NAAC-★★★★

ST. XAVIER'S COLLEGE
(An Autonomous College of Ranchi University)
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Department of Chemistry

Ref. .....

Date. 29/11/2024

To,

Rev. Fr. Principal
St. Xavier's College Ranchi.

Subject: - Approval of syllabus in Chemistry for PG /M.Sc. Chemistry for session 2022 - 2024 and 2023 – 2025.

Respected sir,

This is to submit that the internal expert committee of Department of Chemistry St. Xavier's College Ranchi, consisting of faculty members, Chemistry Department, St. Xavier's College do approve the syllabuses for two year post graduate program under choice based credit scheme (CBCS) designed by Ranchi University for session 2022-2024 and 2023-2025.

The same syllabuses mentioned above is to be followed for PG / M.Sc. in Chemistry in St. Xavier's College Ranchi in Toto, without any change.

List of Internal Expert Committee — Signature

1. Dr. U. R. Sen- (Chairman) H.O.D. Sxc Ranchi of Chemistry) — 29/11/24 — 29/11/2024
2. Dr. N.K. Roy- Member, Department of Chemistry
3. Dr. H.N. Kumar - Member, Department of Chemistry — 29.11.24
4. Dr. S.K. Pandey- Member, Department of Chemistry
5. Dr. Anita Karmokar -Member, Department of Chemistry — A. Karmakar 29/11/24
6. Dr. Sumita Hazra - Member, Department of Chemistry
7. Dr. Reman Kumar Singh- Member, Department of Chemistry — Reman 29/11/24

29/11/2024

H.O.D, Chemistry
St. Xavier's College Ranchi.

HEAD
DEPARTMENT OF CHEMISTRY
ST. XAVIER'S COLLEGE. RANCHI

MODIFIED CBCS CURRICULUM OF

M.Sc. CHEMISTRY PROGRAMME

SUBJECT CODE = CHE

FOR POST GRADUATE COURSES UNDER RANCHI UNIVERSITY

Implemented w.e.f.
Academic Session 2018-2020

30/11/24

30/11/2024

Members of Board of Studies of CBCS P.G. Syllabus as per Guidelines of the Ranchi University, Ranchi.

1. **Chairman –**

   Dr. Hari Om Pandey
   Associate Professor & Head,
   University Department of Chemistry, Ranchi University, Ranchi

2. **Internal Members-**

   i. **Dr. Mahmood Alam**
   Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   ii. **Dr. Sanjoy Misra**
   Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   iii. **Dr. Sudhanshu Shekhar Singh**
   Associate Professor,
   University Department of Chemistry, Ranchi University, Ranchi

   iv. **Dr. Anil Kumar Delta**
   Associate Professor,
   University Department of Chemistry, Ranchi University, Ranchi

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

   vi. **Dr. Neeraj**
   Assistant Professor,
   University Department of Chemistry, Ranchi University, Ranchi
   & OSD Examinations, Ranchi University, Ranchi

3. **External Members :-**

   i. **Dr. A.K. Sinha**
   Associate Professor & Head, S.S. Memorial College, R.U., Ranchi

   ii. **Dr. Khurshid Akhtar**
   Assistant Professor(SS) & Head, Shyama Prasad Mukherjee University, Ranchi

   iii. **Dr. Neeta Sinha**
   Assistant Professor & Head, Ranchi Womens' College, Ranchi

   iv. **Dr. Reena Bhadani**
   Assistant Professor, Ranchi Womens' College, Ranchi

   v. **Dr. Shilpi Singh**
   Assistant Professor & Head, Doranda College, Ranchi University, Ranchi

Submitted for publication on R.U. Website

HEAD
Department of Chemistry
University, Ranchi

Dr. Hari Om Pandey
H.O.D.
HEAD
Department of Chemistry
Ranchi University, Ranchi

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COURSE STUCTURE FOR M.Sc. CHEMISTRY

Table AI-1: Distribution of 80 Credits for Subjects having Practical Papers

[*wherever there is a practical examination there will be no tutorial and vice –versa.]

Course	Papers	Credits Theory + Practical	Credits Theory + Tutorial
I. Foundation Course (FC)			
1. Foundation Course Compulsory Foundation/ Elective Foundation	**(FC)** 1 Paper	1X5=5	1X5=5
II. Core Course (CC)	**(CC 1 to 10/11)**		
Theory	7 Papers/11 Papers	7X5=35	11X5=55
Practical/ Tutorial*	3 Papers/----------	3X5=15	
Project	1 Paper	1X5=5	1X5=5
III. Elective Course (EC)			
A. Ability Enhancement Course of the Core Course opted	**(AE/EC 1)** 1 Paper	1X5=5	1X5=5
B. Discipline Centric Elective	**(DC/EC 2&3)**		
Theory +	2 Papers	2X5=10	
Practical	1 Paper	1x5=5	
OR Theory/Practical/Tutorial*	1Paper + 1 Practical/Dissertation		2X5=10
OR Generic Elective/ Interdisciplinary	**(GE/EC 2&3)**		
Theory OR	2 Papers		
Theory/Practical/Tutorial*	1 Paper + 1 Practical/Dissertation		
	Total Credit = 80		**= 80**

Table AI-1.1: Course structure for M.Sc Programme with Practical Papers

Semester	Subject (Core Courses) 11 Papers	Allied (Elective Courses) 4 Papers	Foundation Course (Compulsory Course) 1 Paper	Total Credits
Sem-I	C-1, C-2, C-3 (5+5+5=15 Credits)		Foundation Course FC (05 Credits)	**20 Credits**
Sem-II	C-4, C-5, C-6, C-7 (5+5+5+5=20 Credits)			**20 Credits**
Sem-III	C-8, C-9, C-10 (5+5+5=15 Credits)	EC1 (05 Credits)		**20 Credits**
Sem-IV	C-11 (Project) (05 Credits)	EC2, EC3, EP (5+5+5=15Credits)		**20 Credits**
				Total = 80 Credits

Table AI-2 Subject Combinations allowed for M. Sc. Programme (80 Credits)

Foundation Course FC 1 Paper	Core Subject CC 11 Papers	Ability Enhancement Course AE 1 Paper	Discipline Centric Elective/ Generic Elective Course DC/ GE/ EC 3 Papers

Table AI-2.1 Semester wise Examination Structure for Mid Sem & End Sem Examinations:

Sem	Core, AE/ GE/ DC/ EC & Compulsory FC Courses				Examination Structure		
	Paper	Paper Code	Credit	Name of Paper	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical / Viva (F.M.)
I	Foundation Course	FCCHE101	5	Foundation Course	30	70	----
	Core Course	CCCHE102	5	Inorganic Chemistry-I	30	70	----
	Core Course	CCCHE103	5	Organic Chemistry-I	30	70	----
	Practical's on Core	CPCHE104	5	Practical-I	----	----	70 + 30
II	Core Course	CCCHE201	5	Analytical Chemistry	30	70	----
	Core Course	CCCHE202	5	Physical Chemistry-I	30	70	----
	Core Course	CCCHE203	5	Group Theory & Spectroscopy	30	70	----
	Practical's on Core	CPCHE204	5	Practical-II	----	----	70 + 30
III	Ability Enhancement Course	ECCHE301	5	A. Bio-Chemistry/ B. Photo Inorganic Chemistry/ C. Computer for Chemists	30	70	----
	Core Course	CCCHE302	5	Environmental Chemistry	30	70	----
	Core Course	CCCHE303	5	Applications of Spectroscopy	30	70	----
	Practical's on Core	CPCHE304	5	Practical-III	----	----	70 + 30
IV	Elective	ECCHE401	5	A. Inorganic-II/ B. Organic-II/ C. Physical-II	30	70	----
	Elective	ECCHE402	5	A. Inorganic-III/ B. Organic-III/ C. Physical-III	30	70	----
	Practical's on Elective	EPCHE403	5	A. Practical Inorganic-IV/ B. Practical Organic-IV/ C. Practical Physical-IV	----	----	70 + 30
	PROJECT	PRCHE404	5	Project Work	----	----	70 + 30

SEMESTER I — 4 Papers

Total 100 x 4 = 400 Marks

I. COMPULSORY FOUNDATION COURSE [FCCHE101]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 **Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

FOUNDATION COURSE — Theory: 60 Hours; Tutorial: 15 Hours

I Stereochemistry and Bonding in Main Group Compounds — 10 Hrs

VSEPR, Walsh diagrams (tri-atomic molecules of type AH_2), dp-pp bonds, Bent rule and energetic of hybridization, some simple reactions of covalently bonded molecules, Atomic Inversion, Berry Pseudorotation.

II Acids, Bases, Electrophiles, Nucleophiles and Catalysis — 05 Hrs

Acid-base dissociation. Electronic and structural effects, acidity and basicity. Acidity functions and their applications. Hard and soft acids and bases. Nucleophilicity scales. Nucleofugacity. The α-effect. Ambivalent nucleophiles. Acid-base catalysis- specific and general catalysis. Bronsted catalysis. Nucleophilic and electrophilic catalysis. Catalysis by non- covalent binding-micellar catalysis.

III Nature of Bonding in Organic Molecules — 10 Hrs

Delocalized chemical bonding-conjugation, cross conjugation, resonance, hyper conjugation, bonding in fullerenes, tautomerism.
Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbons, Huckel's rule, energy level of 7-molecular orbitals, annulenes, anti-aromaticity, Y-aromaticity, homo-aromaticity, PMO approach.

Bonds weaker than covalent- addition compounds, crown ether complexes and cryptands, inclusion compounds, cyclodextrins, catenanes and rotaxanes.

IV Stereochemistry **12 Hrs**

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity, conformation of sugars, steric strain due to unavoidable crowding.

Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral carbon (biphenyls, allenes and spiranes), chirality due to helical shape.

Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

V Introduction to Exact Quantum Mechanical Results **07 Hrs**

The Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom.

VI Unifying Principles **10 Hrs**

Electromagnetic radiation, interaction of electromagnetic radiation with matter-absorption, emission, transmission, reflection, refraction, dispersion, polarisation and scattering. Uncertainty relation and natural line width and natural line broadening, transition probability, results of the time dependent perturbation theory, transition moment, selection rules, intensity of spectral lines, Born-Oppenheimer approximation, rotational, vibrational and electronic energy levels.

VII Metal-Ligand Equilibria in Solution **06 Hrs**

Step wise and overall formation constants and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, chelate effect and its thermodynamic origin, determination of binary formation constants by pH-metry and spectrophotometry.

Books Suggested:

- Inorganic Chemistry, J.E. Huhey, Harpes & Row.
- Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
- Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
- Quantum Chemistry, Ira N. Levine, Prentice Hall.
- Chemical Applications of Group Theory, F. A. Cotton.
- Physical Methods in Chemistry, R.S. Drago, Saunders College.
- Introduction to Molecular Spectroseopy, Q.M. Barrow, McCraw Hill.

