UNIVERSITY OF JAMMU

(NAAC ACCREDITED 'A' GRADE' UNIVERSITY)
(Baba Sahib Ambedkar Road, Jammu-180006 (J&K)

Academic Section
Email: academicsectionju14@gmail.com

NOTIFICATION
(24/Feburary/Adp./113)

It is hereby notified for the information of all concerned that the Vice-Chancellor, in anticipation of the approval of the Academic Council, is pleased to authorize the adoption of the Syllabi and Courses of Study in the subject of **Chemistry** of Semesters Vth, VIth, VIIth and VIIIth **for Four Year Under Graduate Programme** under the **Choice Based Credit System** as per **NEP-2020 (as given in the annexure)** for the examinations to be held in the years as per the details given below:

Subject	Semester	for the examination to be held in the years
Chemistry	Semester-V	December 2024, 2025 and 2026
	Semester-VI	May 2025, 2026 and 2027
	Semester-VII	December 2025, 2026 and 2027
	Semester-VIII	May 2026, 2027 and 2028

The Syllabi of the courses are available on the University website: www.jammuuniversity.ac.in

Sd/-
DEAN ACADEMIC AFFAIRS

No. F. Acd/II/24/ 14685-740
Dated: 14-03-2024
Copy for information and necessary action to:

1. Dean, Faculty of Science
2. Convener, Board of Studies in **Chemistry**
3. Sr. P.A.to the Controller of Examinations
4. All members of the Board of Studies
5. Confidential Assistant to the Controller of Examinations
6. I/C Director, Computer Centre, University of Jammu
7. Deputy Registrar/Asst. Registrar (Conf. /Exams. UG/Eval Non-Prof)
8. Incharge, University Website for Uploading of the notification

Sumita Sharma 13/3/24.
Deputy Registrar (Academic)

12/3/24 12/3/24 12/3/24

UNIVERSITY OF JAMMU

SYLLABUS FOR FOUR YEAR UNDERGRADUATE PROGRAMME (FYUGP) IN CHEMISTRY W.E.F. ACADEMIC SESSION 2022 AS PER NATIONAL EDUCATION POLICY (NEP 2020)

Semester-wise Grid Plan [Semesters I–VIII]

S. No.	Sem., Level	Credits and Type of Course	Course Code	Course Title	Credits Distribution Lecture-Tutorial-Practical (L-T-P)
1.	UG/Sem-I, **100 Levels**	4 as Major	UMJCHT101	Foundation Course Chemistry-I	4 (3-0-1)
2.	UG/Sem-I, **100 Levels**	4 as Minor	UMICHT102	Foundation Course Chemistry-I	4 (3-0-1)
3.	UG/Sem-I	3 as Multidisciplinary	UMDCHT103	Chemistry in Everyday Life	3 (3-0-0)
4.	UG/Sem-I	2 as Skill Enhancement	USECHT104	Basic Analytical Techniques in Chemistry	2 (1-0-1)
5.	UG/Sem-II, **100 Levels**	4 as Major	UMJCHT201	Foundation Course Chemistry-II	4 (3-0-1)
6.	UG/Sem-II, **100 Levels**	4 as Minor	UMICHT202	Foundation Course Chemistry-II	4 (3-0-1)
7.	UG/Sem-II	3 as Multidisciplinary	UMDCHT203	Hazardous Waste and its Treatment	3 (3-0-0)
8.	UG/Sem-II	2 as Skill Enhancement	USECHT204	Chemistry of Soaps, Detergents and Surfactants	2 (1-0-1)
9.	UG/Sem-III, **200 Levels**	4 as Major	UMJCHT301	Foundation Course Chemistry-III	4 (3-0-1)
10.	UG/Sem-III, **200 Levels**	4 as Major	UMJCHT302	Analytical Chemistry	4 (3-0-1)
11.	UG/Sem-III, **200 Levels**	4 as Minor	UMICHT303	Foundation Course Chemistry-III	4 (3-0-1)
12.	UG/Sem-III	3 as Multidisciplinary	UMDCHT304	Chemistry in Everyday Life	3 (3-0-0)
13.	UG/Sem-III	2 as Skill Enhancement	USECHT305	Chemistry of Food and Cosmetics	2 (1-0-1)
14.	UG/Sem-IV, **200 Levels**	4 as Major	UMJCHT401	Physical Chemistry-I	4 (3-0-1)
15.	UG/Sem-IV, **200 Levels**	4 as Major	UMJCHT402	Organic Chemistry-I	4 (3-0-1)
16.	UG/Sem-IV, **200 Levels**	4 as Major	UMJCHT403	Inorganic Chemistry-I	4 (3-0-1)
17.	UG/Sem-IV, **200 Levels**	4 as Major	UMJCHT404	Spectroscopic & Nuclear Chemistry	4 (3-1-0)
18.	UG/Sem-IV, **200 Levels**	4 as Minor	UMICHT405	Inorganic Chemistry-I	4 (3-0-1)
19.	UG/Sem-V, **300 Levels**	4 as Major	UMJCHT501	Physical Chemistry-II	4 (3-0-1)
20.	UG/Sem-V, **300 Levels**	4 as Major	UMJCHT502	Organic Chemistry-II	4 (3-0-1)
21.	UG/Sem-V, **300 Levels**	4 as Major	UMJCHT503	Inorganic Chemistry-II	4 (3-0-1)
22.	UG/Sem-V, **300 Levels**	2 as Major	UMJCHT504	Polymer Science & Technology	2 (2-0-0)
23.	UG/Sem-V, **200 Levels**	4 as Minor	UMICHT-505	Organic Chemistry-I	4 (3-0-1)
24.	UG/Sem-V	2 as Skill Enhancement	USECHT506	Summer Internship	2 (0-0-2)
25.	UG/Sem-VI, **300 Levels**	4 as Major	UMJCHT-601	Physical Chemistry-III	4 (3-0-1)
26.	UG/Sem-VI, **300 Levels**	4 as Major	UMJCHT-602	Organic Chemistry-III	4 (3-0-1)
27.	UG/Sem-VI, **300 Levels**	4 as Major	UMJCHT-603	Inorganic Chemistry-III	4 (3-0-1)
28.	UG/Sem-VI, **300 Levels**	4 as Major	UMJCHT-604	Green Chemistry Technology	4 (3-1-0)
29.	UG/Sem-VI, **200 Levels**	4 as Minor	UMICHT-605	Physical Chemistry-I	4 (3-0-1)
30.	UG/Sem-VII, **400 Levels**	4 as Major	UMJCHT-701	Physical Chemistry-IV	4 (3-1-0)
31.	UG/Sem-VII, **400 Levels**	4 as Major	UMJCHT-702	Organic Chemistry-IV	4 (3-0-1)
32.	UG/Sem-VII, **400 Levels**	4 as Major	UMJCHT-703	Inorganic Chemistry-IV	4 (3-0-1)
33.	UG/Sem-VII, **400 Levels**	4 as Major (for Honors)	UMJCHT-704	Principles of Spectroscopy	4 (3-1-0)
		4 as Major (for Honors with Research)	UMJCHT-705	Research Methodology & Research Ethics	4 (3-1-0)
34.	UG/Sem-VII, **300 Levels**	4 as Minor	UMICHT-706	Principles of Spectroscopy	4 (3-1-0)

S. No.	Sem., Level	Credits and Type of Course	Course Code	Course Title	Credits Distribution Lecture-Tutorial-Practical (L-T-P)
B. Sc. Honors					
35.	UG/Sem-VIII, **400 Levels**	4 as Major	UMJCHT-801	Physical Chemistry-V	4 (3-0-1)
36.	UG/Sem-VIII, **400 Levels**	4 as Major	UMJCHT-802	Organic Chemistry-V	4 (3-0-1)
37.	UG/Sem-VIII, **400 Levels**	4 as Major	UMJCHT-803	Inorganic Chemistry-V	4 (3-0-1)
38.	UG/Sem-VIII, **400 Levels**	4 as Major	UMJCHT-804	Applications of Spectroscopy in Organic Chemistry	4 (3-1-0)
39.	UG/Sem-VIII, **300 Levels**	4 as Minor	UMICHT-805	Green Chemistry Technology	4 (3-1-0)
B. Sc. Honors with Research					
40.	UG/Sem-VIII, **400 Levels**	4 as Major	UMJCHT-806/ UMJCHT-807/ UMJCHT-808/ UMJCHT-809	Physical Chemistry-V Or Organic Chemistry-V Or Inorganic Chemistry-V Or Applications of Spectroscopy in Organic Chemistry	4 (3-0-1)
41.	UG/Sem-VIII, **300 Levels**	4 as Minor	UMICHT-810	Green Chemistry Technology	4 (3-1-0)
42.	UG/Sem- VIII	12 as Major	UMJCHP-811	Research Project as Dissertation	12 (0-0-12)

Course Codes:
U= Undergraduate
MJ=Major; MI=Minor; MD=Multi-Disciplinary; SE=Skill Enhancement
CH= Chemistry
T= Theory; I=Internship; P=Project

Semester-I
Course No.: UMJCHT101 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Atomic Structure in terms of atomic orbitals and electronic configuration
- Periodic properties through periodic table
- Electronic displacement and bond cleavage in organic molecules
- Properties of Gaseous state

Unit-I: Atomic Structure **(15 Hours)**

Introduction to Quantum mechanics, Time independent Schrodinger wave equation and its derivation. Significance of ψ and ψ^2, Application of Schrödinger equation to hydrogen atom(in terms of spherical polar coordinates),Radial and angular parts of the hydrogenic wavefunctions (atomic orbitals) and their variations for 1*s*, 2*s*, 2*p*, 3*s*, 3*p* and 3*d* orbitals (Only graphical representation). Radial and angular nodes and their significance. Probability distribution curves and radial probability distribution curves,Quantum numbers and their significance, Shapes of *s*, *p* and *d* atomic orbitals.

Rules governing electronic configuration in various atomic orbitals: Aufbau principle, Pauli's Exclusion Principle and Hund's rule of maximum multiplicity, Concept of exchange energy-extra stability of half-filled and fully filled electronic configurations. Anomalous electronic configurations.

Unit-II: Classifications of Elements and Periodic Properties **(10 Hours)**

Periodic Table- Periodic Laws (Mendeleev and Mosley), Classification of elements into s, p, d and f-blocks, Nuclear Charge, Effective Nuclear Charge, Shielding effect and their inter-relation i.e., Slater's Rule.

Concept, Variations and factors affecting various periodic properties (atomic/ionic radii, ionisation energy, electron affinity and electronegativity), Inert pair effect, Anomalous behaviour of first element in respective groups of representative elements, Diagonal relationship of Li and Mg; Be and Al.

Unit-III: General Organic Chemistry **(10 Hours)**

Electronic Displacements: Inductive Effect, Electromeric Effect, Mesomeric Effect/Resonance and Hyperconjugation, Polar and Non-Polar organic Molecules, Dipole moment and Hydrogen bonding.

Bond Cleavage: Homolytic and Heterolytic fission with suitable examples, formal charge, Concept of Electrophiles and Nucleophiles (with suitable examples).

Semester-I
Course No.: UMJCHT101 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 hours (Theory) and 2½ Hours (Practical)

Reactive Intermediates: Types, shape and relative stability of Carbocations, Carbanions, Free radicals and carbenes.
Introduction to types of organic reactions: Addition, Elimination and Substitution reactions.

UNIT-IV: States of Matter -I **(10 Hours)**
Gaseous State: Postulates of Kinetic Theory of Gases, Concept of Ideal & Non-ideal Gases, Ideal Gas equation, Deviation of gases from ideal behaviour, compressibility factor, causes of deviation and van der Waal's equation.
Molecular velocities: Root mean square, average and most probable velocities, Collision Theory- Collision number, mean free path and collision diameter.
Liquefaction of gases, LPG and critical phenomenon, Critical constants and their calculations from van der Waals equation. Andrew's isotherm of CO_2.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of 4 short answer type questions of (3 marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

Semester-I
Course No.: UMJCHT101 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 hours (Theory) and 2½ Hours (Practical)

BOOKS RECOMMENDED:

1. Concise Inorganic Chemistry; J.D. Lee; 5thEdn., OUP/Wiley India Pvt. Limited, 2008.
2. Principles of Inorganic Chemistry; B.R. Puri, L.R. Sharma and K.C. Kalia; 33rdEdn., Milestone Publishers & Distributors/ Vishal Publishing Co., 2017.
3. Advanced General Organic Chemistry: A Modern Approach; S.K. Ghosh; 3rd Revised Edn., New Central, 2010.
4. Organic Chemistry; R.T. Morrison, R.N. Boyd, S. K. Bhattacharjee; 7th Edn., Pearson India, 2011.
5. Organic Chemistry; J. Clayden, N. Greeves and S. Warren, 2nd Edn., Oxford University Press, 2012.
6. Advanced Organic Chemistry; Dr.Jagdamba Singh and LDS Yadav; Pragati edition, 2017.
7. Principles of Physical Chemistry; B.R. Puri, L.R. Sharma and L.S. Pathania; 47thEdn.,Vishal Pubs & Co, 2017.
8. Physical Chemistry; T. Engel, P. Reid;3rd Edn., Pearson India, 2013.
9. Atkins' Physical chemistry; P. Atkins, J. De Paula and J. Keeler, 11th Edn., Oxford University Press, 2017.

