carbanion, free radicals and Types of organic reactions.

   (5 Lectures)

Reference Books:

1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5th Edn.
2. Indrajit Kumar and Ashish Kumar Saha, Undergraduate Chemistry, Pragati Prakashan Meerut, 2021.
3. Atkins, P. W. and De Paula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press, 2014.
4. Morrison, R. N. & Boyd, R. N. *Organic Chemistry*, 6th Edn., Dorling Kindersley (India)Pvt. Ltd. (Pearson Education).
5. Pine S. H. Organic Chemistry, Fifth Edition, McGraw Hill, 2007
6. F. A. Carey, Organic Chemistry, Seventh Edition, Tata McGraw Hill, 2008.
7. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, 2nd Ed., 2012, Oxford University Press.
8. F. A. Carey, R. J. Sundberg, Advanced Organic Chemistry, Part A: Structure andmechanism, Kluwer Academic Publisher, 2000.

I. MAJOR COURSE –MJ 1:

(Credits: Theory-04, Practicals-02)

Marks: 15 (5 Attendance & others + 10 SIE: 1Hr) + 60 (ESE: 3Hrs) = 75	Pass Marks: Th (MSE + ESE) = 30

Instruction to Question Setter for

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

The Semester Internal Examination shall have two components. (a) One Semester Internal Assessment Written Test (SIA) of 15 Mark (b) Class Attendance Score (CAS) including the behaviour of the student towards teachers and other students of the College of 5 marks.

End Semester Examination (ESE 60 marks):

*There will be **two** group of questions. **Group A** will contain three questions in which all are to be answered. **Question No.1** will be **very short answer type (not MCQ)** consisting of five questions of 1 mark each. **Question No.2 & 3 will be short answer type** of 5 marks each.**Group B will contain descriptive type** five questions of fifteen marks each, out of which any three are to be answered.*

***Note:** There may be subdivisions in each question of group B.*

INORGANIC CHEMISTRY-I Theory: 60 Lectures

Course Objectives:

On completion of this course, the students will be able to 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. Identity of given element, relative size, charges of proton, neutron and electrons, and their assembly to form different atoms.
7. Defining isotopes, isobars and isotones.
8. Physical and chemical characteristics of elements in various groups and periods according to ionic size, charge, etc. and position in periodic table.
9. Characterize bonding between atoms, molecules, interaction, and energetics
10. Hybridization and shapes of atomic, molecular orbitals, bond parameters, bond- distances and energies.
11. Valence bond theory, concept of hybridization, predicting geometry of molecules.
12. Importance of hydrogen bonding and metallic bonding.

Course Learning Outcomes:

On successful completion of this course the student will be able to know:

1. Electronic configuration of various elements in periodic table
2. Periodicity
3. Predicting structure of molecules
4. Effect of hydrogen bonding
5. Inorganic polymers

Course Outlines:

Atomic Structure, Chemical Bonding: lonic bond, Covalent bond, Metallic Bond, Weak Chemical Forces, Oxidation-Reduction and general principle of metallurgy, Inorganic Polymers

Course Content:

1. Atomic Structure: (12 Lectures)

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. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

2. Periodicity of Elements:

The long form of periodic table, *s*, *p*, *d* and *f* - block elements, Detailed discussion of the following properties of the elements, with reference to *s* & *p*-block.

a. Effective nuclear charge, shielding 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
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 and Allred Rochow scales, electronegativity and polarisation of bonds.

(12 Lectures)

3. Chemical Bonding:

(i) *Ionic bond:*

Ionic bond- general characteristics of ionic compounds, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation, expression for lattice energy, Madelung's constant, Born-Haber cycle and its applications, Solvation energy.

(4 Lectures)

(ii) *Covalent bond:*

Lewis structure, Valence Shell Electron Pair Repulsion Theory (VSEPR), Shapes of simple molecules and ions, 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, Bent's 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, Ionic character in covalent compounds: Bond moment and dipole moment, Ionic character from dipole moment and electronegativities.

(12 Lectures)

(iii) *Metallic Bond:*

Qualitative idea of free electron model, Molecular orbital theory/Band theory and explanation of Conductors, Semiconductors & Insulators with examples.

(6 Lectures)

(iv) *Weak Chemical Forces:*

van der Waals forces, ion-dipole, dipole-dipole & dipole - induced dipole interactions, Lenard-Jones potential, hydrogen bonding and its effects on melting point, boiling point and solubility of compounds.

(6 Lectures)

4. Inorganic Polymers:

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

(8 Lectures)

Reference Books:

1. Lee, J. D. *Concise Inorganic Chemistry,* Wiley, 5th Edn.
2. Indrajit Kumar and Ashish Kumar Saha, Undergraduate Chemistry, Pragati Prakashan Meerut, 2021.
3. Douglas, B.E., McDaniel, D.H., Alexander J.J., *Concepts & Models of Inorganic Chemistry, (Third Edition)* John Wiley & Sons, 1999.
4. Atkins, P. W. and De Paula, J. *Physical Chemistry*, Tenth Edition, Oxford University Press, 2014.
5. Rodger, G. E. *Inorganic and Solid-State Chemistry*, Cengage Learning, 2002.
6. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry3rd Ed.*, John Wiley Sons, N.Y. , 1994.
7. Rodger, G.E. *Inorganic and Solid-State Chemistry*, Cengage Learning India Edition, 2002.
8. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry* Fourth Ed., Pearson, 2010
9. Dr. S. K. Agrawal and Dr. Keemti Lal , Advanced Inorganic Chemistry, Pragati Prakashan Meerut, 2020.

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

Experiment (1)	*= 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) and oxalic acid using standardized $KMnO_4$ solution.
- (ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
- (iii) 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.