II. CORE COURSE [CCCHE102]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

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

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

INORGANIC CHEMISTRY-I Theory: 60 Hours; Tutorial: 15 Hours

I. Reaction Mechanism of Transition Metal Complexes 20 Hrs

Energy profile of a reaction, reactivity of metal complexes, inert and labile complexes, kinetic application of valence bond and crystal field theories, kinetics of octahedral substitution, acid hydrolysis, factors affecting acid hydrolysis, base hydrolysis, conjugate base mechanism, direct and indirect evidences in favour of conjugate mechanism, anation reactions, reactions without metal ligand bond cleavage. Substitution reactions in square planar complexes, the trans effect, mechanism of the substitution reaction. Redox reactions, electron transfer reactions, mechanism of one electron transfer reactions, outer- sphere type reactions, cross reactions and Marcus-Hush theory, inner sphere type reactions

II. Metal-Ligand Bonding 05 Hrs

Limitation of crystal field theory, molecular orbital theory, octahedral, tetrahedral and square planar complexes, p-bonding and molecular orbital theory.

III. Electronic Spectra and Magnetic Properties of Transition Metal Complexes 12 Hrs

Spectroscopic ground states, correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), calculations of Dq, B and β parameters, charge transfer spectra, spectroscopic method of assignment of absolute configuration in optically active metal chelates and their stereochemical information, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

IV. Metal Clusters 05 Hrs

Higher boranes, carboranes, metalloboranes and metallocarboranes. Metal carbonyl and halide clusters, compounds with metal-metal multiple bonds.

V. Metal π-Complexes 15 Hrs

Metal carbonyls, structure and bonding, vibrational spectra of metal carbonyls for bonding and structural elucidation, important reactions of metal carbonyls; preparation, bonding, structure and important reactions of transition metal nitrosyl, dinitrogen and dioxygen complexes: tertiary phosphine as ligand.

VI. Isopoly and Heteropoly Acids and Salts 03 Hrs

Books Suggested:

- Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
- Inorganic Chemistry, J.E. Huhey, Harpes & Row;
- Chemisiry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon.
- Inorganic Electron ioSpeci roscopy, A. B. P. Leve r, Elsevier.
- Magnetochemistry, R.L. Cariin, Springer Vertag,
- Comprehensive Coordination Chemistry eds., Q. Wilkinson, R.D. Gillars and J.A. Mc Cleverty, Pergamon.

III. CORE COURSE [CCCHE103]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ORGANIC CHEMISTRY-I Theory: 60 Hours; Tutorial:15 Hours

1 Reaction Mechanism: Structure and Reactivity 10 Hrs

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, kinetic and thermodynamic control, Hammond's postulate, Potential energy diagrams, transition states and intermediates, methods of determining mechanisms, isotope effects. Hard and soft acids and bases. Generation, structure, stability and reactivity of carbocations, carbanions, free radicals, carbenes and nitrenes.

Effect of structure on reactivity, resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship, substituent and reaction constants. Taft equation.

Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates, Steric LFER. Conformational barrier to bond rotation-spectroscopic detection of individual conformers. Acyclic and monocyclic systems. Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.

II Aliphatic Nucleophilic Substitution 12 Hrs

The S_N2, S_N1, mixed S_N1 and S_N2 and SET mechanisms. Structural and electronic effects on S_N1 and S_N2 reactivity. Solvent effects. Kinetic isotope effects. Intramolecular assistance: Electron transfer nature of S_N2 reaction.

The neighbouring group mechanism, neighbouring group participation by R and π-bonds, anchimeric assistance.

Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations.
The S_Ni mechanism. Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon. Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

III Aliphatic Electrophilic Substitution **05 Hrs**

Elecrophilic reactivity, general mechanism. Bimolecular mechanisms- S_E2 and S_Ei. The S_E1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.
Kinetic of S_E2-Ar reaction. Structural effects on rates and selectivity.

IV Addition to Carbon-Carbon Multiple Bonds **05 Hrs**

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemo-selectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenartion of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidation.

V Addition to Carbon-Hetero Multiple Bonds **05 Hrs**

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, Organozinc and Organolithium reagents to carbonyl and unsaturated carbonyl compounds. Mechanism of condensation reactions involving enolates- Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions. Hydrolysis of esters and amides, ammonolysis of esters.

VI Aromatic Electrophilic Substitution **8 Hrs**

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.

VII Aromatic Nucleophilic Substitution **05 Hrs**

The S_NAr, S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity - effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser, and Smiles rearrangements.

VIII Free Radical Reactions **10 Hrs**

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance. Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity.

Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

Books Suggested:

- Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
- Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Plenum.
- A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
- Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press.
- Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
- Modern Organic Reactions, H. 0. House, Benjamin.
- Principles of Organic Synthesis, R. 0. C. Norman and J. M. Coxon, Blackle Academic & Professional.
- Pericyclic Reactions, S. M. Mukherji, Macmillan, India.
- Reaction Mechanism in Organic Chemistry, S. M. Mukherji and S. P. Singh, Macmillan.
- Stereochemistry of Organic Compounds, D. Nasipuri, New Age international.
- Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.

IV. CORE COURSE PRACTICAL [CPCHE104]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL-I

Practical: 60Hours

INORGANIC CHEMISTRY

1. **Cent per cent quantitative Analysis of Cement.**
2. **Estimation of the following:**
   - (a) Magnesium by E.D.T.A. Methods (Volumetrically)
   - (b) Zinc by potassium ferrocyanide (Volumetrically)
   - (c) Nickel by Dimethylglyoxime (Gravimetrically)
   - (d) Managnese in steel by sodium bismuthate method.
3. **A.** Separation and determination of two metal ions Cu-Ni, Ni-Zn, Cu-Fe etc. involving volumetric and gravimetric methods.

   B. Separation of cations and anions by a) Paper chromatography b) Column Chromatography.
4. **Preparation of inorganic compounds:**
   - (i) $[Cu(NH_3)_4]SO_4.H_2O$
   - (ii) $K_3[Fe(C_2O_4)_3]$
   - (iii) Prussian Blue, Turnbull's Blue
   - (iv) $[Ni(NH_3)_6]Cl_2$
   - (v) $[Ni(dmg)_2]$

ORGANIC CHEMISTRY

5. **Organic Qualitative**
   Identification of organic compounds containing one functional group using Chemical & Spectral Analysis
6. Separation, purification and identification of binary mixture (one liquid and one solid) involving TLC and Column Chronatography. Chemical tests and Functional group identification.

7 **Preparation of organic compounds using methods not involving more than two steps. Some of the experiments listed below:**

(i) Preparation of methyl Orange
(iv) Preparation of Martius yellow
(vi) Preparation of p-nitro aniline from acetanilide
(viii) Preparation of Cinnamic acid from Benzaldehyde

8 **Estimation of Glucose**

Books Suggested:

- McIver and Page- Society
- K. Davis, Human Society
- Fox, Robin. Kinship and Marriage
- Karvey, Iravati . Hindu Kinship Organisation
- Prabhu, P.N. Hindu Social Organisation
- Kapadiya, K.M. Family and Marriage in India
- Sharma, V. P. Gramin Samajik Sanrachna Evam Gramin Vikas
- Gaya Pandey : Social-Cultural Anthropolgoy (English & Hindi)

SEMESTER II 4 Papers

Total 100 x 4 = 400 Marks

I. CORE COURSE [CCCHE201]: (Credits: Theory-05)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ANALYTICAL CHEMISTRY Theory: 60 Hours; Tutorial:15 Hours

I Introduction 12 Hrs

Role of analytical chemistry. Classification of analytical methods-classical and instrumental. Types of instrumental analysis. Selecting an analytical method. Neatness and cleanliness. Laboratory operations and practices. Analytical balance. Techniques of weighing, errors. Volumetric glassware-cleaning and calibration of glassware. Sample preparations - dissolution and decompositions. Gravimetric techniques. Selecting and handling of reagents. Laboratory notebooks. Safety in the analytical laboratory.

II Errors and Evaluation 15 Hrs

Definition of terms in mean and median. Precision-standard deviation, relative standard deviation. Accuracy-absolute error, relative error. Types of error in experimental data-determinate (systematic), indeterminate (or random) and gross. Sources of errors and the effects upon the analytical results. Methods for reporting analytical data. Statistical evaluation of data-indeterminate errors. The uses of statistics.

III Food Analysis 10 Hrs

Moisture, ash, crude protein, fat, crude fibre, carbohydrates, calcium, potassium, sodium and phosphate. Food adulteration-common adulterants in food, contamination of food stuffs. Microscopic examination of foods for adulterants. Pesticide analysis in food products. Extraction and purification of sample. HPLC. Gas chromatography for organophosphates. Thin-layer chromatography for identification of chlorinated pesticides in food products.

IV Analysis of Water Pollution 13 Hrs

Origin of waste water, types, water pollutants and their effects. Sources of water pollution-domestic, industrial, agricultural soil and radioactive wastes as sources of pollution. Objectives *of* analysis-parameter for analysis-colour, turbidity, total solids, conductivity, acidity, alkalinity, hardness, chloride, sulphate, fluoride, silica, phosphates and different forms of nitrogen. Heavy metal pollution-public health significance of cadmium, chromium, copper, lead, zinc, manganese, mercury and arsenic. General survey of instrumental technique for the analysis of heavy metals in aqueous systems. Measurements of DO, BOD and COD. Pesticides as water pollutants and analysis. Water pollution laws and standards.

V Analysis of Soil, Fuel, Body Fluids and Drugs 10 Hrs

(a) Analysis of soil: moisture, pH, total nitrogen, phosphorus, silica, lime, magnesia, manganese, sulphur and alkali salts.

(b) Fuel analysis: solid, liquid and gas. Ultimate and proximate analysis-heating values grading of coal. Liquid fuels-flash point, aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas-calorific value.

(c) Clinical chemistry: Composition of blood-collection and preservation of samples. Clinical analysis. Serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumin, globulins, barbiturates, acid and alkaline phosphatases. Immunoassay: principles of radio immunoassay (RIA) and applications. The blood gas analysis trace elements in the body.

(d) Drug analysis: Narcotics and dangerous drugs. Classification of drugs. Screening by gas and thin-layer chromatography and spectrophotometric measurements.

Books Suggested:

- Analytical Chemistry, G.D. Christian, J. Wiley.
- Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J. Holler, W. B. Saunders.
- Analytical Chemistry-Principles, J.H. Kennedy, W. B. Saunders.
- Analytical Chemistry-Principles and Techniques, L.G. Hargis, Prentice Hall.
- Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, W. B. Saunders.
- Principles of Instrumental Analysis, D.A. Skoog, W. B. Saunders.
- Quantitative Analysis, R.A. Day, Jr. and A.L. Underwood, Prentice Hall.
- Environmental Solution Analysis, S.M. Khopkar, Wiley Eastern
- Basic Concepts of Analytical Chemistry, S.M. Khopkar, Wiley Eastern
- Handbook of Instrumental Techniques for Analytical Chemistry, F. Settle, Prentice Hall.
- Analytical Chemistry, G.D. Christian, J. Wiley.