Practical: 01 Credit **Contact Hours: 30 hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Preparation of standard solutions of different concentrations
- Purification of organic compounds by different methods
- Determination of extra elements present in the organic compound.

Suggested Experiments:

1. Preparation of solutions of different concentrations; Standardization of solutions (acids and bases).
2. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
3. Volumetric estimation of oxalic acid by titrating it with $KMnO_4$.
4. Purification of organic compounds by crystallization (from water and alcohol) and sublimation.
5. Criteria of purity: Determination of melting point/boiling point.
6. Detection of N, S and halogens in organic compounds.

Semester-I
Course No.: UMJCHT101 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Comprehensive Practical Organic Chemistry: Qualitative analysis V. K. Ahluwalia & Sunita Dhingra; Universities Press, India, 2004.
2. Advanced Practical Organic Chemistry; N. K. Vishnoi; 3rd Edn; Vikas Publishing, 2009.
3. Advanced Practical Physical Chemistry; J.B. Yadav; Krishna Prakashan Media(P) Limited, 2015.
4. Advanced Physical Chemistry Experiments; J. N. Gurtu, A. Gurtu, Pragati Prakashan, 2008.

Semester-I
Course No.: UMICHT102 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Atomic Structure in terms of atomic orbitals and electronic configuration
- Periodic properties through periodic table
- Electronic displacement and bond cleavage in organic molecules
- Properties of Gaseous state

Unit-I: Structure of atom **(15 Hours)**
Recapitulation of Bohr's theory and its limitations. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance.
Schrödinger's wave equation (Elementary idea only), Significance of ψ and ψ^2.
Quantum numbers and their significance. Radial and angular nodes, Shapes of s, p and orbitals. Rules governing electronic configuration in various atomic orbitals: Aufbau principle, Pauli's Exclusion Principle and Hund's rule of maximum multiplicity, Concept of exchange energy-extra stability of half-filled and fully filled electronic configurations.

Unit-II: Classifications of Elements and Periodic Properties **(10 Hours)**
Periodic Table- Classification of elements into s, p, d and f-blocks, Nuclear Charge, Effective Nuclear Charge, Shielding effect and their inter-relation i.e., Slater's Rule.
Concept, Variations and factors affecting various periodic properties (atomic/ionic radii, ionisation energy, electron affinity and electronegativity), Inert pair effect, Diagonal relationship of Lithium and Magnesium.

Unit-III: General Organic Chemistry **(10 Hours)**
Electronic Displacement: Inductive Effect, Electromeric Effect, Mesomeric Effect/Resonance and Hyperconjugation, Polar and Non-Polar organic Molecules, Dipole moment and Hydrogen bonding.
Bond Cleavage: Homolytic and Heterolytic fission with suitable examples, formal charge, Concept of Electrophiles and Nucleophiles (with suitable examples).
Reactive Intermediates: Types, shape and relative stability of Carbocations, Carbanions and Free radicals.
Introduction to types of organic reactions: Addition, Elimination and Substitution reactions (Elementary idea only).

Semester-I
Course No.: UMICHT102 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Unit- IV: States of Matter -I **(10 Hours)**

Gaseous State: Kinetic Theory of Gases, Ideal & Non-ideal Gases, Ideal Gas equation, Deviation of gases from ideal behaviour, van der Waal's equation.

Molecular velocities: Root mean square, average and most probable velocities (basic concepts only). Collision Theory- Collision number, mean free path and collision diameter. Liquefaction of gases, LPG and critical phenomenon (Andrew's Experiment).

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Concise Inorganic Chemistry; J.D. Lee; 5thEdn., OUP/Wiley India Pvt. Limited, 2008.
2. Principles of Inorganic Chemistry; B.R. Puri, L.R. Sharma and K.C. Kalia; 33rd Edn., Milestone Publishers & Distributors/ Vishal Publishing Co., 2017.
3. Advanced General Organic Chemistry: A Modern Approach; S.K. Ghosh; 3rd Revised Edn., New Central, 2010.
4. Organic Chemistry; R.T. Morrison, R.N. Boyd, S. K. Bhattacharjee; 7th Edn., Pearson India, 2011.
5. Organic Chemistry; J. Clayden, N. Greeves and S. Warren, 2nd Edn., Oxford University Press, 2012.

Semester-I
Course No.: UMICHT102 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

6. Advanced Organic Chemistry; Dr. Jagdamba Singh and LDS Yadav; Pragati edition, 2017.
7. Principles of Physical Chemistry; B.R. Puri, L.R. Sharma and L.S. Pathania; 47thEdn.,Vishal Pubs & Co, 2017.
8. Physical Chemistry; T. Engel, P. Reid; 3rd Edn., Pearson India, 2013.
9. Atkins' Physical chemistry; P. Atkins, J. De Paula and J. Keeler, 11th Edn., Oxford University Press, 2017.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Preparation of standard solutions of different concentrations
- Purification of organic compounds by different methods
- Determination of extra elements present in the organic compound.

Suggested Experiments:

1. Preparation of solutions of different concentrations; Standardization of solutions (acids and bases).
2. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
3. Volumetric estimation of oxalic acid by titrating it with $KMnO_4$.
4. Purification of organic compounds by crystallization (from water and alcohol) and sublimation.
5. Criteria of purity: Determination of melting point/boiling point.
6. Detection of N, S and halogens in organic compounds.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

Semester-I
Course No.: UMICHT102 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

BOOKS RECOMMENDED:

1. Comprehensive Practical Organic Chemistry: Qualitative analysis V. K. Ahluwalia, & Sunita Dhingra; Universities Press, India, 2004.
2. Advanced Practical Organic Chemistry; N. K. Vishnoi; 3rd Edn; Vikas Publishing, 2009.
3. Advanced Practical Physical Chemistry; J.B. Yadav; Krishna Prakashan Media(P) Limited, 2015.
4. Advanced Physical Chemistry Experiments; J. N. Gurtu, A. Gurtu, Pragati Prakashan, 2008.

Semester-I
Course No.: UMDCHT103 (Multi -Disciplinary Course)
Title: CHEMISTRY IN EVERYDAY LIFE

Credits: 03
Maximum Marks: 75
Contact Hours: 45 Hours
Duration of Examination: 3 Hours

Course learning outcomes:
After completing this course contents, students will be able to understand

- To learn about food additives and chemical composition of drugs.

Unit-I: Chemotherapy **(13 Hours)**
Definition of chemotherapy- examples each for (i) Analgesics, (ii) antibacterial, (iii) anti-inflammatory, (iv) antipyretic, (v) antibiotic, (vi) antacid (vii) antiviral, (viii)antidepressant, (ix)antiallergic, (x) antidiabetics, (xi) antihypertensive, (xii) anaesthetics (local and general)
Structures not necessary.

Unit-II: Food Additives and Preservation **(12 Hours)**
Artificial sweeteners - saccharin - cyclomate and asparatate, food flavours esters and aldehydes. Food colours - restricted use of spurious colors - emulsifying agents - leavening agents, baking powder, yeast - taste makers - MSG, vinegar. Food preservation – Methods – preservation by low temperature, high temperature - preservatives.
Structures not necessary.

Unit-III: Biomolecules-I **(10 Hours)**
Carbohydrates: Definition, classification and their importance
Amino acids: Essential and non-essential. Definition, classification and their importance.
Oils and Fats: Definition, classification and importance. Saponification value
Structure not necessary.

Unit- IV: Biomolecules-II **(10 Hours)**
Vitamins: Nomenclature and Classification, Sources, deficiency diseases due to vitamins A, B,C, D, E and K. Structure not necessary.
Minerals: Macro and micro elements, importance and deficiency diseases.
Structure not necessary.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Semester-I
Course No.: UMDCHT103 (Multi -Disciplinary Course)
Title: CHEMISTRY IN EVERYDAY LIFE

Credits: 03
Maximum Marks: 75
Contact Hours: 45 Hours
Duration of Examination: 3 Hours

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Thangamma Jacob, Textbook of Applied chemistry for home science and Allied Science, New Delhi, Macmillan Co., (1979).
2. Macmillan, 1st Ed., 1990. M. Swaminathan, Text Book on Food chemistry, Printing and Publishing Co., Ltd., Bangalore, 1993.
3. Alex Ramani, V., Food Chemistry, MJP Publishers, Triplicane, Chennai, 2009. 9. Sivasankar, B., Food Processing and Preservation, PHI Learning Private Limited, Delhi, 2013.
4. B. S. Bahl, A. Bhal, —Textbook of Organic chemistryl, S. Chand and Company Ltd., New Delhi, 22nd Ed., 2016.
5. Organic Chemistry of Natural Products-Volume I and II by Gurdeep R Chatwal, Himalaya Publishing House.

Semester-I
Course No.: USECHT104 (Skill Enhancement Course)
Title: BASIC ANALYTICAL TECHNIQUES IN CHEMISTRY

Credits: 01 (Theory) + 01 (Practical)
Maximum Marks: 50 [25 (Theory) + 25 (Practical)]
Duration of Examination: 2 Hours (Theory) and 2½ Hours (Practical)

Theory: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Principles of the volumetry
- Various types of titrations.
- Normality, equivalent weight of compounds.
- Hardness and analysis of water.
- Purification and separation techniques in Organic Chemistry

Unit-I **(5 Hours)**
Titrimetric Analysis: definitions - standard solutions, equivalence point, end point, molarity, molality, normality, mole fraction, primary and secondary standards - types of titrimetric reactions - acid-base, redox, acid-base and redox indicators (External and Internal Indicators) Oxidation-reduction: oxidation number and oxidation states - equivalent weights of oxidizing and reducing agents.

Unit-II **(5 Hours)**
Water quality parameters: Introduction, Hard water and Soft water, Measurement of Hardness of Water, Water softening, Chemical Analysis (Dissolved Oxygen, Total Dissolved, suspended and volatile Solids, Chlorides contents, Free and available chlorine and chlorine demand), Battery water and its preparation.

Unit-III **(5 Hours)**
Distillation and Chromatographic Techniques: Introduction, Basic Distillation apparatus, Simple, Fractional and Steam Distillation, Separation of Liquid mixture, Azeotropes.
Chromatographic techniques and types-Paper chromatography, Thin Layer chromatography and Column Chromatography. Separation of Mixtures and R_f value.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **25 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of **4** short answer type questions of (2½ marks each) with atleast one question from each unit. The students have to attempt all the questions from Section-A.

Semester-I
Course No.: USECHT104 (Skill Enhancement Course)
Title: BASIC ANALYTICAL TECHNIQUES IN CHEMISTRY

Credits: 01 (Theory) + 01 (Practical)
Maximum Marks: 50 [25 (Theory) + 25 (Practical)]
Duration of Examination: 2 Hours (Theory) and 2½ Hours (Practical)

Section-B shall comprise of a total of **6** questions with two questions selected from each unit. Each question shall be of **5 marks**. The students have to attempt **3** questions be selecting only one question from each unit.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Preparation of standard solutions
- Practical applications of volumetric analysis

Suggested Experiments:

1. Preparation of solutions of different concentrations; Standardization of Solutions, acid base and redox titrations.
2. Estimation of sodium carbonate and Sodium Hydrogen Carbonate present in a mixture.
3. Preparation of Battery water.
4. Purification of Organic compounds by Distillation.
5. Identification and separation of components of a given mixture (amino acids and sugars) by paper chromatography.
6. Determination of chloride, available chloride and chlorine demand.
7. Determination of Suspended solid (SS),Total Dissolved solid (TDS), Total suspended solid (TSS) and Total volatile solids (TVS).