II. CORE COURSE [CCCHE202]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PHYSICAL CHEMISTRY-I Theory: 60 Hours; Tutorial:15 Hours

I. Quantum Chemistry 25 Hrs

A Approximate Methods

The variation theorem, linear variation principle. Perturbation theory (first order and non-degenerate). Applications of variation method and perturbation theory to the Helium atom.

B Angular Momentum

Ordinary angular momentum, generalized angular momentum, eigen functions for angular momentum, eigenvalues of angular momentum, operator using ladder operators, addition of angular momenta, spin, antisymmetry and Pauli exclusion principle.

C Electronic Structure of Atoms

Electronic configuration, Russell-Saunders terms and coupling schemes, Slater-Condon parameters, term separation energies of the p^n configuration, term separation energies for the d^n configurations, magnetic effects: spin-orbit coupling and Zeeman splitting, introduction to the methods of self -consistent field, the virial theorem.

D Molecular Orbital Theory

Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical, cyclobutadiene etc. Introduction to extended Huckel theory.

II. Classical Thermodynamics 10 Hrs

Brief resume of concepts of laws of thermodynamics, free energy, chemical potential and entropies. Partial molar properties; partial molar free energy, partial molar volume and partial molar heat content and their significances. Determinations of these quantities. Concept of fugacity and determination of fugacity. Non-ideal systems: Excess functions for non-ideal solutions.

Activity, activity coefficient, Debye-Huckel theory for activity coefficient of electrolytic solutions; determination of activity and activity coefficients; ionic strength. Gibb's Duhen equation, Nernst heat theorem and its applications, Determination of absolute entropy Maxwell's thermodynamic relation.

III Chemical Dynamics **15 Hrs**

Methods of determining rate laws, collision theory of reaction rates, steric factor, activated complex theory, Arrhenius equation and the activated complex theory; ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions, treatment of unimolecular reactions.

Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde, decomposition of ethane), photochemical (hydrogen-bromine and hydrogen-chlorine reactions) and oscillatory reactions (Belousov -Zhabotinsky reaction), homogeneous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, flash photolysis and the nuclear magnetic resonance method. Dynamics of molecular motions, probing the transition state, dynamics of barrierless chemical reactions in solution, dynamics of unimolecular reactions (Lindemann - Hinshelwood and Rice-Ramsperger - Kassel-Marcus [RRKM] theories of unimolecular reactions).

IV Surface Chemistry **05 Hrs**

Surface phenomena: Surface active agents, classification of surface active agents, micellization, hydrophobic interaction, critical micelle concentration (CMC), Krafft temperature, Factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization, solubilization, microemulsions, reverse micelles, surface films (eletrokinetic phenomena), catalytic activity at surfaces. Electrode/ electrolyte interface; electrical double layer, electrode kinetics, Nernst equation.

V Electrochemistry **05 Hrs**

Electrochemistry: Electrochemical cells, Nernst equation and applications of Debye-Huckel-theory, Electrolytic conductivity and the Debye-Hückel-Onsangar treatment, electrified interfaces, overpotential, Electrocatalysis- influence of various parameters. Hydrogen electrode. Introduction to corrosion, homogenous theory, forms of corrosion, corrosion monitoring and prevention methods.

Books Suggested:

- Physical Chemistry, P.W. Atkins, ELBS.
- Introduction to Quantum Chemistry, A.K. Chandra, Tata McGraw Hill.
- Quantum Chemistry, Ira N. Levine, Prentice Hall.
- Coulson's Valence, R. McWeeny, ELBS.
- Chemical Kinetics, K. J. Laidler, Mcgraw-Hill.
- Kinetics and Mechanism of Chemical Transformations, J. Rajaraman and J. Kuriacose, McMillan.
- Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum
- Modern Electrochemistry Vol. I and Vol. II, J.O.M. Bockris and A.K.N. Reddy, Plenum.

III. CORE COURSE [CCCHE203]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

GROUP THEORY & SPECTROSCOPY Theory: 60 Hours; Tutorial: 15 Hours

I Symmetry and Group Theory in Chemistry 18 Hrs

Symmetry elements and symmetry operation, definitions of group, subgroup, relation between orders of a finite group and its subgroup. Conjugacy relation and classes. Point symmetry group. Schonflies symbols, representations of groups by matrices (representation for the Cn, Cnv, Cnh. Dnh etc. groups to be worked out explicitly). Character of a representation. The great orthogonality theorem (without proof) and its importance. Character tables and their use; spectroscopy.

II Microwave Spectroscopy 03 Hrs

Classification of molecules, rigid rotor model, effect of isotopic substitution on the transition frequencies, intensities, non-rigid rotor. Stark effect, nuclear and electron spin interaction and effect of external field. Applications.

III Vibrational Spectroscopy 10 Hrs

A. Infrared Spectroscopy

Review of linear harmonic oscillator, vibrational energies of diatomic molecules, zero point energy, force constant and bond strengths; anharmonicity, Morse potential energy diagram, vibration-rotation spectroscopy, P,Q,R branches. Breakdown of Oppenheimer approximation; vibrations of polyatomic molecules. Selection rules, normal modes of vibration, group frequencies, overtones, hot bands, factors affecting the band positions and intensities, far IR region, metal-ligand vibrations, normal co-ordinate analysis,

B. Raman Spectroscopy

Classical and quantum theories of Raman effect. Pure rotational, vibrational and vibrational-rotational Raman spectra, selection rules, mutual exclusion principle. Resonance Raman spectroscopy, coherent anti Stokes Raman spectroscopy (CARS).

IV Magnetic Resonance Spectroscopy **15 Hrs**

A. Nuclear Magnetic Resonance Spectroscopy

Nuclear spin, nuclear resonance, saturation, shielding of magnetic nuclei, chemical shift, deshielding, spin-spin interactions, factors influencing coupling constant "j" Classification (AXB, AMX, ABC, A_2B_2 etc.), spin decoupling; basic ideas about instrument, NMR studies of nuclei other than proton-^{13}C, ^{19}F and ^{31}P. FT NMR, advantages of FT NMR.

B. Nuclear Quadrupole Resonance Spectroscopy

Quadrupole nuclei, quadrupole moments, electric field gradient, coupling constant, splitting. Applications.

C. Electron Spin Resonance Spectroscopy

Basic principles, zero field splitting and Kramer's degeneracy, factors affecting the 'g' value. Isotropic and anisotropic hyperfine coupling constants, spin Hamiltonian, spin densities and Mc Connell relationship, measurement techniques, applications.

V Electronic Spectroscopy **8 Hrs**

A. Atomic Spectroscopy

Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

B. Molecular Spectroscopy

Energy levels, molecular orbitals, vibronic transitions, vibrational progressions and geometry of the excited states, Franck-Condon principle, electronic spectra of polyatomic molecules. Emission spectra; radiative and non-radiative decay, internal conversion, spectra of transition metal complexes, charge-transfer spectra.

VI X-ray Diffraction **6 Hrs**

Bragg condition, -Miller indices, Laue method, Bragg method, Debye-Scherrer method of X-ray structural analysis of crystals, index reflections, identification of unit cells from systematic absences in diffraction pattern. Structure of simple lattices and X-ray intensities, structure factor and its relation to intensity and electron density, phase problem. Description of the procedure for an X-ray structure analysis, absolute configuration of molecules, Ramchandran diagram.

Books Suggested:

- Modern Speciroscopy, J.M. Hollas, John Wiley.
- Applied Electron Spectroscopy lor Chemical Analysis Ed. H. Windawi and F.L. Ho. Wiley Interscience.
- NMR, NOR, EPR and Massbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Harwood.
- Physical' Methods in Chemistry, R.S. Drago, Saunders College.
- Chemical Applications of Group Theory, F. A. Cotton.
- Introduction to Molecular Spectroseopy, Q.M. Barrow, McCraw Hill.
- Basic Principles of Spectroscopy. R. Chang, McOraw Hill.
- Theory and Applications of UV Spectroscopy, H.H. Jatie and M. Orehin, IBH-Oxford.
- Introduction to Photoelectron Spectroscopy, P. K. Ghosh, John Wiley.
- Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.

IV. CORE COURSE PRACTICAL [CPCHE204]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100 **Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL-II **Practical: 60Hours**

1. **Measurement of density of gases and vapours**
   (a) Victor Meyer's Method Determination of Molecular weight of Acetone, Chloroform, Benzene, (Mixture).
   (b) Duma's Method Determination of molecular weight of acetone, Carbon-Tetrachloride.
2. **Determination of Molecular weight of substances**
   (a) Beckmann's freezing point Method
   (b) Beckmann's Boiling point method.
3. **Viscosity of liquids and solution by ostwald tube**
   Determination of percentage composition of a mixture of two liquids.
4. **Surface Tension of liquids and solutions**
   (a) Study of the effect of conc. on surface tension of acetic acid and Sodium chloride solutions.
   (b) Determination of Parachor.
5. **Thermochemistry**
   (a) Determination of water equivalent of a calorimeter
   (b) Determination of the Heat of Neutralization of :
      (i) Strong acid and strong base (HCl and NaOH)
      (ii) Weak acid and strong base (NaOH and CH_3COOH).
   (c) Determination of Heat of solution of Potassium Nitrate
   (d) Determination of basicity of succinic Acid by Thermochemical Method.
6. **Order of Reaction**
   (a) Determination of the rate constant of hydrolysis of an ester with an acid (Methyl acetate and HCl).
   (b) Determination of the rate constant of saponification of ethyl acetate by NaOH.
7. **Partition Co-efficient**
   (a) Determination of partition coefficient of:
      (i) Benzoic acid between water and Benzene
      (ii) Iodine between water and carbon tetrachloride
9. **Conductivity**
   (a) Determination of cell constant
   (b) Determination of equivalent conductivity of weak acid (acetic and succinic acid) at several concentrations and calculation of the dissociation constant of the acid
   (c) Determination of the basicity of an acid (citric acid and oxalic acid)
   (d) Titration of:
      (i) strong acid and strong base (HCl and NaOH)
      (ii) weak acid and strong base (CH_3COOH and NaOH)

SEMESTER III 4Papers

Total 100 x 4 = 400 Marks

I. ABILITY ENHANCEMENT COURSE [ECCHE301A]: (Credits: Theory-05)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

BIO-CHEMISTRY Theory: 60 Hours; Tutorial:15Hours

GROUP-A (Bioinorganic Chemistry)

I Metal Ions in Biological Systems **02 Hrs**

Essential and trace metals. Na^+/K^+ Pump
Role of metals ions in biological processes,

II Bioenergetics and ATP Cycle **05 Hrs**

DNA polymerisation, glucose storage, metal complexes in transmission of energy; chlorophylls, photosystem I and photosystem II in cleavage of water. Model systems.

III Transport and Storage of Dioxygen **06 Hrs**

Heme proteins and oxygen uptake, structure and function of hemoglobin, myoglobin, hemocyanins and hemerythrin, model synthetic complexes of iron, cobalt and copper.

IV Electron Transfer in Biology **05 Hrs**

Structure and function of metalloproteins in electron transport processes - cytochromes and iron-sulphur proteins, synthetic models

V Nitrogenase **05 Hrs**

Biological nitrogen fixation, molybdenum nitrogenase, spectroscopic and other evidence, other nitrogenases model systems.

GROUP-B (Bioorganic Chemistry)

I Enzymes and Mechanism of Enzyme Action **02 Hrs**

Basic considerations. Proximity effects and molecular adaptation.

Enzymes **05 Hrs**

Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, specificity and regulation. Nomenclature and classification, extraction and purification. Fischer's lock and key and Koshtand's induced fit hypothesis, concept and identification of active site by the use of inhibitors, affinity labeling and enzyme modification by site-directed mutagenesis. Enzyme kinetics, Michaelis-Menten and Lineweaver-Burk plots, reversible and irreversible Inhibition.

Mechanism of Enzyme Action **03 Hrs**

Transition-state theory, orientation and steric effect, acid-base catalysis, covalent catalysis, strain or distortion. Examples of some typical enzyme mechanisms for chymotrypsin, ribonuclease, lysozyme and carboxypeptidase A.

II **Kinds of Reactions Catalysed by Enzymes** **05 Hrs**

Nucleophilic displacement on a phosphorus atom, multiple displacement reactions and the coupling of ATP cleavage to endergonic processes. Addition and elimination reactions, enolic intermediates in isomerization reactions, p-cleavage and condensation, some isomerization and rearrangement reactions. Enzyme catalyzed carboxylation and decarboxylation.

III **Co-Enzyme Chemistry** **04 Hrs**

Enzyme Models. Cofactors as derived from vitamins, coenzymes, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD^+, $NADP^+$ FMN, FAD, lipolc acid, vitamin B_{12}. Mechanisms of reactions catalyzed by the above cofactors.

IV **Biotechnological Applications of Enzymes** **04 Hrs**

Large-scale production and purification of enzymes, techniques and methods of immobilization of enzymes, effect of immobilization on enzyme activity, application of immobilized enzymes, use of enzymes in food and drink industry-brewing and cheese- making, syrups from corn starch, enzymes as targets for drug design. Clinical uses of enzymes, enzyme therapy, enzymes and recombinant DNA technology.

GROUP-C (Biophysical Chemistry)

I **Biological Cell and its constituents** **02 Hrs**

Biological cell, structure and functions of proteins, enzymes, DNA and RNA in living systems. Helix coil transition.

II **Biopolymer Interactions** **04 Hrs**

Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion forces, dispersion force interactions, Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves.

III **Thermodynamics of biopolymer Solutions** **04 Hrs**

Thermodynamics of biopolymer Solutions, osmotic pressure, membrane equilibrium, muscular contraction and energy generation in mechanochemical system.

IV **Cell Membrane and Transport of Ions** **04 Hrs**

Structure and functions of cell membrane, ion transport through cell membrane, irreversible thermodynamic treatment of membrane support, Nerve conduction.

Books Suggested:

- Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
- Bioinorganic Chemistry, I. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
- Inorganic Biochemistry vols I and II. ed. G.L. Eichhorn, Elsevier.
- Progress in Inorganic Chemistry, Vols 18 and 3S ed. J.J. Lippard, Wiley.
- Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C. Penny, Springer-Verlag.
- Understanding Enzymes, Trevor Palmer, Prentice Hall.
- Enzyme Chemistry: Impact and Applications, Ed. Collin J Suckling, Chapman and Hail.
- Enzyme Mechanisms Ed, M. 1. Page and A. Williams, Royal Society of Chemistry.
- Fundamentals of Enzymology, N.C. Price and L. Slovens, Oxford University Press.
- Immobilized Enzymes: An Introduction and Applications In Biotechnology, Michael 0. Trevan, John Wiley.
- Enzymatic Reaction Mechanisms, C. Walsh, W. H. Freeman.
- Enzyme Structure and Mechanism, A Fersht, W.H. Freeman.
- Biochemistry: The Chemical Reactions of Living Cells, D. E. MeUler, Academic Press.

OR

ABILITY ENHANCEMENT COURSE [ECCHE301B]: (Credits: Theory-05)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PHOTO INORGANIC CHEMISTRY **Theory: 60 Hours; Tutorial:15 Hours**

I Photochemical Reactions **10 Hrs**

Interaction of electromagnetic radiation with matter, types of excitations, fate of excited molecule, quantum yield, transfer of excitation energy, Energy dissipation by radiative and on-radiative processes, absorption spectra, Franck-Condon principle, photochemical stages – primary and secondary processes.

II Properties of Excited States **10 Hrs**

Structure, dipole moment, acid-base strengths, reactivity,. Photochemical kinetics. Bimolecular deactivation - quenching

III Excited States of Metal Complexes **10 Hrs**

Excited states of metal complexes: comparison with organic compounds, electronically excited states of metal complexes, charge-transfer spectra, charge transfer excitations, methods for obtaining charge-transfer spectra.

IV Ligand Field Photochemistry **10 Hrs**

Photosubstitution, photooxidation and photoreduction, lability and selectivity, zero vibrational levels of ground state and excited state, energy content of excited state, zero zero spectroscopic energy and development of the equations for redox potentials of the excited states.

V Redox Reactions by Excited Metal Complexes **15 Hrs**

Energy transfer under conditions of weak interaction and strong interaction-exciplex formation; conditions of the excited states to be useful as redox reactants, excited electron transfer, metal complexes as attractive candidates (2,2'-bipyridine and 1,10-phenonthroline complexes), illustration of reducing and oxidising character of Ruthenium^{2+} (bipyridal complex, comparision with Fe(bipy)$_3$; role of spin-orbit coupling-life time of these complexes. Application of redox processes of electronically excited states for catalytic purposes, transformation of low energy reactants into high energy products, chemical energy into light

VI Metal Complex Sensitizers **5 Hrs**

Metal complex sensitizer, electron relay, metal colloid systems, semiconductor supported metal or oxide systems, water photolysis, nitrogen fixation and carbon dioxide reduction

Books Suggested:

- Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley.
- Inorganic Photochemistry, J. Chem. Educ., vol. 60, no. 10, 1983.
- Progress in Inorganic Chemistry, vol. 30, ed. S.J. Lippard, Wiley.
- Coordination Chem. Revs., 1981, vol. 39, 121, 131; 1960, 15, 321; 1990, 97, 313.
- Photochemistry of Coordination Compounds, V. Balzari and V. Carassiti, Academic Press.
- Elements of Inorganic Photochemistry, G. J. Ferraudi, Wiley.

OR

ABILITY ENHANCEMENT COURSE [ECCHE301C]: (Credits: Theory-05)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

COMPUTER FOR CHEMISTS

Theory: 75 Hours

Section-I

Instruction to Question Setter for Section-I:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 10 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type two** questions of five marks each, out of which any one to be answered. There will be 10 marks questions set from Mathematics and Biology separately.*

End Semester Examination (ESE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered. There will be 20 marks questions set from Mathematics and Biology separately.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

MATHEMATICS [For students: B.Sc. with Biology] [F.M. = 40]

I Vectors **4 Hrs**
Vectors, dot, cross and triple products etc. gradient, divergence and curl, Vector Calculus.

II Matrix Algebra **4 Hrs**
Addition and multiplication; inverse, adjoint and transpose of matrices.

III Differential Calculus **8 Hrs**
Functions, continuity and differentiability, rules for differentiation, applications of differential calculus including maxima and minima (examples related to maximally populated rotational energy levels, Bohr's radius and most probable velocity from Maxwell's distribution etc.).

IV Integral calculus **6 Hrs**
Basic rules for integration, integration by parts, partial fractions and substitution. Reduction formulae, applications of integral calculus. Functions of several variables, partial differentiation, co-ordinate transformations (e.g. Cartesian to spherical polar). First-order and first degree differential equations, Applications to chemical kinetics.

IV Permutation and Probability **3 Hrs**
Permutations and combinations, probability and probability theorems average, variance root means square deviation examples from the kinetic theory of gases etc., fitting (including least squares fit etc with a general polynomial fit.

Books Suggested:

- The chemistry Mathematics Book, E.Steiner, Oxford University Press.
- Mathematical for Physical Chemistry : F. Daniels, Mc. Graw Hill.
- Applied Mathematics for Physical Chemistry, J.R. Barante, Prentice Hall.
- Chemical Mathematics D.M. Hirst, Longman.

OR

BIOLOGY [For students: B.Sc. with Mathematics] **[F.M. = 40]**

Instruction to Question Setter for Section-I:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 10 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type two** questions of five marks each, out of which any one to be answered. There will be 10 marks questions set from Mathematics and Biology separately.*

End Semester Examination (ESE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered. There will be 20 marks questions set from Mathematics and Biology separately.*

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

I Carbohydrates **8 Hrs**

Conformation of monosaccharides, structure and functions of important derivatives of monosaccharides like glycosides, deoxy sugars, myoinositol, amino sugars. Nacetylmuramic acid, sialic acid disaccharides and polysaccharides. Structural polysaccharides cellulose and chitin. Storage polysaccharides-starch and glycogen. Structure and biological function of glucosaminoglycans of mucopolysaccharides. Carbohydrates of glycoporteins and glycolipids. Role of sugars in biological recognition. Blood group substances. Ascorbic acid.

II Amino-acids, Peptides and Proteins **6 Hrs**

Chemical and enzymatic hydrolysis of proteins to peptides, amino acid sequencing. Secondary structure of proteins. Force responsible for holding of secondary structures. α-helix, β-sheets, super secondary structure, triple helix structure of collagen. Tertiary structure of protein-folding and domina structure. Quaternary structure. Amino acid metabolism-degradation and biosynthesis of amino acids, sequence determination: chemical/enzymatic/mass spectral, racemization/detection. Chemistry of oxytocin and tryptophan releasing hormone (TRH).

III Lipid **6 Hrs**

Fatty acids, essential fatty acids, structure and function of triacylglycerols, glycerophospholipids, sphingolipids, cholesterol, bile acids, prostaglandins. Liproproteins-compositiion and function, role in atherosclerosis. Properties of lipid aggregates-micelles, bilayers, liposomes and their possible biological functions. Biological membranes. Fluid mosaic model of membrane structure. Lipid metabolismboxidation of fatty acids.