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks = viva-voce examination)

Semester-I

Course No.: USECHT104 (Skill Enhancement Course)

Title: BASIC ANALYTICAL TECHNIQUES IN CHEMISTRY

Credits: 01 (Theory) + 01 (Practical)

Maximum Marks: 50 [25 (Theory) + 25 (Practical)]

Duration of Examination: 2 Hours (Theory) and 2½ Hours (Practical)

BOOKS RECOMMENDED:

(Theory and Practicals)

1. P. L. Soni, Mohan Katyal, "Text book of Inorganic Chemistry", 20th Revised Ed., (2007), Sultan Chand & Sons, New Delhi. (UNIT I & II)
2. Shashi Chawla, "A textbook of Engineering Chemistry,'' S. Chand.
3. Vogel's textbook of quantitative chemical analysis Mendham, John. Denney, Ronald C. Barnes, John D. Thomas, M., 7th Ed., Prentice Hall, New York, 6th Ed., 2000.
4. A K De, Environmental Chemistry, VIII Edition, New Age International Publishers.
5. Svehla, G. *Vogel's Qualitative Inorganic Analysis*, Pearson Education,2012.
6. Mendham, J. *Vogel's Quantitative Chemical Analysis*, Pearson,2009.
7. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
8. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.

Semester-II
Course No.: UMJCHT201 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Properties of liquid state
- Properties of solid state
- Ionic and covalent bonding
- Basics of organic stereochemistry

Unit-I: States of Matter–II **(10 Hours)**
Liquids: Intermolecular forces, vapour pressure and boiling point of liquids, viscosity and its determination by Ostwald's Viscometersurface tension and its determination by stalagmometer, factors affecting viscosity and surface tension.
Liquid Crystals – Introduction and types (nematic, sematic and cholesteric) with examples.

Unit-II: States of Matter–III **(12 Hours)**
Solids: Characteristics of solids, Amorphous and crystalline solids, space lattice and unit cell, Primitive and centred unit cells, radius ratio rule, Structure of NaCl and CsCl, Closed Packed Structures (1D, 2D and 3D).
Symmetry Elements, Crystal Systems, Bravis lattice types and identification of Lattice planes. Laws of Crystallography- Law of constancy of interfacial angles, law of rational indices, miller indices, Bragg's Law.
Imperfections in solids-Types of point defects (Stoichiometric, non-stoichiometric and Impurity defects)

Unit-III: Chemical Bonding and Molecular Structure **(11 Hours)**
Ionic Bonding: General characteristics of ionic bond, Born-Haber cycle and its applications, lattice energy and solvation energy, polarizing power and polarizability- Fajan's rules and its applications. Dipole moment and percentage ionic character.
Covalent bonding: Postulates of Valence Bond theory and concept of Hybridization (sp, sp^2, sp^3, dsp^2, $sp^3d$and sp^3d^2). VSEPR Theory: Shapes of CH_4, NH_3, H_2O, SF_4 and ClF_3)
Molecular orbital theory (MOT)- rules for the LCAO method, Molecular orbital diagrams of homodiatomic molecules (N_2 and O_2) and heterodiatomic molecules (CO and NO). Comparison of VB and MO approaches.

Semester-II
Course No.: UMJCHT201 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Unit-IV: Stereochemistry **(12 Hours)**

Conformational Isomerism: Conformations with respect to ethane, butane and cyclohexane. Representation of Flying-Wedge, Newmann, Sawhorse and Fischer projections and their interconversion. Concept of Chirality (upto two carbon atoms)

Configuration Isomerism: Relative(D/L) and Absolute (R/S) configurations, CIP rules, Geometrical isomerism (cis & trans; E/Z nomenclatures) and Optical isomerism, Enantiomerism, Diastereomerism and Meso compounds. Threo and erythro nomenclature.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Concise Inorganic Chemistry; J.D. Lee; 5thEdn., OUP/Wiley India Pvt. Limited, 2008.
2. Principles of Inorganic Chemistry; B.R. Puri, L.R. Sharma and K.C. Kalia; 33rdEdn., Milestone Publishers & Distributors/ Vishal Publishing Co., 2017.
3. Principles of Physical Chemistry; B.R. Puri, L.R. Sharma and L.S. Pathania; 47thEdn., Vishal Pubs & Co, 2017.
4. Physical Chemistry; T. Engel, P. Reid,; 3rd Edn., Pearson India, 2013.
5. Atkins' Physical chemistry; P. Atkins, J. De Paula and J. Keeler, 11th Edn., Oxford University Press, 2017.

Semester-II
Course No.: UMJCHT201 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

6. Organic Chemistry; J. Clayden, N. Greeves and S. Warren, 2nd Edn., Oxford University Press, 2012.
7. Stereochemistry of Organic Compounds: Principles and Applications; D. Nasipuri, 4thEdn. Kent, England: New Academic science Limited, 2013.
8. Advanced Organic Chemistry; Dr. Jagdamba Singh and LDS Yadav; Pragati edition, 2017.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Measurement of density, surface tension and viscosity of different liquids.
- Synthesize and identify functional groups in different organic compounds.

Suggested Experiments:

1. Measurement of density and relative density of various liquids using pyknometer/density bottle.
2. Measurement of viscosity of given liquids using Ostwald Viscometer.
3. Measurement of Surface tension of a given liquid using stalagmometer.
4. Functional Group Identification: Aromatic hydrocarbons, unsaturation, carboxylic acids, carbonyl compounds, phenols, alcohols, amines, amides, nitro compounds.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Comprehensive Practical Organic Chemistry: Qualitative analysis Ahluwalia, V.K. & Sunita Dhingra; Universities Press, India, 2004.
2. Advanced Practical Organic Chemistry; N. K. Vishnoi; 3rdEdn; Vikas Publishing, 2009.
3. Advanced Practical Physical Chemistry; J.B. Yadav; Krishna Prakashan Media (P) Limited, 2015.

Semester-II
Course No.: UMJCHT201 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

4. Selected Experiments in Physical Chemistry; Mukherjee N.G.& Ghosh, J.N.; S. Chand & Sons.
5. Advanced Physical Chemistry Experiments; J.N. Gurtu, A.Gurtu, Pragati Prakashan, 2008.
6. Experiments in Physical Chemistry; Das, R. C, and Behra, B.; Tata McGraw Hill.

Semester-II
Course No.: UMICHT202 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Properties of liquid state
- Properties of solid state
- Ionic and covalent bonding
- Basics of organic stereochemistry

Unit-I:State of Matter –II **(10 Hours)**

Liquids: Properties of liquids- vapour pressure, boiling point, viscosity, surface tension, determination of viscosity by Ostwald's Viscometer, determination of surface tension by stalagmometer, factors affecting viscosity and surface tension.
Liquid Crystals – Introduction and types (nematic, sematic and cholesteric) with examples.

Unit-II: State of Matter –III **(12 Hours)**

Solids: Characteristics of solids, Amorphous and crystalline solids, space lattice and unit cell, Primitive and centred unit cells, radius ratio rule, Structure of NaCl and CsCl, Closed Packed Structures (1D, 2D and 3D).
Imperfections in solids-Types of point defects (Stoichiometric, non-stoichiometric and Impurity defects)

Unit-III: Chemical Bonding and Molecular Structure **(11 Hours)**

Ionic Bonding: General characteristics of ionic bond, Born-Haber cycle and its applications, lattice energy and solvation energy, polarizing power and polarizability- Fajan's rules and its applications. Dipole moment and percentage ionic character.
Covalent bonding: Postulates of Valence Bond theory and concept of Hybridization (sp, sp^2, sp^3, dsp^2, $sp^3d$and sp^3d^2). VSEPR Theory: Shapes of CH_4, NH_3, H_2O, SF_4andClF_3)

Unit-IV: Stereochemistry **(12 Hours)**

Conformational Isomerism: Conformations of ethane, butane and cyclohexane. Representation of Flying-Wedge, Newmann, Sawhorse and Fischer projections. Concept of chirality
Configuration Isomerism: Relative(D/L) and Absolute (R/S) configurations, CIP rules, Geometrical isomerism (cis & trans; E/Z nomenclatures) and Optical isomerism, Enantiomerism, Diastereomerism and Meso compounds.

Semester-II
Course No.: UMICHT202 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Concise Inorganic Chemistry; J.D. Lee; 5thEdn., OUP/Wiley India Pvt. Limited, 2008.
2. Principles of Inorganic Chemistry; B.R. Puri, L.R. Sharma and K.C. Kalia; 33rdEdn., Milestone Publishers & Distributors/ Vishal Publishing Co., 2017.
3. Principles of Physical Chemistry; B.R. Puri, L.R. Sharma and L.S. Pathania; 47th Edn., Vishal Pubs & Co, 2017.
4. Physical Chemistry; T. Engel, P. Reid,; 3rd Edn., Pearson India, 2013.
5. Atkins' Physical chemistry; P. Atkins, J. De Paula and J. Keeler, 11th Edn., Oxford University Press, 2017.
6. Organic Chemistry; J. Clayden, N. Greeves and S. Warren, 2nd Edn., Oxford University Press, 2012.
7. Stereochemistry of Organic Compounds: Principles and Applications; D. Nasipuri, 4thEdn. Kent, England: New Academic science Limited, 2013.
8. Advanced Organic Chemistry; Dr. Jagdamba Singh and LDS Yadav; Pragati edition, 2017.

Semester-II
Course No.: UMICHT202 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Measurement of density, surface tension and viscosity of different liquids.
- Synthesize and identify functional groups in different organic compounds.

Suggested Experiments:

1. Measurement of density and relative density of various liquids using pyknometer/density bottle.
2. Measurement of viscosity of given liquids using Ostwald Viscometer.
3. Measurement of Surface tension of a given liquid using stalagmometer.
4. Functional Group Identification: Aromatic hydrocarbons, unsaturation, carboxylic acids, carbonyl compounds, phenols, alcohols, amines, amides, nitro compounds.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Comprehensive Practical Organic Chemistry: Qualitative analysis Ahluwalia, V.K. &Sunita Dhingra; Universities Press, India, 2004.
2. Advanced Practical Organic Chemistry; N. K. Vishnoi; 3rdEdn; Vikas Publishing, 2009.
3. Advanced Practical Physical Chemistry; J.B. Yadav; Krishna Prakashan Media (P) Limited, 2015.
4. Selected Experiments in Physical Chemistry; Mukherjee N.G.& Ghosh, J.N.; S. Chand & Sons.
5. Advanced Physical Chemistry Experiments; J.N. Gurtu, A.Gurtu, Pragati Prakashan, 2008.
6. Experiments in Physical Chemistry; Das, R. C, and Behra, B.; Tata McGraw Hill.

Semester-II
Course No.: UMDCHT203 (Multi-Disciplinary Course)
Title: HAZARDOUS WASTE AND ITS TREATMENT

Credits: 03
Maximum Marks: 75
Contact Hours: 45 Hours
Duration of Examination: 3 Hours

Course learning outcomes:
After completing this course contents, students will be able to understand

- Hazardous wastes and its impact on environment
- Treatment and disposal of hazardous wastes

Unit-I: Hazardous waste **(11 Hours)**
Definition, Classification based on ignitability, Corrosivity,Reactivity and Toxicity. Types of listed Hazardous Wastes: F-type, K-type and U-type and their origin sources. Household hazardous materials and their health and Environmental impact.

Unit-II: Environmental Chemistry of Hazardous Wastes **(11 Hours)**
Origins, Transport, Reactions, Effects and Fates.Physical and Chemical Properties of Hazardous Wastes. Management of hazardous wastes: generation, storage, collection and transportation. Waste minimization, utilization and recycling.

Unit-III: Treatment **(12 Hours)**
Chemical treatment: Acid/base neutralization, Chemical precipitation, Chemical extraction and leaching, Oxidation, Ion exchange and Reduction, Thermal treatment.
Microbial Treatments: Aerobic, Anaerobic and Reductive dehalogenations (by anaerobic bacteria).

Unit-IV: Disposal of Hazardous wastes **(11 Hours)**
Disposal Above ground, Land Treatment, Open Dumping & Disadvantages, Composting and Landfill Sanitary landfills, Secure landfills and Monofills.
Deep Well Injection Technique: Categories of injection wells.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Semester-II
Course No.: UMDCHT203 (Multi-Disciplinary Course)
Title: HAZARDOUS WASTE AND ITS TREATMENT

Credits: 03
Maximum Marks: 75
Contact Hours: 45 Hours
Duration of Examination: 3 Hours

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Environmental Chemistry, Stanley E Manahan, 6th Edition, Lewis Publishers.
2. Principles of Environmental Chemistry, James E. Girard, 3rd Edition., Jones and Bartlett Learning, 2015.

Semester-II

Course No.: USECHT204 (Skill Enhancement Course)

Title: CHEMISTRY OF SOAPS, DETERGENTS AND SURFACTANTS

Credits: 01 (Theory) + 01 (Practical)

Maximum Marks: 50 (25 (Theory) + 25 Hours (Practical))

Duration of Examination: 2 Hours (Theory) and 2½ Hours (Practical)

Theory: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Cleaning agents and technology of soap
- Detergents and surfactants

Unit-1: Cleansing agents **(05 Hours)**

Introduction, synthesis and applications of Natural cleaning agents, cleansing action, Floor cleaner, Toilet Cleaner, Bathroom Cleaner, Kitchen Cleaner. Introduction to soaps and detergents. Types of soaps-bathing, toilet soaps, antibacterial soaps, transparent soaps, liquid soaps.

Unit-II: Technology of Soap **(05 Hours)**

Chemistry of soap, Raw material for soap industry and their selection, hard fats yielding and oil yielding soaps, Chemical reactions of soaps, Hard and Soft soaps, General principles of soap making, chemistry of soap boiling and saponification reaction, Liquid hand wash and liquid dish wash.

Unit-III: Detergents and surfactants **(05 Hours)**

Introduction; Different terms used in detergents, Types of detergents, Classification of detergents (anionic, cationic, nonionic, amphoterics), biodegradability.

Raw materials for detergents; Washing action of detergents; Introduction of surfactants; Types of surfactants.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **25 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (2½ marks each) with atleast one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **6** questions with two questions selected from each unit. Each question shall be of **5 marks**. The students have to attempt **3** questions be selecting only one question from each unit.

Semester-II
Course No.: USECHT204 (Skill Enhancement Course)
Title: CHEMISTRY OF SOAPS, DETERGENTS AND SURFACTANTS

Credits: 01 (Theory) + 01 (Practical)
Maximum Marks: 50 (25 (Theory) + 25 Hours (Practical))
Duration of Examination: 2 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Preparation of soaps and detergents.
- Impact of soaps and detergents on surface tension of water.

Suggested Experiments:

1. Preparation of different types of soaps and Detergents.
2. Study the effect of the surfactants on the surface tension of waters.
3. Determination of critical micelle concentration of different surfactants.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks = viva-voce examination)

BOOKS RECOMMENDED:
(Theory and Practicals)

1. Handbook on Soaps, Detergents & Acid Slurry by NIIR Board, Asia Pacific Business Press.
2. Small scale industries and house hold industries in developing economy by Shetty M.C.
3. Surface Active Agents & Detergents by Anthony M. Schwartz, James W. Perry & Julian Berch, Interscience Publishers
4. The Complete Technology Book on Soaps by NIIR Board, Asia Pacific Business Press.
5. The Complete Technology Book on Detergents by NIIR Board, Asia Pacific Business Press.
6. Shreve's Chemical Process Industries by George T. Austin Vol. V, McGraw-Hill.

Semester-III
Course No.: UMJCHT-301 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemistry of saturated, unsaturated Aliphatic and aromatic Hydrocarbons
- Concept of thermodynamics
- Chemistry of s and p Block Elements

Unit-I: Chemistry of saturated and unsaturated Aliphatic Hydrocarbons **(13 Hours)**

a) Chemistry of Alkanes : Formation of alkanes by Wurtz Reaction, Wurtz Fitting Reaction, Free Radical Substitution in alkanes, Halogenation : Relative reactivity and selectivity.
b) Chemistry of Alkenes and Alkynes:
Formation of Alkenes by E1, E2, E1cB reactions, Hoffmann Elimination and Saytzeff rule. Addition of Halogen to alkenes: Carbocation and Halonium ion Mechanism. Ozonolysis of Propene with Mechanism. Addition of Hydrogen halides to alkenes with mechanism, Markownikoff's rule Addition of HBr to Propene (Peroxide Effect/Anti-Markownikoff addition), Syn and Anti Addition Hydrogenation, Hydroxylation , Hydration , reaction with NBS
Alkynes: Acidity of Alkynes, Alkylation of terminal Alkynes, hydrogenation and hydration of Alkynes
Relative Reactivity of Alkenes and Alkynes
c) Butadiene: 1,2 and 1,4 addition reaction of butadiene
d) Cycloalkanes (upto Cyclohexane) : Nomenclature, Methods of Preparation. Stability of Cycloalkanes: Bayer Strain Theory

Unit-II: Aromatic hydrocarbons **(10 Hours)**
Concept of Aromaticity: Benzenoids and Hückel's rule, **Structure of Benzene**: Kekule Structures, Resonance and Molecular Orbital Theory
Preparation (Case Benzene): from Phenol, , from Acetylene, from Benzene sulphonic acid, by decarboxylation
Reactions: (Case Benzene): General mechanism of Electrophilic Substitution reactions, σ and π complexes, Nitration, Halogenation and Sulphonation.
Friedel-Craft's reaction: alkylation (upto 3 carbons on benzene) and **acylation**
Side chain oxidation of alkyl benzenes (upto 3 carbons on benzene).
Activating and Deactivating groups, Orientation effect, Ortho-para ratio
Aromatic nucleophilic Substitution (S_NAr) with mechanism.

Semester-III
Course No.: UMJCHT-301 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Unit-III: Thermodynamics-I **(11 Hours)**

Definition of thermodynamics terms: system, surroundings, boundary. Types of system, Thermodynamic variables, intensive and extensive properties. State and path functions. Thermodynamic equilibrium. Thermodynamic process. Concept of heat and work.

First Law of Thermodynamics: Statement and our daily life examples, internal energy and its physical significance. Heat change at constant volume, heat change at constant pressure: Enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Variation of internal energy with temperature and volume, Joules law. Variation of enthalpy with temperature and pressure, Joule-Thomson coefficient and inversion temperature.

Unit-IV: Chemistry of s and p Block Elements-I **(11 Hours)**

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Preparation, structure and bonding of borohydrides (diborane).

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

Semester-III
Course No.: UMJCHT-301 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

BOOKS RECOMMENDED:

1. Morrison, R.N., Boyd, R.N.' Bhattacharjee, S.K. (2010) Organic Chemistry.
2. Finar, I.L. (2002) Organic Chemistry Volume I, II, 6th Edition Pearson Education.
3. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
4. Sykes, P.A. Guidebook to Mechanism in Organic Chemistry, Orient Longman, Longman, New Delhi (1988).
5. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
6. R.P. Rastogi, R.R. Misra. Sixth Revised Edition. Vikas Publishing House Pvt. Ltd.
7. Bell, R. P., Proton in Chemistry, 2nd Ed., Chapmaon Hall, (1973).
8. Drago, R. S., Modern Approach to Acid base Chemistry, J. C.Chem. Educ., 51, 300 (1974).
9. Gillespie, R. R., Proton acids, Lewis acids, hard acids, soft acids and super acids. Chapman and Hall (1975).
10. Jensen, W.B., The Lewis Acid-Base Concepts, Wiley, New York (1980).
11. Nicholls, D. Inorganic Chemistry in Liquid Ammonia, Elsevier (1979).
12. Pearson, R. G., Ed., Hard and Soft Acids and Bases, Dowden, Hutchinson (1973).

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Qualitative analysis of common organic compounds
- Determination of heat capacity and heat of neutralization
- Semi-micro qualitative analysis of cations and anions

Suggested Experiments:

Section A: Organic Chemistry:

Qualitative analysis of following Organic Compounds:

1. Naphthalene
2. Anthracene
3. Benzoic Acid
4. Salicylic Acid
5. Glucose
6. Sucrose
7. Catechol
8. Resorcinol

Semester-III
Course No.: UMJCHT-301 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

9. Salicylaldehyde
10. Acetophenone
11. Benzophenone
12. P-aminobenzoic
13. Urea
14. Thiourea
14. Acetamide
15. Benzamide

(Note: Any 07 to 09 Compounds to be analysed in a semester)

Section B: Physical Chemistry:
1. Determination of heat capacity of calorimeter.
2. Determination of heat of neutralization hydrochloric acid with sodium hydroxide.

Section C: Inorganic Chemistry:
Semi-micro qualitative analysis using H_2S of mixtures of salts (not more than four ionic species, two anions and two cations and excluding insoluble salts) out of the following:
Cations : NH_4^+ , Pb^{2+}, Ag+ , Bi^{3+} , Cu^{2+} , Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+} , Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+
Anions : CO_3^{2-} , S^{2-} , SO_2^- , $S_2O_3^{2-}$, NO_3^- , $CH3COO^-$, Cl^- , Br^- , I^-, NO_3^- ,SO_4^{2-} , PO_4^{3-} , BO_3^3, $C_2O_4^{2-}$, F^- (Students should be encouraged to perform Spot tests wherever feasible)

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

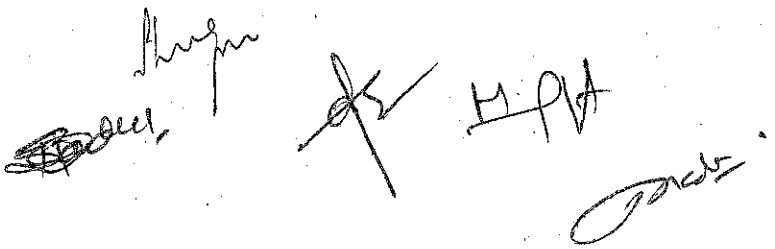
BOOKS RECOMMENDED:

1. Vogel's Textbook of Practical Organic Chemistry, Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell: Pearson, 5th Edition, 2012.
2. Man, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson education (2009).
3. Practical Physical Chemistry; Khosla, B. D.; Garg, V. C. & Gulati, A.; R. Chand & Co.; 2011.
4. Experiments in Physical Chemistry; Das, R. C, and Behra, B.; Tata McGraw Hill.

Semester-III
Course No.: UMJCHT-301 (Major course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

5. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
6. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.



Semester-III
Course No.: UMJCHT-302 (Major course)
Title: ANALYTICAL CHEMISTRY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Basics of analytical Chemistry
- Acid-base, complexometric, precipitation and redox titrations
- Chromatographic methods

Unit-I: Basics of Analytical chemistry **(12 Hours)**

Classification of analytical techniques. Choice of analytical method chosen: accuracy, precision, sensitivity, selectivity and method validation. Limit of detection (LOD), Limit of quantification (LOQ), Limitations of analytical methods – Errors: Determinate and indeterminate errors, absolute error, relative error, minimization of errors.

Basic laboratory practices: calibration of glassware (pipette, burette and volumetric flask), Sampling (solids and liquids), weighing, drying, dissolving, Acid treatment, Safety in Chemical

Laboratory, Rules of fire prevention and accidents, First aid, Precautions to be taken while handling toxic chemicals, concentrated/fuming acids and organic solvents.

Unit-II: Acid-base and complexometric Titrimetry **(11 Hours)**

Basic principle and Classification of titrimetric analysis.

Acid-base titrimetry: Titration curves for strong acid vs strong base, weak acid vs strong base and weak base vs strong acid titrations. Titration curves, Quantitative applications – selecting and standardizing a titrant, inorganic analysis - alkalinity, acidity.

Complexometric titrimetry: Indicators for EDTA titrations- theory of metal ion indicators, titration methods employing EDTA - direct, back, displacement and indirect determinations, Application-determination of hardness of water.

Unit-III: Redox and Precipitation Titrimetry and Gravimetric Analysis **(11 Hours)**

Redox titrimetry: Balancing redox equations, calculation of the equilibrium constant of redox reactions, titration curves, Theory of redox indicators, calculation of standard potentials using Nernst equation. Applications.

Precipitation titrimetry: Titration curves, titrants and standards, indicators for precipitation titrations involving silver nitrate- Volhard's and Mohr's methods and their differences.

Gravimetric Analysis: Principle and mechanism of precipitation, Factors influencing precipitation, Co-precipitation, post-precipitation, Advantages of organic reagents over

Semester-III
Course No.: UMJCHT-302 (Major course)
Title: ANALYTICAL CHEMISTRY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Separation of organic compounds and transition metal ions by chromatographic methods
- Use of complexometric, redox and acid-base titrations in practical applications

Suggested Experiments:

1. Separation of ortho- & para-nitrophenol and o- and p-aminophenol by thin layer chromatography (TLC) and calculation of their R_f values.
2. Separation of divalent 3d transition metal ions by paper chromatography.
3. Determination of carbonate and bicarbonate present in water sample.
4. Preparation of EDTA solution and estimation of hardness ($CaCO_3$) of two different samples.
5. Preparation of standard Na_2CO_3 solution, standardization of given HCl solution and estimation of alkali present in given antacid.
6. Determination of chlorine in two different samples of bleaching powder by iodometry (standard sodium thiosulphate solution to be supplied)
7. Estimation of Cu(II) using sodium thiosulphate solution (Iodometrically).
8. Estimation of $K_2Cr_2O_7$ using sodium thiosulphate solution (Iodometrically).