IV Nucleic Acids **5 Hrs**

Purine and pyrimidine bases of nucleic acids, base pairing via H-bounding. Structure of ribonucleic acids (RNA) and deoxyribonucleic acid (DNA), double helix model of DNA and forces responsible for holding it. Chemical and enzymatic hydrolysis of nucleic acids. The chemical basis for heredity, an overview of replication of DNA, transcription, translation and genetic code. Chemical synthesis of mono and trinucleoside.

Books Suggested:

- Principles of Biochemistry, A.L. Lehninger, Worth Publishers.
- Biochemistry, L. Stryer, W.H. Freeman.
- Biochemistry, J. David Rawan, Neil Patterson.
- Biochemistry, Voet and Voet, John Wiley.

Section-II

Instruction to Question Setter for Section-II:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 10 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type two** questions of five marks each, out of which any one to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions in written examinations of 50 marks. **Group A is compulsory** and will contain two questions of **very short answer type** consisting of 5 marks each. **Group B will contain descriptive type three** questions of twenty marks each, out of which any two are to be answered.*

COMPUTER **[F.M. = 60]**

I Introduction to Computers and Computing **5 Hrs**

Basic structure and functioning of computers with a PC as an illustrative example. Memory, I/O devices. Secondary storage. Computer languages. Operating systems with DOS as an example. Introduction to UNIX and WINDOWS. Data Processing, principles of programming. Algorithms and flow-charts.

II Computer Programming in C Language **10 Hrs**

Elements of the Computer Language Constants and variables and data types. Operators and Expressions, Arithmetical, Relational, Logical, Assignment, Increment and Decrement operators. Input and output statements. Branching statements such as (if-else, goto, switch) statements. Decision making and looping (while, for, do).Arrays (one dimensional and two dimensional arrays).Sorting of data in an array. Function (user defined functions).

III Programming in Chemistry **23 Hrs**

Development of small computer codes involving simple formulae in chemistry, such as vander Waals equation, pH titration, kinetics, radioactive decay. Evaluation of lattice energy and ionic radii from experimental data. Linear simultaneous equations to solve secular equations within the Huckel theory. Elementary structural features such as bond lengths, bond angles, dihedral angles etc. of molecules extracted from a database such as Cambridge data base.

IV Use of Computer Programmes **12 Hrs**

The students will learn how to operate a PC and how to run standard programmes and packages. Execution of linear regression, X-Y plot, numerical integration and differentiation as well as differential equation solution programmes. Monte Carlo and Molecular dynamics. Programmes with data preferably from physical chemistry laboratory. Packages- MS-Word, MS-Excel, ORIGIN, MATLAB.

Books Suggested:

- Comdex Computer Course kit (XP Edition), Vikas Gupta, Dreamtech, New Delhi
- Fox Pro For DOS & Windows, R.K. Taxali, BPB Publication.
- Programming in ANSIC, E. Balaguruswamy, Tata McGraw Hill
- Computer for Chemist Bansal, Pragati Prakshan
- K.V. Raman, Computers in Chemistry, Tata McGraw Hill.
- Mullish Cooper, The spirit of C, An Introduction to Modern Programming.

II. CORE COURSE [CCCHE302]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 **Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ENVIRONMENTAL CHEMISTRY **Theory: 60 Hours; Tutorial:15 Hours**

I Environment **10 Hrs**

Introduction. Composition of atmosphere, vertical temperature, heat budget of the earth atmospheric system, vertical stability atmosphere. Biogeochemical cycles of C, N, P, S and 0. Biodistribution of elements.

II Hydrosphere **15 Hrs**

Chemical composition of water bodies-lakes, streams, rivers and wet lands etc. Hydrological cycle. Aquatic pollution - inorganic, organic, pesticide, agricultural, industrial and sewage, detergents, oil spills and oil pollutants. Water quality parameters - dissolved oxygen, biochemical oxygen demand, solids, metals, content of chloride, sulphate, phosphate, nitrate and micro-organisms. Water quality standards. Analytical methods for measuring BOD, DO, COD, F, Oils, metals (As, Cd, Cr, Hg, Pb, Se etc.), residual chloride and chlorine demand. Purification and treatment of water.

III Soils **05 Hrs**

Composition, micro and macro nutrients, Pollution'- fertilizers, pesticides, plastics and metals. Waste treatment.

IV Atmosphere **15 Hrs**

Chemical composition of atmosphere - particles, ions and radicals and their formation. Chemical and photochemical reactions in atmosphere, smog formation, oxides of N, C, S, 0 and their effect, pollution by chemicals, petroleum, minerals, chlorofluorohydrocarbons. Green-house effect, acid rain, air pollution controls and their chemistry. Analytical methods for measuring air pollutants. Continuous monitoring instruments.

V Industrial Pollution **8 Hrs**

Cement, sugar, distillery, drug, paper and pulp, thermal power plants, nuclear power plants, metallurgy. Polymers, drugs etc. Radionuclide analysis. Disposal of wastes and their management.

VI Environmental Toxicology **7 Hrs**

Chemical solutions to environmental problems, biodegradability, principles of decomposition, better industrial processes. Bhopal gas tragedy, Chernobyl, Three mile island, Sewozo and Minamata disasters.

Books Suggested:

- Environmental Chemistry, S. E. Manahan, Lewis Publishers.
- Environmental Chemistry, Sharma & Kaur, Krishna Pubilshers.
- Environmenlal Chemistly, A. K. De, Wiley Easlem.
- Environmental Pollution Analysis, S.M. Khopkar, Wiley Eastern
- Standard Method of Chemical Analysis, FJ. Weleher Vol. III. Van Nostrand Reinhold Co.
- Environmental Toxicology, Ed. J. Rose, Gordon and Breach Science Publication.
- Elemental Analysis of Airborne Particles, Ed. S. Landsberger and M. Crealchman, Gordon and Breach Science Publication.
- Environmentai Chemistry, C. Baird, W. H. Freeman.
- Raziuddin, M.., Mishra P.K. 2014, *A Handbook of Environmental Studies*, Akanaksha Publications, Ranchi.
- Mukherjee, B. 2011: *Fundamentals of Environmental Biology*.Silverline Publications, Allahabad.
- Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
- Gadgil, M., & Guha, R.1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
- Gleeson, B. and Low, N. (eds.) 1999.*Global Ethics and Environment*, London, Routledge.
- Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
- Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.*Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
- Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science*, 339: 36--37.
- McCully, P. 1996. *Rivers no more: the environmental effects of dams*(pp. 29--64). Zed Books.
- McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
- Odum, E.P., Odum, H.T. & Andrews, J. 1971.*Fundamentals of Ecology*. Philadelphia: Saunders.
- Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
- Rao, M.N. & Datta, A.K. 1987. *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd.
- Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.*Environment*. 8th edition. John Wiley & Sons.
- Rosencranz, A., Divan, S., & Noble, M. L. 2001. *Environmental law and policy in India. Tripathi 1992.*
- Sengupta, R. 2003. *Ecology and economics*: An approach to sustainable development. OUP.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. *Ecology, Environmental Science and Conservation*. S. Chand Publishing, New Delhi.
- Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. *Conservation Biology: Voices from the Tropics*. John Wiley & Sons.
- Thapar, V. 1998. *Land of the Tiger: A Natural History of the Indian Subcontinent.*
- Warren, C. E. 1971. *Biology and Water Pollution Control*. WB Saunders.
- Wilson, E. O. 2006.*The Creation: An appeal to save life on earth*. New York: Norton.
- World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University

III. CORE COURSE [CCCHE303]: (Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 **Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

APPLICATIONS OF SPECTROSCOPY **Theory: 60 Hours; Tutorial:15 Hours**

Inorganic Chemistry

I Electronic Spectroscopy **07 Hrs**

Electronic Spectral Studies for d^1- d^9 systems in octahedral, tetrahedral and square planer complexes,

II Vibrational Spectroscopy **05 Hrs**

Symmetry and shapes of AB_2, AB_3, AB_4, AB_5 and AB_6, mode of bonding of ambidentate ligands, nitrosyl, ethylenediamine and diketonato complexes, application of resonance. Raman spectroscopy and its applications.

III Electron Spin Resonance Spectroscopy **7 Hrs**

Hyperfine coupling, spin polarization for atoms and transition metal ions, spin-orbit coupling and significance of g-tensors, application to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4, F_2^- and $[BH_3]^-$.

IV Nuclear Magnetic Resonance of Paramagnetic Substances in Solution **05 Hrs**

The contact and Pseudo contact shifts, factors affecting nuclear relaxation, some applications including biochemical systems, an overview of NMR of metal nuclide with emphasis on ^{195}Pt and ^{119}Sn NMR.

V Mössbauer Spectroscopy **05 Hrs**

Basic principles, spectral parameters and spectrum display. Application of the technique to the studies of (1) bonding and structures of Fe^{+2} and Fe^{+3} compounds including those of intermediate spin, (2) Sn^{+2} and Sn^{+4} compounds - nature of M-L bond, coordination number, structure and (3) detection of oxidation state and inequivalent MB atoms.

Organic Chemistry

I Ultraviolet and Visible Spectroscopy **5 Hrs**

Various electronic transitions (185-800 nm), Beer—Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes,

conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds.

II Infrared Spectroscopy **8 Hrs**

Instrumentation and sample handling. Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds).Effect of hydrogen bonding and solvent effect on vibrations frequencies, overtones, combination bands and Fermi resonance. FT IR. IR of gaseous, solids and polymeric materials.

III Nuclear Magnetic Resonance Spectroscopy **8 Hrs**

PMR Spectroscopy

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines, amides & mercapto), chemical exchange, effect of deuteration, solvent effects. Fourier transform technique.

Carbon-13 NMR Spectroscopy **05 Hrs**

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants. Two dimension NMR spectroscopy - COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques.

IV Mass Spectrometry **5 Hrs**

Introduction, ion production - El, Cl, FD and FAB, factors affecting fragmentation, ion analysis, ion abundance. Mass spectral fragmentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule. High resolution mass spectrometery. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books Suggested:

- Physical Methods lor Chemistry, R.S. Drago, Saunders Company.
- Structural Melhods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS
- Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
- Progress in Inorganic Chemistry vol., 8, ed., F.A. Cotton, vol., 15, ed. S.J. Lippard, Wiley.
- Transition Metal Chemistry eA R.L. Carlin voi. S, Dekker
- Inorganic Elecironie Speciroscopy,. A.P.B. Lever, Elsevier.
- NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
- Practical NMR Spoctroacopy, M.L Martin, J.J. Delpeuch and Q.J. fArtin, Heyden.
- Spedrometric identitication of Organic Compounds, R. M. Silverstein, Q. C. gassier and T. C. Morrill, John Wiley
- InirodlJCtion lo NMR Spectroscopy. R. J. Abraham, J. Fisher and P. Loftus, Wiley.
- Application of Spectroscopy of Oiganic Compounds, J. R. Dyer, Prentice Hail.
- Spectroscopic Methods in Organic Chemistry, D. H. Williams, 1. Fleming, Tala McGraw-Hill.