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

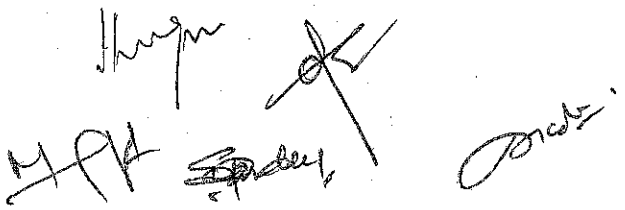
BOOKS RECOMMENDED:

1. Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. Vogel's Textbook of Quantitative Chemical Analysis, John Wiley & Sons, 1989.
2. Willard, H. H., Merritt, L.L., Dean, J. & Settle, F.A. Instrumental Methods of Analysis, Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
3. Christian, G.D; Analytical Chemistry, VI Ed. John Wiley & Sons, New York, 2004.

Semester-III
Course No.: UMJCHT-302 (Major course)
Title: ANALYTICAL CHEMISTRY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

4. Harris, D. C. Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Skoog, D. A. Holler F.J. & Nieman, T.A. Principles of Instrumental Analysis, Cengage Learning India Ed, 2017.
6. Ditts, R.V. Analytical Chemistry; Methods of Separation, van Nostrand, 1974.
7. Fifield, F.W.; Kealey, D. (2000), Principles and Practice of Analytical Chemistry, Wiley.
8. Harris, D. C. (2007), Exploring Chemical Analysis, W.H. Freeman and Co.
9. Harris, D. C. (2007), Quantitative Chemical Analysis, 6th Edition, Freeman.
10. Mikes, O. (2000), Laboratory Handbook of Chromatographic methods, D.Van Nostrand Company Inc.



Semester-III
Course No.: UMJCHT-302 (Major course)
Title: ANALYTICAL CHEMISTRY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

inorganic reagents, Importance of reagents used in gravimetry [8-hydroxyquinoline (oxine) and dimethyl glyoxime (DMG)].

Unit-IV: Chromatographic Methods **(11 Hours)**

Classification of chromatographic methods: Principles of differential migration, description of Chromatographic process, distribution coefficients, capacity factor, column efficiency and resolution, Techniques of sample preparation in chromatography.

Brief overview of paper chromatography (detections of spots, retardation factors, factors that affect reproducibility of R_f values) and Thin Layer Chromatography (Stationary phase, adsorbents, liquid phase support, plate preparation, mobile phase, sample application, development, detection of spot, R_f values).

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

Semester-III
Course No.: UMICHT-303 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemistry of saturated, unsaturated Aliphatic and aromatic Hydrocarbons
- Concept of thermodynamics
- Chemistry of s and p Block Elements

Unit-I: Chemistry of saturated and unsaturated Aliphatic Hydrocarbons **(13 Hours)**

a) Chemistry of Alkanes: Formation of alkanes by Wurtz Reaction , Wurtz Fitting Reaction, Free Radical Substitution in alkanes, Halogenation : Relative reactivity and selectivity.
b) Chemistry of Alkenes and Alkynes:
Formation of Alkenes by E1, E2, E1cB reactions, Hoffmann Elimination and Saytzeff rule. Addition of Halogen to alkenes: Carbocation and Halonium ion Mechanism. Ozonolysis of Propene with Mechanism. Addition of Hydrogen halides to alkenes with mechanism, Markownikoff's rule, Addition of HBr to Propene (Peroxide Effect/Anti-Markownikoff addition), Syn and Anti Addition Hydrogenation, Hydroxylation, Hydration.
Alkynes: Acidity of Alkynes, Alkylation of terminal Alkynes, hydrogenation and hydration of Alkynes
Relative Reactivity of Alkenes and Alkynes
c) Cycloalkanes (upto Cyclohexane) : Nomenclature and Methods of Preparation.

Unit-II: Aromatic hydrocarbons **(10 Hours)**

Concept of Aromaticity: Benzenoids and Hückel's rule, **Structure of Benzene**: Kekule Structures, Structure of Benzene on the basis of Resonance and Molecular Orbital Theory. Concept of resonance energy.
Preparation (Benzene): from Phenol, from Acetylene, from Benzene sulphonic acid, by decarboxylation
Reactions: (Benzene): General mechanism of Electrophilic Substitution reactions, Nitration, Halogenation and Sulphonation.
Friedel-Craft's reaction : alkylation (upto 3 carbons on benzene) and acylation
Activating and deactivating groups, Orientation effect, ortho-para ratio.

Unit-III: Thermodynamics-I **(11 Hours)**

Definition of thermodynamics terms: system, surroundings, boundary. Types of system, Thermodynamic variables, intensive and extensive properties. State and path functions. Thermodynamic equilibrium. Thermodynamic process. Concept of heat and work.

Semester-III
Course No.: UMICHT-303 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

First Law of Thermodynamics: Statement and our daily life examples, internal energy and its physical significance. Heat change at constant volume, heat change at constant pressure: Enthalpy. Heat capacity, heat capacities at constant volume and pressure and their relationship. Variation of internal energy with temperature and volume. Variation of enthalpy with temperature and pressure. Entropy and its significance. 2nd Law of thermodynamics.

Unit-IV: Chemistry of s and p Block Elements – I **(11 Hours)**

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and p block elements. Hydrides and their classification ionic, covalent and interstitial. Preparation, structure and bonding of borohydrides (diborane).

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Morrison, R.N., Boyd, R.N.' Bhattacharjee, S.K. (2010) Organic Chemistry.
2. Finar, I.L. (2002) Organic Chemistry Volume I, II , 6th Edition, Pearson Education.
3. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed., Cengage Learning India Edition, 2013.

Semester-III
Course No.: UMICHT-303 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

4. Sykes, P.A. Guidebook to Mechanism in Organic Chemistry, Orient Longman, Longman, New Delhi (1988).
5. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
6. R.P. Rastogi, R.R. Misra. Sixth Revised Edition. Vikas Publishing House Pvt. Ltd.
7. Bell, R. P. , Proton in Chemistry , 2nd Ed., Chapmaon Hall, (1973).
8. Drago, R. S., Modern Approach to Acid base Chemistry, J. C.Chem. Educ., 51, 300 (1974),
9. Gillespie, R. R., Proton acids, Lewis acids, hard acids, soft acids and super acids. Chapman and Hall (1975).
10. Jensen, W.B., The Lewis Acid-Base Concepts, Wiley, New York (1980).
11. Nicholls, D. Inorganic Chemistry in Liquid Ammonia, Elsevier (1979).
12. Pearson, R. G., Ed., Hard and Soft Acids and Bases, Dowden, Hutchinson (1973).

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Qualitative analysis of common organic compounds
- Determination of heat capacity and heat of neutralization
- Semi-micro qualitative analysis of cations and anions

Suggested Experiments:

Section A: Organic Chemistry :
Qualitative analysis of following Organic Compounds :
1. Naphthalene
2. Anthracene
3. Benzoic Acid
4. Oxalic Acid
5. Salicylic Acid
6. Sucrose
7. Catechol
8. Resorcinol
9. Salicylaldehyde
10. Acetophenone
11. Benzophenone
12. P-aminobenzoic acid
13. p-chlorobenzoic acid

Semester-III
Course No.: UMICHT-303 (Minor course)
Title: FOUNDATION COURSE CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

14. Thiourea
15. Acetamide
16. Benzamide

(Note : Any 07 to 09 Compounds to be analysed in a semester)

Section B: Physical Chemistry :

1. Determination of heat capacity of calorimeter.
2. Determination of heat of neutralization hydrochloric acid with sodium hydroxide.
3. Determination of heat of neutralization acetic acid with sodium hydroxide.

Section C: Inorganic Chemistry :

Semi-micro qualitative analysis using H_2S of mixtures of salts (not more than four ionic species, two anions and two cations and excluding insoluble salts) out of the following:

Cations : NH_4^+ , Pb^{2+}, Ag+ , Bi^{3+} , Cu^{2+} , Cd^{2+}, Sn^{2+}, Fe^{3+}, Al^{3+}, Co^{2+} , Cr^{3+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, K^+

Anions : CO_3^{2-} , S^{2-} , SO_2^- , $S_2O_3^{2-}$, NO_3^- , $CH3COO^-$, Cl^- , Br^- , I^-, NO_3^- ,SO_4^{2-}, PO_4^{3-} , BO_3^3, $C_2O_4^{2-}$, F^- (Students should be encouraged to perform Spot tests wherever feasible)

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Vogel's Textbook of Practical Organic Chemistry, Brian S. Furniss, Antony J. Hannaford, Peter W. G. Smith, Austin R. Tatchell. Pearson 5th Edition, 2012.
2. Man, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson education (2009).
3. Practical Physical Chemistry; Khosla, B. D.; Garg, V. C. & Gulati, A.; R. Chand & Co.; 2011.
4. Experiments in Physical Chemistry; Das, R. C, and Behra, B.; Tata McGraw Hill.
5. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
6. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2023, 2024 & 2025)

Semester-III
Course No.: UMDCHT-304 (Multi-Disciplinary Course)
Title: CHEMISTRY IN EVERYDAY LIFE

Credits: 03
Maximum Marks: 75
Contact Hours: 45 Hours
Duration of Examination: 3 Hours

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemotherapy
- Food Additives and Preservation
- Biomolecules

Unit-I: Chemotherapy **(13 Hours)**
Definition of chemotherapy- examples each for (i) Analgesics, (ii) antibacterial, (iii) anti-inflammatory, (iv) antipyretic, (v) antibiotic, (vi) antacid (vii) antiviral, (viii) antidepressant, (ix) antiallergic, (x) antidiabetics, (xi) antihypertensive, (xii) anaesthetics (local and general)
Structures not necessary.

Unit-II: Food Additives and Preservation **(12 Hours)**
Artificial sweeteners - saccharin - cyclomate and asparatate, food flavours esters and aldehydes. Food colours - restricted use of spurious colors - emulsifying agents - leavening agents, baking powder, yeast - taste makers - MSG, vinegar. Food preservation – Methods – preservation below temperature, high temperature - preservatives.
Structures not necessary.

Unit-III: Biomolecules-I **(10 Hours)**
Carbohydrates: Definition, classification and their importance
Amino acids: Essential and non-essential. Definition, classification and their importance.
Oils and Fats: Definition, classification and importance. Saponification value
Structure not necessary.

Unit- IV: Biomolecules-II **(10 Hours)**
Vitamins: Nomenclature and Classification, Sources, deficiency diseases due to vitamins A, B,C, D, E and K. Structure not necessary.
Minerals: Macro and micro elements, importance and deficiency diseases.
Structure not necessary.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Semester-III
Course No.: UMDCHT-304 (Multi-Disciplinary Course)
Title: CHEMISTRY IN EVERYDAY LIFE

Credits: 03
Maximum Marks: 75
Contact Hours: 45 Hours
Duration of Examination: 3 Hours

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Thangamma Jacob, Textbook of Applied chemistry for home science and Allied Science, New Delhi, Macmillan Co., (1979).
2. Macmillan, 1st Ed., 1990. M. Swaminathan, Text Book on Food chemistry, Printing and Publishing Co., Ltd., Bangalore, 1993.
3. Alex Ramani, V., Food Chemistry, MJP Publishers, Triplicane, Chennai, 2009. 9. Sivasankar, B., Food Processing and Preservation, PHI Learning Private Limited, Delhi, 2013.
4. B. S. Bahl, A. Bhal, —Textbook of Organic chemistryl, S. Chand and Company Ltd., New Delhi, 22nd Ed., 2016.
5. Organic Chemistry of Natural Products-Volume I and II by Gurdeep R Chatwal, Himalaya Publishing House.

Semester-III
Course No.: USECHT-305 (Skill Enhancement Course)
Title: CHEMISTRY OF FOOD AND COSMETICS

Credits: 01 (Theory) + 01 (Practical)
Maximum Marks: 50 [25 (Theory) + 25 (Practical)]
Duration of examination: 2 Hours (Theory) and 2½ Hours (Practical)

Theory: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Food Preservation and Food Adulteration
- Chemistry of Cosmetics

Unit-I: Food Preservation and Food Adulteration (05 Hours)
Principles of Food Preservation: Meaning, mode of action and changes in foods.
Traditional methods of Food Preservation: Smoking, Sun Drying, Pickling and Fermentation.
Food Adulteration: Common adulterants in different foods- milk and milk products, vegetable oils, and fats, spices and condiments, cereals, pulses.
Sweetening agents and beverages.
Contamination with toxic chemicals- pesticides and insecticides. Methods involved in the detection and prevention of food adulteration.

Unit-II: Chemistry of Cosmetics (05 Hours)
History of cosmetics, classification of cosmetics, professional image of self grooming, beauty and wellness. Chemical peels and peeling agents, lasers and light devices, Electro Chemistry, bath salts, gels, soaps, bubble baths and scrubs.

Unit-III: Cosmetic Products (05 Hours)
A general study including preparation and uses of the following: Hair dye, hair spray, shampoo, suntan lotions, sun screen, face powder, lipsticks, talcum powder, nail enamel, creams (cold, vanishing and shaving creams), moisturisers, cleansers, acne and anti aging creams.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **25 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of 4 short answer type questions of (2½ marks each) with atleast one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **6** questions with two questions selected from each unit. Each question shall be of **5 marks**. The students have to attempt **3** questions be selecting only one question from each unit.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2023, 2024 & 2025)

Semester-III
Course No.: USECHT-305 (Skill Enhancement Course)
Title: CHEMISTRY OF FOOD AND COSMETICS

Credits: 01 (Theory) + 01 (Practical)
Maximum Marks: 50 [25 (Theory) + 25 (Practical)]
Duration of examination: 2 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Methods of preparation of shampoo, face cream, soap and lip balm
- Testing of adulterants in food samples

Suggested Experiments:

1. Preparation of shampoo
2. Preparation of face cream
3. Preparation of Soap
4. Preparation of Lip Balm
5. Testing for the presence of adulterants in various food samples -milk and milk products, vegetable oils, and fats, spices and condiments, cereals, pulses.
6. Practice any two traditional methods of food Preservation (from theory component).

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Rick Parker (2003) Introduction to Food Science, New York: Delmar Thomson Learning.
2. Scottsmith and Hui Y.H (Editors) (2004) Food Processing – Principles and Applications, London Blackwell Publishing.
3. Subbulakshmi, G and Udipi, S. A. (2001).Foods Processing and Preservation, New Delhi, New Age International (P) Ltd. Publishing.
4. Swaminathan, M. (1995). Food Science Chemistry and Experimental Food, The Bangalore Printing and Publishing Co. Ltd.
5. Vacklavick, V. and Christian, E. (2003). Essentials of Food Science. New York, Kluwer Academic/ Plenum Publisher.
   ** All new journals related to Food Preservation**
6. Perry Romanowski, Beginning Cosmetic Chemistry, Allured Pub Corp.2009.
7. Dr. Ramesh Kumari, Chemistry of Cosmetics, Prestige Publishers.

Semester-III
Course No.: USECHT-305 (Skill Enhancement Course)
Title: CHEMISTRY OF FOOD AND COSMETICS

Credits: 01 (Theory) + 01 (Practical)
Maximum Marks: 50 [25 (Theory) + 25 (Practical)]
Duration of examination: 2 Hours (Theory) and 2½ Hours (Practical)

8. Srilakshmi B., Food Science, New age International Pvt. Ltd. Publishers, III ed. 2003.
9. Shakuntala Manay N. and Shadaksharaswamy M. FOODS: Facts and Principles. New Age International Pvt. Ltd. Publishers, II ed. 2002.
10. Norman N. Potter, Food Science, CBS Publishers and Distributors, New Delhi. 1994.
11. Swaminathan M. Advanced Text Book on Food and Nutrition, Volume I and II Printing and Publishing Co., Ltd., Bangalore. 1993.

Semester-IV
Course No.: UMJCHT-401 (Major course)
Title: PHYSICAL CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical equilibrium and phase equilibrium
- Electrochemistry

Unit-I: Chemical Equilibrium **(11 Hours)**

Introduction , State of chemical equilibrium , Law of mass action, Law of chemical equilibrium, Thermodynamic derivation of the law of chemical equilibrium, , Types of equilibrium constants , Relationship between K_p and K_c , Application of equilibrium constants, Van't Hoff Reaction Isotherm, Le Chatlier's Principle, Applications of Le Chatlier's Principle, Clausius-Clapeyron Equation.

Unit-II: Phase Equilibrium **(12 Hours)**

Introduction , Phase, Component , Degree of freedom, Criteria for Phase Equilibrium, Thermodynamic derivation of phase rule, Phase Diagram, One Component system, phase diagram of water, Sulphur, Freezing Mixtures.

Immiscible liquids, Steam Distillation, Partially miscible liquids (Upper and Lower Critical Solution Temperature), Effect of temperature on Critical Solution Temperature, Nernst Distribution Law, Introduction, thermodynamic derivation of law and its applications.

Unit-III: Electrochemistry-I **(11 Hours)**

Introduction, Electrolytic Conductance, Conductance, Cell constant, Specific conductivity, Equivalent conductivity, Molar conductivity and their relation with specific conductivity , Variation of different types of conductivities with dilution.

Arrhenius theory of ionisation , Ostwald's dilution law, Debye-Huckel-Onsager equation, Anomalous behaviour of strong electrolytes, Kohlrausch's Law, Transport Number, Determination of transport number (Hittorf's and Moving Boundary Method), Conductometric titrations.

Unit-IV: Electrochemistry-II **(11 Hours)**

Electrochemical Cell, Electrolytic Cell, EMF of a cell, Reversible and Irreversible Cell, Types of electrodes, Relationship between electrical energy and chemical energy, Measurement of electrode potentials (Zinc and copper electrodes), Electrochemical series, Applications, Nernst Equation for measuring EMF of a cell, Conentration Cells (definition and examples only), Liquid Junction Potential (definition only), Potentiometric titrations.

Semester-IV
Course No.: UMJCHT-401 (Major course)
Title: PHYSICAL CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of 2 questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Rodgers, G.E. Inorganic and solid state chemistry, Cengage Learning India Ltd., (2008).
2. Barrow, G.M. Physical Chemistry Tata McGraw-Hill, (2007)
3. Castellan, G.W. Physical Chemistry 4th Ed. Narosa, (2004)
4. P. W. Atkins, J de Paula, Physical Chemistry, 8th Ed, Oxford University Press, New Delhi, (2006).
5. I. N. Levine, Physical Chemistry, 6th Ed, Mcgraw Hill Education, (2011).

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Different phases of a substance.
- Miscibility of two liquids
- Conductance of the different electrolytic solutions

Semester-IV
Course No.: UMJCHT-401 (Major course)
Title: PHYSICAL CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Suggested Experiments:

1. Determination of critical solution temperature and composition of phenol-water system.
2. Effect of impurities on critical solution temperature on phenol-water system.
3. Construction of phase diagrams.
4. Determination of cell constant.
5. Determination of equivalent conductivity, degree of dissociation and dissociation of a weak acid.
6. Determination of equivalent conductivity of a strong electrolyte and hence verify Debye-Huckel Onsager Equation.
7. Conductometric Titrations of Strong acid, weak acids and their different combinations.
8. Potentiometric Titrations of Strong acid, weak acids and their different combinations.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. UGC Advanced Physical Chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan.
2. Advanced Practical Chemistry, Singh, Yadav, Siddiqui, Pragati Prakashan.
3. Advanced Practical Physical Chemistry, J.B. Yadav, God Publishing House, Krishna Prakash Media Ltd.
4. Advanced Physical Chemistry Experiments, J.N. Gurtu, A. Gurtu, Pragati Prakashan.

Semester-IV
Course No.: UMJCHT-402 (Major course)
Title: ORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Reactions of alkyl & aryl halides, alcohols & phenols
- Reactions of ethers, epoxides and carbohydrates

Unit-I: Alkyl & Aryl Halides **(12 Hours)**

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.
Preparation: from alkenes *and* alcohols.
Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis.
Aryl Halides *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit-II: Alcohols & Phenols **(13 Hours)**

Alcohols
Preparation: Preparation of 1^0, 2^0 and 3^0 alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.
Reactions: With sodium, HX (Lucas test), esterification, oxidation (PCC, Alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation.
Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts.
Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch reaction.

Unit-III: Ethers & Epoxides **(10 Hours)**

Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Unit-IV: Carbohydrates **(10 Hours)**

Classification and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of

Semester-IV
Course No.: UMJCHT-402 (Major course)
Title: ORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

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disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
6. Bahl, A & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
7. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
8. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co.: New York (1985).
9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).

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Semester-IV
Course No.: UMJCHT-402 (Major course)
Title: ORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Purification of organic compound
- Mechanisms of various reactions

Suggested Experiments:

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.
4. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone
5. Action of salivary amylase on starch
6. Effect of temperature on the action of salivary amylase on starch.
7. Differentiation between a reducing and a non-reducing sugar.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years May 2024, 2025 & 2026)

Semester-IV

Course No.: UMJCHT-403 (Major Course)

Title: INORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)

Maximum Marks: 100 [75 (Theory) + 25 (Practical)]

Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Chemistry of s and p Block Elements
- Chemistry of transition elements, lanthanides and actinides
- Basics of coordination chemistry

Unit-I: Chemistry of s and p Block Elements – II **(12 Hours)**

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, carboranes and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, Phosphorus andchlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens. Occurrence and uses, preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).

Unit-II: Transition Elements-I **(11 Hours)**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Chemistry of elements of second and third transition series- general characteristics, comparative treatment with their 3d analogues in respect of ionic radii, oxidation states, magnetic behaviour spectral properties and stereochemistry.

Unit-III: Transition Elements-II **(11 Hours)**

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy). Lanthanoids and Actinoids: Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides(ion-exchange method only). General features of actinoids, separation of Np, Pm, Am from U.

Unit-IV: Basics of coordination chemistry **(11 Hours)**

Definitions and terminology, Werner's coordination theory and its experimental verification, EAN concept, IUPAC nomenclature of coordination compounds, structural and stereoisomerism in complexes with coordination numbers 4and6, Distinction between cis- and trans- compounds. A brief outline of thermodynamic and kinetic stability of metal complexes, stepwise and overall stability constants, factors affecting the stability of complexes, chelate effect.

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Semester-IV
Course No.: UMJCHT-403 (Major Course)
Title: INORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5th Edn., 2008.
2. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry –Principles of structure and reactivity, Pearson Education, 4th Ed. 2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rded., 2017.
4. Shriver D. E., Atkins P. W., Inorganic Chemistry, Oxford UniversityPress, 5th Edn., (2010).
5. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
6. Cotton, F.A. and Wilkinson, G Basic Inorganic Chemistry, Wiley.
7. Catherine E. Housecraft and Alan G. Sharpe, Inorganic Chemistry, Pearson.
8. Gary L. Miessler, Paul Fischer and Donald A. Tarr, Inorganic Chemistry, Pearson.
9. James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Mehdi, Pearson.
10. Banerjea D., Coordination Chemistry, Asian Books.

Semester-IV
Course No.: UMJCHT-403 (Major Course)
Title: INORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Gravimetry and complexometric methods
- Applications of UV-visible spectroscopy

Suggested Experiments:

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.
4. Estimate the amount of aluminium as oximate in a given solution gravimetrically.
5. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/$CuSO_4$) and estimate the concentration of the same in a given solution.
6. Estimation of total hardness of a given sample of water by complex metric titration.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Semester-IV
Course No.: UMJCHT-404 (Major Course)
Title: SPECTROSCOPY AND NUCLEAR CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Molecular spectroscopy
- Ultraviolet (UV) Absorption Spectroscopy
- Nuclear chemistry

Unit-I: Molecular Spectroscopy I **(12 Hours)**
Introduction: Electromagnetic radiation, regions of electromagnetic spectrum, basic features of different spectrometers.
Origin of molecular spectra: Born-Oppenheimer approximation.
Rotational spectra of diatomic molecules: Relationship between internuclear distance and moment of inertia. Expression for pure rotational spectra of diatomic molecules. Numerical problems. Criterion for absorption of radiation-selectionrule.

Unit-II: Molecular Spectroscopy II **(11 Hours)**
Vibrational spectroscopy: Hooke's law- Expression for the frequency of SHO-force constant and its significance. Expression for vibrational energy levels of SHO. Zero-point energy, numerical problems. Degree of freedom of polyatomic molecules– modes of vibration for CO_2 and H_2O molecules.