IV. CORE COURSE PRACTICAL [CPCHE304]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100	Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto60%, 1mark; 60<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PRACTICAL-III

❖ **One question from Group A or Group B is to be set and field work (group C) is compulsory.**

1. Experiments-I (Lab-work) **(50)**

Group-A: Estimation of following in water

(a) Ca (b) Fe (c) Mg
(d) Chemical oxygen demand (COD)
(e) Biochemical oxygen demand (BOD) &
(f) Dissolved oxygen (DO)

Group-B: Analysis of soil for the followings

(a) Ca (b) Mg (c) Total nitrogen
(d) Carbonate (e) Organic matter (f) Ammonia & (g) Nitrate nitrogen

2. Experiments-II (Field-work) **(20)**

Group-C: Field work consist of

1. Visit to some nearby areas (river, villages, industrial area) for collection of water & soil samples
2. Analysis of sample with reference to pollution and
3. Submission of report of field work

3. Note book and attendance **(10)**

4. viva-voce **(20)**

SEMESTER IV 4 Papers

Total 100 x 4 = 400 Marks

I. GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECCHE401A]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

INORGANIC-II

Theory: 60 Hours; Tutorial: 15 Hours

I Alkyls and Aryls of Transition Metals **05 Hrs**

Types, routes of synthesis, stability and decomposition pathways, organocopper in organic synthesis

II Compounds of Transition Metal-Carbon Multiple Bonds **10 Hrs**

Alkylidenes, alkylidynes, low valent carbenes and carfaynes- synthesis, nature of bond, structural characteristics, nucleophilic and electrophilic reactions on the ligands, role in organic synthesis

III Transition Metal π-Complexes **15 Hrs**

Transition metal π-complexes with unsaturated organic molecules, alkenes, alkynes, allyl, diene, dienyl, arene and trienyl complexes, preparations, properties, nature of bonding and structural features. Important reactions relating to nucleophilic and electrophilic attack on ligands and to organic synthesis

IV Transition Metal Compounds with Bonds to Hydrogen **10 Hrs**

Transition Metal Compounds with Bonds to Hydrogen.

V Homogeneous Catalysis **10 Hrs**

Stoichiometric reactions for catalysis, homogeneous catalytic hydrogenation, Zeigler-Natta polymerization of olefins, catalytic reactions involving carbon monoxide such as hydrocarbonylation of oletins (oxo reaction), oxopalladation reactions, activation of C-H bond.

VI Fluxional Organometalilc Compounds **10 Hrs**

Fluxionality and dynamic equilibria in compounds such as h^2- olefin, h^3 allyl and dienyl complexes

Books Suggested:

- Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Pinke, University Science Books.
- The Organometaltic Chemistry o1 the Transition Metals, R.H. Crabtree, John Wiley
- Metallo-organic Chemistry, A.J. Pearson, Wiley.
- Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.

OR

GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECCHE401B]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 **Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

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

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ORGANIC-II

Theory: 60 Hours; Tutorial: 15 Hours

I Curve Crossing Model to Chemical Reactions — 05 Hrs

Valence bond (VB) configuration mixing diagrams. Relationship between VB configuration mixing and resonance theory. Reaction profiles. Rules for constructing Valance Bond Correlation Diagram. Reactivity pattern based on Valance Bond State Correlation Diagram (VBSCD model). Curve crossing model-nature of activation barrier in chemical reactions.

V.B. Correlation diagram for

One Bond Reactions: V.B. Configuration of Ionic Bond. Heterolysis of Polar Covalent bond in solutions.

Two Bond Process: Covalent Bond: Radical Exchange Reactions, Nucleophilic Exchange Reactions, Nucleophilicity and S_N2 reactivity based on curve-crossing model. Electrophilic Exchange Reactions. Curve-crossing approach to electrophilic reactivity; Ionic Bond.

II Principles of Reactivity — 05 Hrs

Mechanistic significance of entropy, enthalpy and Gibb's free energy. Arrhenius equation. Transition state theory. Uses of activation parameters, Hammond's postulate. Bell-Evans -Polanyi principle. Potential energy surface model. Marcus theory of electron transfer. Reactivity and selectivity principles.

III Kinetic Isotope Effect — 04 Hrs

Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects, Tunneling effect. Solvent effects.

IV Structural Effects on Reactivity **05 Hrs**

Linear free energy relationships (LFER).The Hammett equation, substituent constants, theories of substituent effects. Interpretation of σ-values. Reaction constant ρ. Deviations from Hammett equation. Dual-parameter correlations, inductive substituent constant. The Taft model, σ_L-and σ_R scales.

V Supramolecular Chemistry **06 Hrs**

Properties of covalent bonds - bond length, inter-bond angles, force constant, bond and molecular dipole moments. Molecular and bond polarizability, bond dissociation enthalpy, entropy.

Intermolecular forces, hydrophobic effects. Electrostatic, induction, dispersion and resonance energy, magnetic interactions, magnitude of interaction energy, forces between macroscopic bodies, medium effects. Hydrogen bond.

Principles of molecular association and organization as exemplified in biological macromolecules like enzymes, nucleic acids, membranes and model systems like micelles and vesicles. Molecular receptors and design principles. Cryptands, cyclophanes, calixeranes, cyclodextrines. Supramolecular reactivity and catalysis. Molecular channels and transport processes. Molecular devices and nanotechnology.

VI Terpenoids and Carotenoids **10 Hrs**

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule. Structure determination, stereochemistry, biosynthesis and synthesis of the following representative molecules: Citral, α-Terpeneol, Zingiberene, Santonin, Bisabolene acid and β-Carotene.

VII Alkaloids **10 Hrs**

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants. Structure, stereochemistry, synthesis and biosynthesis of the following: Ephedrine, (+)-Coniine, Nicotine Atropine, Quinine, Morphine, Narcotine and Reserpine.

VIII Steroids **15 Hrs**

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon and stereochemistry. Isolation, structure determination and synthesis of Cholesterol, Bile acids, Androsterone, Testosterone, Estrone, Progestrone, Biosynthesis of steroids

Books Suggested:

- Molecular Mechanics, U. Burkert and N. L. Allinger, ACS Monograph 177, 1982.
- Organic Chemists' Book of Orbitals. L. Salem and W. L. Jorgensen, Academic Press.
- Mechanism and Theory in Organic Chemistry, T. H. Lowry and K. C. Richardson, Harper and Row.
- Introduction to Theoretical Organic Chemistry and Molecular. Modeling, W. B. Smith, VCH, Weinheim.
- Physical Organic Chemistry, N. S. Isaacs, ELBS/Longman.
- The Physical Basis of Organic Chemistry, H. Maskill, Oxford University Press.
- Natural Products: Chemistry and Biological Significance, J.Mann, R.S. Davision, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Logman, Essex.

OR

GENERIC/ DISCIPLINE CENTRIC ELECTIVE [ECCHE401C]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 **Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PHYSICAL-II

Theory: 60 Hours; Tutorial: 15 Hours

I Diffraction of X-rays by crystals **08 Hrs**
Debye Scherrer mechod, indexing powder pattern for cubic and tetragonal crystals, rotating crystal method, Fourier transform and reciprocal lattices, Bragg equation in reciprocal lattice, neutron diffraction.

II Metallic bonds **12 Hrs**
Free electron theory, band theory, Fermi level, Brillouin zone, wave function for electrons in solids, metallic conductors, insulator, semiconductors (intrinsic & extrinsic), properties of junctions.

III Polymer **07 Hrs**
Polymer solution, thermodynamics of polymer solutions, molar mass and molar mass distribution, methods of measuring molar masses, micelle formation and hydrophobic interaction.

IV Electrically conducting polymers **08 Hrs**
Electrically conducting polymers electrochemical polymerization, band structure of polymers, mechanism of conduction in polymers, doping of polymers, application of conduction polymers.

V Potential Energy Surfaces **15 Hrs**
Mechanism of activation, potential energy surface for three atom reaction, Potential energy curve for successive reactions, Properties of potential energy surfaces, Inter conversion of translational and vibrational energies, Combination of atoms, Orthopara conversion, Activated state of three atom and four atom reactions, Potential energy profile, reaction co-ordinate, Transmission co-efficient, non-adiabatic reaction.

VI Study of Fast Reactions **15 Hrs**
Photo physical Chemistry-Flash Photolysis, Relaxation technique, Nuclear Magnetic Resonance Method, Molecular Beam and Shock-tube Kinetics, Flow method. Reactions of Protons, Electrons metal ions.

II. GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECCHE402A]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

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

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

INORGANIC-III

Theory: 60 Hours; Tutorial: 15 Hours

I Metal Storage Transport and Biomineralization **05 Hrs**

Ferritin, transferrin, and siderophores

II Calcium in Biology **8 Hrs**

Calcium in living cells, transport and regulation, molecular aspects of intramolecular processes, extracellular binding proteins

III Metalloenzymes **15 Hrs**

Zinc enzymes - carboxypeptidase and carbonic anhydrase. Iron enzymes - catalase, peroxidase and cytochrome P-450. Copper enzymes - superoxide dismutase. Molybdenum oxatransferase enzymes - xanthine oxidase. Coenzyme vitamin BII

IV Metal-Nucleic Acid Interactions **07 Hrs**

Metal ions and metal complex interactions. Metal complexes - nucieic acids

V Metals in Medicine **05 Hrs**

Metal deficiency and disease, toxic effects of metals, metals used for diagnosis and chemotherapy with particular reference to anticancer drugs

VI Supramolecular Chemistry **20 Hrs**

Concepts and language.

(A) Molecular recognition: Molecular receptors for different types of molecules including arisonic substrates, design and synthesis of coreceptor molecules and multiple recognition.

(B) Supramolecular reactivity and catalysis.

(C) Transport processes and carrier design.

(D) Supramolecular devices. Supramolecular photochemistry, supramolecular electronic, ionic and switching devices. Some example of self-assembly in supramolecular chemistry

Books Suggested:

- Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.
- Bioinorganic Chemistry, 1. Bertini, H.B. Gray, S.J. Lippard and J.S. Valentine, University Science Books.
- Inorganic Biochemistry vols I and II. ed. 0.L Eichhom, Elsevier.
- Progress in inorganic Chemistry, Vols 18 and 38 ed. J.J. Lippard, Wiley.
- Supramolecular Chemistry, J.M. Lehn, VCH.

OR

GENERIC/DISCIPLINE CENTRIC ELECTIVE [ECCHE402B]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):
*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):
*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*
*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ORGANIC-III

Theory: 60 Hours; Tutorial: 15 Hours

I Pericyclic Reactions — 12 Hrs

Radical stability, polar influences, solvent and steric effects. A curve crossing approach to radical addition, factors effecting barrier heights in additions, regioselectivity in radical reactions, Reactivity, specificity and periselectivity in pericyclic reactions.