Unit-III: Ultraviolet (UV) Absorption Spectroscopy **(11 Hours)**
Absorption laws (Beer-Lambert law), molar absorptivity, types of electronic transitions, concept of chromophores and auxochromes, absorption and intensity shifts, effect of conjugation, effect of solvents. UV spectra of conjugated Enes and Enones (Woodward - Fieser rules).

Unit-IV: Nuclear Chemistry **(11 Hours)**
Natural and artificial radioactivity, nuclear reactions, artificial transmutation of elements, nuclear energy-nuclear fission and fusion, nuclear reactors, Radioactive isotopes and their uses, Half-life period, Applications of Radioactivity and Radioisotopes as radio tracers, for medical use and, radio-dating of minerals and rocks.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Semester-IV
Course No.: UMJCHT-404 (Major Course)
Title: SPECTROSCOPY AND NUCLEAR CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Alberty, R.A, Physical Chemistry,4th Edition Wiley Eastern Ltd ,2001.
2. Atkins, P W, The Elements of Physical Chemistry, Oxford, 1991.
3. Barrow, G.M, International Student Edition. McGraw Hill, McGraw-Hill,1973.
4. Clayden, J., Greeves, N., Warren, S., Organic Chemistry, Second edition, Oxford University Press 2012.
5. Silverstein, R.M., Bassler, G. C., Morrill, T. C. Spectrometric Identification of Organic Compounds, John Wiley and Sons, INC, Fifth edition.
6. Pavia, D.L. et al. Introduction to Spectroscopy, 5th Ed. Cengage Learning India Ed.
7. Willard, H.H. et.al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
8. Christian, G.D. Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
9. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age International Publisher, 2009.
10. Mukherji, Singh, Kapoor, Organic Chemistry, Vol 1 and 2. New Age International 2014
11. R.L. Madan, Chemistry for Degree Students Elective Sem V/VI as per CBS Quantum and Spectroscopy, S Chand Publishing
12. Y.R. Sharma, Elementary Organic Spectroscopy Vol 4, S Chand.
13. Gurdeep Raj, Advanced Physical Chemistry, Krishna Publishing.
14. K.L. Kapoor, A Textbook of Physical Chemistry - Quantum Chemistry and Molecular Spectroscopy, Volume 4, Macmillan.

Semester-IV
Course No.: UMJCHT-404 (Major Course)
Title: SPECTROSCOPY AND NUCLEAR CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

15. T.N. Srivastva and P.C. Kampoj, Systematic Analytical Chemistry, Shobanlal Nagin Chand.
16. H.J. Arnikar, Essentials of Nuclear Chemistry, 4th ed., New Age International, New Delhi, 1995.
17. Bariyar, and Goyal, Physical Chemistry-II, Krishna Prakashan Media, Meerut, Third Edition, 2019.

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand
- Beer-Lambert Law and its applications
- Radioactivity in surface soil, cement and fly ash.

Syllabus for Tutorial
1. To verify Beer – Lambert Law for $KMnO_4/K_2Cr_2O_7$ and determining the concentration of the given solution of the substance from absorption measurement
2. Analyse the given vibration-rotation spectrum of HCl(g).
3. Determine the dissociation constant of an indicator (phenolphthalein).
4. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H_2SO_4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
5. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$
6. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds
7. Determination of Radioactivity in Surface Soil, Cement and Fly Ash.

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (Time Duration: 1½ hour)

Semester-IV
Course No.: UMJCHT-404 (Major Course)
Title: SPECTROSCOPY AND NUCLEAR CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

BOOKS RECOMMENDED:

1. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
2. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
3. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
4. Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).
5. Advance Practical Physical Chemistry by J.B. Yadav, Goel Publication, Meerut.
6. Practical Physical Chemistry by B. Vishwanathan and P.S. Raghvan, Viva Books Pvt. Ltd.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years May 2024, 2025 & 2026)

Semester-IV

Course No.: UMICHT-405 (Minor Course)

Title: INORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)

Maximum Marks: 100 [75 (Theory) + 25 (Practical)]

Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Chemistry of s and p Block Elements
- Chemistry of transition elements, lanthanides and actinides
- Basics of coordination chemistry

Unit-I: Chemistry of s and p Block Elements – II **(12 Hours)**

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, carboranes and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, Phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens. Occurrence and uses, preparation and properties of XeF2, XeF4 and XeF6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF2). Molecular shapes of noble gas compounds (VSEPR theory).

Unit-II: Transition Elements-I **(11 Hours)**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer & Bsworth diagrams). Chemistry of elements of second and third transition series- general characteristics, comparative treatment with their 3d analogues in respect of ionic radii, oxidation states, magnetic behaviour spectral properties and stereochemistry.

Unit-III: Transition Elements-II **(11 Hours)**

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy). Lanthanoids and Actinoids: Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only). General features of actinoids, separation of Np, Pm, Amfrom U.

Unit-IV: Basics of coordination chemistry **(11 Hours)**

Definitions and terminology, Werner's coordination theory and its experimental verification, EAN concept, IUPAC nomenclature of coordination compounds, structural and stereoisomerism in complexes with coordination numbers 4and6, Distinction between cis- and trans- compounds. A brief outline of thermodynamic and kinetic stability of metal complexes, stepwise and overall stability constants, factors affecting the stability of complexes, chelate effect.

Semester-IV
Course No.: UMICHT-405 (Minor Course)
Title: INORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5th Edn., 2008.
2. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry –Principles of structure and reactivity, Pearson Education, 4th Ed. 2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rded., 2017.
4. Shriver D. E., Atkins P. W., Inorganic Chemistry, Oxford University Press, 5th Edn., (2010).
5. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
6. Cotton, F.A. and Wilkinson, G Basic Inorganic Chemistry, Wiley.
7. Catherine E. Housecraft and Alan G. Sharpe, Inorganic Chemistry, Pearson.
8. Gary L. Miessler, Paul Fischer and Donald A. Tarr, Inorganic Chemistry, Pearson.
9. James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Mehdi, Pearson.
10. Banerjea D., Coordination Chemistry, Asian Books.

Semester-IV
Course No.: UMICHT-405 (Minor Course)
Title: INORGANIC CHEMISTRY-1

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Gravimetry and complexometric methods
- Applications of UV-visible spectroscopy

Suggested Experiments:

1. Estimate the amount of nickel present in a given solution as bis(dimethylglyoximato) nickel(II) in a given solution gravimetrically.
2. Estimation of (i) Mg^{2+} or (ii) Zn^{2+} by complexometric titrations using EDTA.
3. Determine the composition of the Fe^{3+}-salicylic acid complex solution by Job's method.
4. Estimate the amount of aluminium as oximate in a given solution gravimetrically.
5. Draw calibration curve (absorbance at λmax vs. concentration) for various concentrations of a given coloured compound ($KMnO_4$/$CuSO_4$) and estimate the concentration of the same in a given solution.
6. Estimation of total hardness of a given sample of water by complex metric titration.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, Pearson Education, 2012.
2. Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009.
3. Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2024, 2025 & 2026)

Semester-V

Course No.: UMJCHT-501 (Major course)

Title: PHYICAL CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)

Maximum Marks: 100 [75 (Theory) + 25 (Practical)]

Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Laws of thermodynamics, chemical kinetics and catalysis
- Adsorption and colloidal state
- Liquid-liquid mixture

Unit–I: Thermodynamics- II **(10 Hours)**

Introduction- Need for the second Law, Different statements of the law, Carnot Cycle and its efficiency, Entropy , Entropy change in reversible and irreversible processes, Entropy change on mixing of ideal gases, Nernst Heat Theorem, Third law of thermodynamics, Importance, Residual Entropy.

Unit-II: Chemical Kinetics and Catalysis **(12 Hours)**

Introduction, Factors affecting rate of reaction, Molecularity of a reaction, Rate Law and rate constant, Zero Order, First Order, Second order Reactions (Definition, examples, integrated rate equations), Relation between half-life period and order of a reaction, Various methods for the determination of order of a reaction, Arrhenius Equation and Temperature Dependence, Collision Theory of reaction rates, Theory of activated complex.

Unit-III: Adsorption and Colloidal State **(11 Hours)**

Introduction, Physical and Chemical Adsorption, Adsorption Isotherm, Freundlich Adsorption Isotherm, Langmuir Adsorption Isotherm, Application of Adsorption.

Introduction and classification of colloids, Lyophilic and lyophobic colloids, Coagulation and Hardy Schulze Rule, Micelles, Protective Colloids and Gold Number.

Unit-IV: Liquid-Liquid Mixtures **(12 Hours)**

Introduction, Miscible, Immiscible , Partially Miscible Liquids, Henry's Law, Principle of distillation (Miscible and immiscible liquids), Azeotropes, Steam Distillation, Partially Miscible Liquids, Critical Solution Temperature (Different Types and Examples), Effect of Temperature on CST, Nernst Distribution Law (definition, examples and limitations).

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Semester-V
Course No.: UMJCHT-501 (Major course)
Title: PHYICAL CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Barrow, G.M. Physical Chemistry, Tata McGraw-Hill, (2007).
2. Castellan, G.W. Physical Chemistry, 4th Ed., Narosa, (2004).
3. P. W. Atkins, J de Paula, Physical Chemistry, 8th Ed, Oxford University Press, New Delhi (2006).
4. I. N. Levine, Physical Chemistry, 6th Ed, McGraw Hill Education (2011).
5. Physical Chemistry by R.L. Madan, McGraw Hill Education (2015).
6. Physical Chemistry by S.C. Hketerpal, Vol. II, Pradeep Publications, 10th Ed. 2012.

Practical : 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Miscibility of different solutions
- Chemical Kinetics

Suggested Experiments:

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.

Semester-V
Course No.: UMJCHT-501 (Major course)
Title: PHYICAL CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

6. Determination of the critical solution temperature and composition of the phenol water system and study of the effect of impurities on it.
7. Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solution temperature.
8. Study of the variation of mutual solubility temperature with the addition of impurity for the phenol water system and determination of the critical solution temperature.
9. Determination of the velocity constant of alkaline hydrolysis of ethyl acetate.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Practical Physical Chemistry; Khosla , B.D. Garg, V.C. & Gulati , A.R. Chanad & Co.; 2011.
2. Advanced physical Chemistry Experiments by J.N. Gurtu and A. Gurtu: Pragati Prakashan
3. Advanced Practical Physical Chemistry by J.B. Yadav, Krishna's Publications.
4. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman
5. Experimental Physical Chemistry; R.C. Das and B. Behera, Tata McGraw Hill.
6. Experiments in Physical Chemistry by Shoemaker.
7. Practical Physical Chemistry by Viswanathan and Raghavan

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2024, 2025 & 2026)

Semester-V
Course No.: UMJCHT-502 (Major course)
Title: ORGANIC CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Reactions of alcohols and phenols.
- Reactions of aldehydes, ketones and carboxylic acids
- Chemistry of lipids and fats

UNIT-I: Alcohols and Phenols-II
Dihydric Alcohols: Preparation from alkenes, formation of Ketals and Acetals, Oxidative cleavage using $Pb(OAc)_4$, HIO_4 and Pinacol- Pinacolone rearrangement.
Trihydric Alcohols: Preparation of glycerol from fatty acids and preparation of trinitro glycerine from glycerol
Acidic character: Comparison of acidic strengths of alcohols and phenols.
Reactions of Phenols: Reactions and mechanism of Fries rearrangement, Kolbe reaction, Acylation, Schotten- Baumann, Laderer- Manasse reaction.

UNIT-II: Aldehydes and Ketones:
Brief introduction of aldehydes and ketones, Preparation from alcohols, alkenes, acid chlorides and nitriles, Etard Reaction.
Reactions: Nucleophilic addition reaction with HCN, ROH, $NaHSO_3$, ammonia and its derivatives, Idoform Test, Aldol, Canizzaro and Witting reaction, Mannich Reaction, Benzoin, Knoevengel Condensation, Clemmenson and Wolff Krishner Reduction, MPV, $LiAlH_4$ and $NaBH_4$ reductions.

UNIT-III: Carboxylic acids and their derivatives
Brief introduction of carboxylic acids, Strength of organic acids, comparative study with emphasis on factors affecting their pK values
Preparation of carboxylic acids: acidic and alkaline hydrolysis of esters and nitriles, Arndt-Eistert homologation.
Reactions: Hell-Vohlard Zelinsky reaction, decarboxylation, reduction, reaction with organolithium and organomagnesium compounds.
Carboxylic acid derivatives
Preparation: Acid chlorides, Anhydrides, Esters and Amides from acids and their interconversion.
Reactions: Comparison of nucleophilicity of acyl derivatives. Reformatsky Reaction and Perkin Condensation.