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system. Classification of periycyclic reactions. Woodward-Hoffmann correlation diagrams. FMO and PMO approach.
Electrocyclic reactions-conrotatory and disrotatory motions, 4n, 4n+2 and allyl systems. Cycloadditions-antarafacial and suprafacial additions, 4n and 4n+2 systems. 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.

Sigmatropic rearrangements-suprafacial and antarafacial shifts of H, sigmatropic involving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

II Heterocycles:

Nomenclature & Classification — 05 Hrs

Replacement and systematic nomenclature (Hantzs MCH-Widman system) for monocyclic fused and bridged heterocycles.

Aromatic Heterocycles
Criteria of aromaticity including ring current and chemical shifts in 1H NMR spectra.

Non-aromatic Heterocycles
Conformation of six-membered heterocycles with reference to molecular geometry, barrier to ring inversion, pyramidal inversion and 1,3-diaxial interaction.

Heterocyclic Synthesis: Princples of heterocyclic synthesis involing cyclization reactions and cycloaddition reactions.

III Small ring Heterocycles **10 Hrs**

Three, Four & Five membered heterocycles including medicinal applications of benzopyrroles, benzofurans and benzothiophenes

IV Six-Membered Heterocycles with one Heteroatom **06 Hrs**

Synthesis and reactions of pyrylium salts and pyrones and their comparison with pyridiniurn & thiopyrylium salts and pyridones. Synthesis and reactions of quinolizinium and benzopyrylium salts, coumarins and chromones.

V Six-Membered Heterocycles with Two or More Heteroatoms **05Hrs**

Synthesis and reactions of diazines, triazines, tetrazines and thiazines

VI Seven- and Large-Membered Heterocycles **05Hrs**

Synthesis and reactions of azepines, diazepines.

VII Heterocyclic Systems Containing P, As, Sb & B **10 Hrs**

Heterocyclic rings containing phosphorus: introduction, nomenclature, Synthesis and characteristics of 5- and 6-membered ring systems-phosphorinanes, phosphorines, phospholanes and phospholes.

Heterocyclic rings containing As and Sb: Introduction, synthesis and characteristics of 5- and 6-membered ring systems.

Heterocyclic rings containing B: Introduction, synthesis reactivity and spectral characteristics of 3- 5- and 6- membered ring system.

VIII Vitamins **07 Hrs**

Determination and Synthesis of Vit. A, B_1, B_2, B_6, Vit. C and Vit. D.

Books Suggested:

- Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
- Molecular Mechanics, U. Burkert and N.L. Allinger, ACS Monograph 177, 1982.
- Organic Chemists' Book of Orbitals. L. Salem and W.L. Jorgensen, Academic Press.
- Mechanism and Theory in Organic Chemistry, T.H. Lowry and K.C. Richardson, Haper and Row.
- Introduction to Theoretical Organic Chemistry and Molecular modelling, W.B. Smith, VCH, Weinheim.
- Supramolecular Chemisrty, Concepts and Perspectives, J.M. Lehn, VCH.
- Heterocyclic Chemistry Vol. 1-3, R. R. Supta, M. Kumar and V Gupta, Springer Verlag.
- The Chemistry of Heterocycles, T. Eicher and S. Hauptmann, Thieme.
- Heterocyclic Chemistry, J. A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
- Heterocyclic Chemistry. T.L Gilchrisl. Longman Scietific Teehinai
- Contemporary Heterocyclic Chemisiry, Q. R. Newkome and W. W. Paudler, Wiley-inter Science.
- An introduction to the Heterocyclic Compounds. Linds, R. M. Acheson, JohnWiley.
- Comprehensive Heterocyclic Chemistry, A. R. Kalriliky and C. W. Rees, eds. Pergamon Press.
- Natural Produds; Chemistry and Biological Significance, J. Mann, R. S. Davidson, J.B. Hobbs, D.V, Banthirope and J. B. Harbome, Longman,Essex.
- Organic Chemistry, Vol 2, l. L. Finar, ELB S.
- Stereoselective Synthesis; A Practical Approach, M. Nogradi. VCH.
- Rodd's Chemistry of Carbon Compounds. Ed. S. Coffey, Elsevier.
- Chemistry, Biological and Pharmacological Properties of Medicinal lants from the Americas, Ed. Kurt Hosiettmann, M. P. Gupla and A. Marston, Harwood Academic Publishers.
- Introduction lo Flavonoids. B.A. Bohm, Harwood Academic Publishers.
- New Trends in Natural Product Chemistry, Atta-ur-Rahman and M I Choudhary, Harwood Academic Publishers.

OR

GENERIC/ DISCIPLINE CENTRIC ELECTIVE [ECCHE402C]:

(Credits: Theory-04, Tutorial-01)

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 **Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of five marks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be very short answer type** consisting of five questions of 1 mark each. **Question No.2 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 be answered.*

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

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. "**Better of Two**" shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PHYSICAL-III

Theory: 60 Hours; Tutorial: 15 Hours

I Super conductivity **10 Hrs**

Super conductivity meissner effect, microscopic theory of superconductivity, conventional organic and high temp, superconductors, fullerenes, applications of superconductors.

Transformation in crystals - thermodynamics of transformation, order-disorder transitions, martensitic transition, polymorphic transformation

II Specific heat of solids **10 Hrs**

Specific heat of solids classical theory, quantum theory of specific heats-Einstein and Debye theories, characteristic temp and its calculation, T-law. Solid state reactions, laws governing nucleation, homogeneous and heterogenous nucleation, thermodynamic barrier.

III Polymer liquid crystal **10 Hrs**

Polymer liquid crystal nematic, cholesteric and smectic phases, liquid crystalline order of the main chain and of the side groups in polymers, synthesis and properties of polymer liquid crystals, liquid crystalline order in biological materials.

IV Surface chemistry **10 Hrs**

Surface chemistry surface films, BET isotherm for, multilayers & its derivation, kinetics of surface processes, unimolecular and bimolecular surface reactions, electrocapillarity, electrokinetic effects, statistical mechanics of adsorption, Colloids.

V Kinetics of Condensed Phase Reactions **20 Hrs**

Rate determining steps in diffusion controlled reactions and activation controlled reactions, Stokes-Einstein equation and dependence of rate constant on co-efficient of viscosity of medium, Kinetics of ionic reactions in solution-electrostatic contribution to free energy in single and double spherical models of activated complex, entropy of activation for ion-ion reactions; Kinetics of dipole-dipole reaction, ion-dipole reaction, dependence of rate constant on ionic strength and dielectric constant of medium, Bronsted-Bjerrum equation.

Books Suggested:

- Crystallography - Philips
- Solid State chernistry-Garner (Butterworth; London)
- Solid State Chemistry -D.K.Chakraborty (New Age int Publication)
- Solid State Chemistry- N. BHannay (Prentice Hall, New Jersay)
- Physical Chemistry- Waller J. Moore
- Principles of polymer chemistry Cornell , P. J. Flory (Univ. Press)
- Handbook of Conducting Polymers Vol I & II" T A. Skolhia

III. GE/DC PRACTICAL [EPCHE403A]: (Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100 **Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

INORGANIC PRACTICAL -IV

1. Qualitative separation and determination of the following pairs of metal ion using gravimetric and volumetric methods
   a. Ag^{+}(g) and Cu^{2+}(v)
   b. Cu^{2+}(g) and Zn^{2+}(v)
   c. Fe^{3+}(g) and Ca^{2+} (v)
   d. Mg^{2+}(g) and Ca^{2+} (v)
2. Quantitative Analysis
   a. Analysis of alloys (brass, type metal, solder, gun metal) cement, steel using conventional chemical analysis/and physical techniques (if possible).
   (Preferably one alloy and cement analysis may be carried out).
3. **Chromatographic Separations**
   a. Cadmium and zinc
   b. Zinc and magnesium.
   c. Thin-layer / Paper chromatography-separation of nickel, manganese, cobalt and zinc. Determination of R_f values.
4. **Synthesis and characterization of following metal complexes:**
   a. Sodium tetrathionate $Na_2S_4O_6$.
   b. Metal complex of dimethyl sulfoxide : $CuCl_2.2DMSO$
   c. Synthesis of metal acetylacetonate
   d. Synthesis of copper and nickel Schiff base complexes.
   e. Synthesis of copper and nickel dithiocarbamates
   f. $[Co(NH_3)_5 Cl] Cl_2$
   g. (ii) $[Co(NH_3)_5 NO_2] Cl_2$
   h. (iii)$[Co(NH_3)_5 ONC] Cl_2$

OR

GE/DC PRACTICAL [EPCHE403B]:

(Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100 **Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

ORGANIC PRACTICAL -IV

1. **Characterization of organic compounds**
   It is expected to carry out separation, purification and identification of the components of a mixture of three organic compounds (three solids or two liquids and on solid, two solids and one liquid). Student should also check the purity of the separated components on TLC plates.

2. **Extraction of Organic compounds from Natural Sources**
   a. Isolation of Caffeine from Tea Leaves (Ref. Experimental Organic Chemistry H Dupon Durst. George W.Gokel, p.464 McGraw Hall Book Co., New York).
   b. Isolation of Casein from milk (Some typical colour reactions of proteins).
   c. Isolation of lactose from milk (purity of sugar should be checked by LC and PC and R_f values reported).
   d. Isolation of Nicotine dipicrate from tobacco
   e. Isolation of piperine from black pepper
   f. Isolation of Lycopene from tomatoes
   g. Isolation of β-carotene from carrots
   h. Isolation of Oleic acid from olive oil
   i. Isolation of Eugenol from cloves
   j. Isolation of (+)Limonine from citrus rinds

3. **Multistep Synthesis of Organic Compounds**
   The exercise should illustrate the use of organic reagents and may involve purification of the products by chromatographic techniques.
   a. Beckman rearrangement: Benzanilide from benzene
      Benzene → Benzophenone → Benzophenone oxime →Benzanilide
   b. Benzilic acid rearrangement: Benzilic acid from benzoin
      Benzoin → Benzil → Benzilic acid
   c. Synthesis using microwaves
      Alkylation of diethyl malonate with benzyl chloride
   d. Synthesis using phase transfer catalyst
      Alkylation of diethyl malonate or ethyl acetoacetate with an alkyl halide

4. **Some illustrative exercises are given below**:
    a. Estimation of phenol / aniline using bromate bromide solution/or acetylation method
    b. Estimation of carbonyl group by using 2,4-dinitrophenyl hydrazine
    c. To determine the percentage or number of phenolic groups in the given sample by the acetylation method.

5. **Identification of organic compounds**
   By the analysis of their spectral data (UV, IR PMR, CMR & MS).

6. **Spectrophotometric (UV/VIS) Estimations**
    a. Amino acids
    b. Proteins
    c. Carbohydrates
    d. Cholesterol
    e. Ascorbic acid
    f. Aspirin
    g. Caffeine

OR

GE/DC PRACTICAL [EPCHE403C]:

(Credits: Practical-05)

Marks: 30 (ESE: 20 Viva + 5Attd. + 5 Record) + 70 (ESE Pr: 6Hrs)=100 **Pass Marks =45**

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks will be awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:
(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<90, 4 marks; 90<Attd, 5 marks).

PHYSICAL PRACTICAL -IV

1. **Conductometry**
   a. To determine the solubility and solubility product of a sparingly soluble salt
   b. To verify Onsager equation for a uni-univalent electrolyte in aqueous solution
   c. To titrate a mixture of HCl, CH_3COOH and $CuSO_4$ with NaOH
   d. To determine the rate constant of saponification of an ester by NaOH.

2. **Determination of Equivalence conductance of following strong electrolyte:**
   a. KCl
   b. NaCl
   c. $AgNO_3$
   d. HCl
   e. KNO_3

3. **Potentiometry**
   a. To determine the solubility and solubility product of AgCl in water
   b. To determine the E^0 of Zn/Zn^{++}, Cu/Cu^{++} electrodes.
   c. To determine the basicity of a polybasic acid and its dissociation constant.
   d. To investigate the complex formed between $CuSO_4$ and NH_3.

4. **Polarography**
   a. Estimation of Pb^{2+} and Cd^{2+}/ Zn^{2+} and Ni^{2+} metal ions in a mixture of Pb^{2+} and Cd^{2+}/ Zn^{2+} and Ni^{2+} by polarography.
   b. Determination of dissolved oxygen in aqueous solution of organic solvents.

5. **Chemical Kinetics**
   a. Determination of relative strengths of HCl and H_2SO_4 (k_1 / k_2) for the hydrolysis of methyl acetate.
   b. Determination of relative strengths of HNO_3 and H_2SO_4 (k_1 / k_2) for the hydrolysis of methyl acetate.

c. To study the kinetics of alkaline hydrolysis of an ester in aquo-organic solvent system with respect to effect of solvent composition and dielectric constant on rate constant.
d. To determine the rate constant of the reaction between $K_2S_2O_8$ and KI at two different temp. and hence to determine the energy of activation of the reaction.

6. Thermochemistry

a. Determination of basicity of a polybasic acid.
b. Determination of heat of displacement of Cu by Zn from Cu^{2+} salt solution.
c. Determination of heat of hydration of Na_2SO_4 to Na_2SO_4, 10 H_2O.

7. Distribution law

a. Determination of Composition of Cupric-ammine sulphate formed between $CuSO_4$ and NH_3
b. Determination of equilibrium constant for the reaction $KI+I_2=KI_3$

8. Viscosity and Surface Tension

a. To determine the radius of a molecule from viscosity measurement.
b. To determine the parachor of - CH_2, C and H

IV. CORE COURSE (PROJECT) [PRCHE404]: (Credits: 05)

Marks : 100 (ESE: 3Hrs)=100	Pass Marks =45

Guidelines to Examiners for

End Semester Examination (ESE):

Overall project dissertation may be evaluated under the following heads:

- *Motivation for the choice of topic*
- *Project dissertation design*
- *Methodology and Content depth*
- *Results and Discussion*
- *Future Scope & References*
- *Participation in Internship programme with reputed organization*
- *Application of Research technique in Data collection*
- *Report Presentation*
- *Presentation style*
- *Viva-voce*

PROJECT WORK

Each student has to submit two copies of the dissertation work duly forwarded by the HOD of Department concerned. The forwarded copies will be submitted in the Department of Chemistry, Ranchi University, for evaluation (Seven days before the seminar).

The paper will consist of

(a) Field work/Lab work related to the project.

(b) Preparation of dissertation based on the work undertaken.

(c) Presentation of project work in the seminar on the assigned topic in the P.G. Department of Chemistry, Ranchi University, Ranchi & open viva there on.

Topics

Project work related to the following Industrial/socially relevant topics may be given.

(a) **Environmental study** such as

(i) Analysis of water,

(ii) soil,

(iii) air etc.

(b) **Industrial goods analysis** such as

(i) Analysis of Cement

(ii) Analysis of minerals available in Jharkhand State

(iii) Synthesis of useful commercial products based on raw materials available in Jharkhand state such as Lac, lime-stone etc.

(iv) Isolation of Constituents of medicinal plants available in Jharkhand State.

NB:- Students will select topics for the project work in consultation with a teacher of the department. The Seminar will be held in the Department of Chemistry Ranchi University, Ranchi.

DISTRIBUTION OF CREDITS FOR P.G. PROGRAMME (SEMESTER-WISE) FOR POSTGRADUATE **'P.G. Voc./M.Sc./M.A./M.Com'** PROGRAMME

Table B-1: Semester wise distribution of 80 Credits for Subjects with Practical Papers.

Semester	CC	FC	GE/DC	AE	Total credits
Semester I	15	05			20
Semester II	20				20
Semester III	15			05	20
Semester IV	5		15		20
	55	**05**	**15**	**05**	**80**

Table B-1: Semester wise distribution of 80 Credits for Subjects without Practical Papers.

Semester	CC	FC	GE/DC	AE	Total credits
Semester I	15	05			20
Semester II	20				20
Semester III	15			05	20
Semester IV	10		10		20
	60	**05**	**10**	**05**	**80**

CC=Core Course; FC=Foundation Compulsory/Elective Course; GE=Generic Elective; SE=Skill Enhancement Course; DC=Discipline Centric Elective

SAMPLE CALCULATION FOR SGPA & CGPA FOR POSTGRADUATE **'P.G. Voc./M.Sc./M.A./M.Com'** PROGRAMME

Table B-2: Sample calculation for SGPA for M.Sc./M.A./M.Com Programme

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit X Grade)	SGPA (Credit Point/Credit)
Semester I					
FC	05	A	8	40	
C-1	05	B+	7	35	
C-2	05	B	6	30	
C-3/CP	05	B	6	30	
Total	**20**			**135**	**6.60 (135/20)**
Semester II					
C-4	05	B	6	30	
C-5	05	C	5	25	
C-6	05	B+	7	35	
C-7/CP	05	A+	9	45	
Total	**20**			**135**	**6.60 (135/20)**
Semester III					
EC-1	05	A+	9	45	
C-8	05	0	10	50	
C-9	05	A	8	40	
C-10/CP	05	A	8	40	
Total	**20**			**175**	**8.75 (175/20)**
Semester IV					
EC-2/EC-2	05	B	6	30	
EC-3/EC-3	05	A+	9	45	
C11/EP	05	B	6	30	
Project	05	A+	9	45	
Total	**20**			**150**	**7.50 (150/20)**
CGPA					
Grand Total	**80**			**595**	**7.44 (595/80)**

Table B-3: Sample calculation for CGPA for P.G. Vocational M.Sc./M.A./M.Com Programme

Semester I	Semester II	Semester III	Semester IV
Credit:20; SGPA:6.60	Credit:20; SGPA: 6.60	Credit:20; SGPA: 8.75	Credit:20; SGPA: 7.50

Thus CGPA= (20x6.60+20x6.60+20x8.75+20x7.50) /80=**7.36**

DISTRIBUTION OF MARKS FOR EXAMINATIONS AND FORMAT OF QUESTION PAPERS

Distribution of Marks for Mid Semester Evaluation:

Table No. 15: Distribution of marks of Theory Examinations of Mid Semester

Topic	Code	Full Marks	Pass Marks	Time	Group-A (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M.	Group-B (Descriptive Questions) No. of Questions x Marks = F.M.	Total No. of Questions to Set	
							Group A	Group B
Mid Sem*	T30*	30 (20 +5 +5)	17	1 Hr	5 x1 =5	3 (out of 5) x5 =15	05	5

***There shall be 20 marks theory examination for mid sem, 05 marks for attendance/ regular interactions & 05 marks for seminar/ assignment/ term paper given by faculty concerned in classrooms.**

Distribution of Marks for End Semester Theory Examinations:

Table No. 16: Marks distribution of Theory Examinations of End Semester

Topic	Code	Full Marks	Pass Marks	Time	Group-A# (Very short answer type Compulsory Questions) No. of Questions x Marks = F.M.	Group-B (Descriptive Questions) No. of Questions x Marks = F.M.	Total No. of Questions to Set	
							Group A#	Group B
End Sem	T50	50	--	3 Hrs	2 x5 =10	2 (out of 3) x20 =40	2	3
	T70	70	28	3 Hrs	Q.No.1 (5x1) + 1x5 =10	4 (out of 6) x15 =60	2	6

 # Question No.1 in Group-A carries very short answer type questions of 1 Mark

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

FORMAT OF QUESTION PAPER FOR MID SEM EXAMINATION

20 MARKS

Ranchi University, Ranchi

Mid Sem No. Exam Year

Subject/ Code

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

General Instructions:
समान्य निर्देश :

i. **Group A** carries very short answer type compulsory questions.
(खंड 'A' में अत्यंत लघु उत्तरीय अनिवार्य प्रश्न हैं।)
ii. **Answer 3 out of 5** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के पाँच में से किन्हीं तीन विषयनिष्ठ / वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. ..... [5x1=5]
2. .....
3. .....
4. .....
5. .....

Group B

6. ..... [5]
7. ..... [5]
8. ..... [5]
9. ..... [5]
10. ..... [5]

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

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

50 MARKS

Ranchi University, Ranchi

End Sem No. Exam Year

Subject/ Code

F.M. =50

General Instructions:

i. **Group A** carries very short answer type **compulsory** questions.
ii. **Answer 2 out of 3** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के तीन में से किन्हीं दो विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)
iii. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
iv. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
v. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

1. ..... [5]
2. ..... [5]

Group B

3. ..... [20]
4. ..... [20]
5. ..... [20]

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

Remarks 30/11/24

30/11/2024

FORMAT OF QUESTION PAPER FOR END SEM EXAMINATION

70 MARKS

Ranchi University, Ranchi

End Sem No. Exam Year

Subject/ Code

F.M. =70 **P.M.**=28 **Time**=3Hrs.

General Instructions:

iii. **Group A** carries very short answer type **compulsory** questions.
iv. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
(खंड 'B' के छः में से किन्हीं चार विषयनिष्ठ/ वर्णनात्मक प्रश्नों के उत्तर दें।)
vi. Answer in your own words as far as practicable.
(यथासंभव अपने शब्दों में उत्तर दें।)
vii. Answer all sub parts of a question at one place.
(एक प्रश्न के सभी भागों के उत्तर एक साथ लिखें।)
viii. Numbers in right indicate full marks of the question.
(पूर्णांक दायीं ओर लिखे गये हैं।)

Group A

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

Group B

3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

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

Remarks 30/11/24

30/11/2024