Semester-V
Course No.: UMJCHT-502 (Major course)
Title: ORGANIC CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

UNIT-IV: Lipids and Fats

Lipids: Definition, Classification and biological functions.
Introduction to oils and fats: Common fatty acids present in oils and fats and their importance, Hydrogenation of fats and oils, Saponification value, acid value, iodine number, Calorific value of food, Soap Detergents and their mechanism of action.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Organic Chemistry-P. Y. Bruice, 7th Ed., Pearson Education Pvt. Ltd., New Delhi (2013).
2. Heterocyclic Chemistry- R. K. Bansal, 3rd Ed., New- Age International, New Delhi, 2004.
3. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed., Cengage Learning India Edition, 2013.
4. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

Semester-V

Course No.: UMJCHT-502 (Major course)

Title: ORGANIC CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)

Maximum Marks: 100 [75 (Theory) + 25 (Practical)]

Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

5. Stereochemistry-Conformation and Mechanism-P. S. Kalsi, Wiley-Eastern Ltd, New Delhi.
6. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
7. Bahl, A. & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
8. Graham Solomons, T. W., Fryhle, C. B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
9. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).
10. Organic Chemistry-F. A. Carey, 4th Edition, McGraw Hill (2000).
11. Modern Organic Chemistry - R.O.C. Norman and D.J. Waddington, ELBS, 1983.
12. Understanding Organic reaction mechanisms - A. Jacobs, Cambridge Univ. Press, 1998.
13. Organic Chemistry - L. Ferguson, Von Nostrand, 1985.
14. Organic Chemistry - M. K. Jain, Nagin & Co., 1987.
15. Organic Chemistry- Mehta and Mehta, PHI Learning Pvt. Ltd, New Delhi, 2005.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- How to test presence of oils and fats in the given sample
- Preparation of some organic compounds

Suggested Experiments:

1. To study some simple tests to identify the presence of oils and fats in the given sample (Solubility test, Translucent spot test, Acrolein test, Baudouin test, Huble's test)
2. To determine the acid value and free fatty acids in the given sample of oil/fat
3. **Preparations**
   i. 2,4-Dinitrophenylhydrazone from benzophenone and 2,4-dinitrophenylhydrazine
   ii. Synthesis of benzamide from benzoic acid
   iii. Benzoylation of α-naphthol
   iv. Cannizaro reaction: Synthesis of benzoic acid and benzyl alcohol

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks

Semester-V
Course No.: UMJCHT-502 (Major course)
Title: ORGANIC CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Vogel, A.I. Elementary Practical Organic Chemistry, Part1: Small Scale Preparations, Pearson 2011).
2. F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson(2012).
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).
6. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
7. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5thedition, 2012.
8. Advanced Organic Practical by N.K. Vishnoi.

Semester-V

Course No.: UMJCHT-503 (Major Course)

Title: INORGANIC CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)

Maximum Marks: 100 [75 (Theory) + 25 (Practical)]

Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Theories of bonding in transition metal complexes
- Acid-bases and non-aqueous solvents
- Theoretical principles in qualitative analysis

Unit-I: Theories of Bonding in Transition Metal Complexes-I **(12 Hours)**

Valence bond theory, Limitations of Valence Bond Theory, The electro neutrality principle and back bonding, Crystal filed theory , Octahedral and tetrahedral, Crystal field stabilizing energy (CFSE), Factors affecting the magnitude of crystal field splitting, Spectrochemical series, Crystal field splitting and magnetic properties of the complexes.

Unit-II: Acids and Bases **(11 Hours)**

Arrhenius, Bronsted-Lowry, the Lux-Flood, solvent system and Lewis concepts of acids and bases, A Generalized Acid Base Concept.

Hard and Soft Acids and Bases (HSAB): Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness.

Unit-III: Non-aqueous Solvents **(11 Hours)**

Physical properties of a solvent, types of solvents and their general characteristics, reaction in non-aqueous solvents with reference to liquid NH_3 and liquid SO_2.

Oxidation-reduction: Redox equations, standard electrode potential and its applications to inorganic reactions. Principles involved in some volumetric analyses (iron and copper).

Unit-IV: Theoretical Principles in Qualitative Analysis **(11 Hours)**

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

Semester-V
Course No.: UMJCHT-503 (Major Course)
Title: INORGANIC CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
2. Chemistry of the Elements, N.N. Greenwood and A. Earnshow, Pergamon.
3. New Concise Inorganic Chemistry by J.D. Lee Edition III Compton Printing Ltd London
4. Cotton, F.A.G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,
5. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4 th Ed., Harper Collins 1993, Pearson, 2006..
6. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J.A. McClaverty, Pergamon.
7. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Prentice Hall (4th Edition), 2010.
8. Concepts and Models of Inorganic Chemistry, Bodie Douglas, Darl Mcdaniel, John Alexander, Wiley; Third edition (2006)
9. Inorganic Chemistry by A. G. Sharpe, Pearson India; 3rd Edition (2002).
10. Vogel, A.I. Qualitative Inorganic Analysis, Longman, 1972.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2024, 2025 & 2026)

Semester-V
Course No.: UMJCHT-503 (Major Course)
Title: INORGANIC CHEMISTRY-II

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical : 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Preparation of some coordination complexes
- Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations.

Suggested Experiments:

1. Inorganic Preparations:
   i) Tetraamminecopper (II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
   ii) Cis and trans $K[Cr(C_2O_4)_2.(H_2O)_2]$
   iii) Potassium dioxalatodiaquachromate (III)
   iv) Tetraamminecarbonatocobalt (III) ion
   v) Potassium tris(oxalate)ferrate(III)
2. Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested: CO_3^{2-}, NO_2^-, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, CH_3COO^-, F^-, Cl^-, Br^-, I^-, NO_3^-, BO_3^{3-}, $C_2O_4^{2-}$, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}
3. Mixtures should preferably contain one interfering anion, or insoluble component ($BaSO_4$, $SrSO_4$, $PbSO_4$, CaF_2 or Al_2O_3) or combination of anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl^- and Br^-, Cl^- and I^-, Br^- and I^-, NO_3^- and Br^-, NO_3^- and I^-.
4. Any other experiment introduced by the Teacher.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Synthesis and Characterization of Inorganic Compounds, William L. Jolly, Prentice Hall.
2. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edn., Longman Group Limited, London.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2024, 2025 & 2026)

Semester-V
Course No.: UMJCHT-504 (Major Course)
Title: POLYMER SCIENCE AND TECHNOLOGY

Credits: 02
Contact Hours: 30 Hours
Maximum Marks: 50
Duration of Examination: 2½ Hours

Course learning outcomes:

After completing this course contents, students will be able to understand

- Polymer chemistry and Technology
- Biopolymers and Bio-nanocomposites

Unit-I: Polymer Chemistry **(10 Hours)**

Definition, Classification of polymers, Chain configuration of macromolecules, Isotactic polymers, Atactic polymers, Syndiotactic polymers, Graft polymers, Mechanism of polymerization, Molecular mass of polymers, Number and Mass average molecular mass, Degree of polymerization, General Characteristics of Chain Growth Polymerization; Alkene Polymerization by Free Radical, Cationic and Anionic Initiators; General Characteristics of Step Growth Polymerization; Synthesis of Polymers by Step Growth Polymerization: Polyesters, Polyamides, Ring-opening Polymerization of Ethers and Lactones

Unit-II: Biopolymers and Bio-nanocomposites **(10 Hours)**

Structure, functions and properties of biopolymers such as chitin, chitosan, alginates, cellulose, hemicellulose, pectins, xanthan, polylactic acid, dextran and starch.
Composites-Matrix, fillers (definition), Biocomposites (definition), Bionanocomposites-methods of fabrications, applications in food packaging, water remediation and biomedical engineering.

Unit-III: Polymer Technology **(10 Hours)**

Additives for Plastics: Fillers, Plasticizers, Stabilizers, Lubricants, Flame Retardants, Foaming Agents, Crosslinking Agents, Manufacture, Properties and Applications of Major Thermoplastics and Thermosetting Polymers: PE, PP, PVC, PS, Polyamides, Polyesters, Phenolic Resins, Amino Resins and Epoxy Resins, Polymeric Coatings

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **40 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of 4 short answer type questions of (**2½** marks each) with atleast one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **6** questions with two questions selected from each unit. Each question shall be of **5 marks**. The students have to attempt **3** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Semester-V
Course No.: UMJCHT-504 (Major Course)
Title: POLYMER SCIENCE AND TECHNOLOGY

Credits: 02
Contact Hours: 30 Hours
Maximum Marks: 50
Duration of Examination: 2½ Hours

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **10** marks and duration of examination shall be 1 hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **2** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **6** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Text Book of Polymer Science by F. W. Billmeyer.
2. Introduction to Polymer Science, V. R. Gowarikar, N. V. Vishwanathan and J. Sridhar - Wiley Eastern.
3. Introduction to Polymers by R. J. Young and P.A. Lovell.
4. Handbook of Biopolymers by Shakeel Ahmed, CRC Press.
5. Polymer Chemistry by G. Challa.
6. Polymers: Chemistry and Physics of Modern Materials by JMG Cowie.
7. Principles of Polymerization by George Odian.
8. Advanced Green Materials, Shakeel Ahmed, Woodhead Publishing, UK.
9. Applications of Advanced Green Materials, Shakeel Ahmed, Woodhead Publishing, UK.
10. Bionanocomposites for Food Packaging Applications, Shakeel Ahmed, Woodhead Publishing, UK.
11. Bionanocomposites in Tissue Engineering and Regenerative Medicine, Shakeel Ahmed, Woodhead Publishing, UK.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2024, 2025 & 2026)

Semester-V
Course No.: UMICHT-505 (Minor course)
Title: ORGANIC CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Reactions of alkyl & aryl halides, alcohols & phenols
- Reactions of ethers, epoxides and carbohydrates

Unit-I: Alkyl & Aryl Halides **(12 Hours)**

Alkyl Halides (Upto 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes *and* alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrile & isonitrile formation. Williamson's ether synthesis.

Aryl Halides *Reactions (Chlorobenzene):* Aromatic nucleophilic substitution (replacement by –OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$). Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

Unit-II: Alcohols & Phenols **(13 Hours)**

Alcohols

Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (PCC, alk. $KMnO_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation.

Phenols: (Phenol case) *Preparation:* Cumene hydroperoxide method, from diazonium salts. *Reactions:* Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben–Hoesch reaction.

Unit-III: Ethers & Epoxides **(10 Hours)**

Nomenclature of ethers and methods of their formation, physical properties, Chemical reactions – cleavage and autoxidation, Ziesel's method. Synthesis of epoxides, Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening, reactions of Grignard and organolithium reagents with epoxides.

Unit-IV: Carbohydrates **(10 Hours)**

Classification and General Properties, Glucose and Fructose (open chain and cyclic structure), Determination of configuration of monosaccharides, absolute configuration of Glucose and Fructose, Mutarotation, ascending and descending in monosaccharides. Structure of

Semester-V
Course No.: UMICHT-505 (Minor course)
Title: ORGANIC CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

disacharrides (sucrose, maltose, lactose) and polysacharrides (starch and cellulose) excluding their structure elucidation.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Graham Solomon, T.W., Fryhle, C.B. & Dnyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
2. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed., Cengage Learning India Edition, 2013.
3. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).
4. Finar, I.L. Organic Chemistry (Vol. I & II), E.L.B.S.
5. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
6. Bahl, A & Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
7. Berg, J.M., Tymoczko, J.L. & Stryer, L. Biochemistry, W.H. Freeman, 2002.
8. Petrucci, R.H. General Chemistry, 5th Ed., Macmillan Publishing Co., New York (1985).
9. Kotz, J.C., Treichel, P.M. & Townsend, J.R. General Chemistry, Cengage Learning India Pvt. Ltd., New Delhi (2009).

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years Dec. 2024, 2025 & 2026)

Semester-V
Course No.: UMICHT-505 (Minor course)
Title: ORGANIC CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Purification of organic compound
- Mechanisms of various reactions

Suggested Experiments:

1. Purification of organic compounds by crystallization (from water and alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed.
4. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
   (a) Bromination of Phenol/Aniline
   (b) Benzoylation of amines/phenols
   (c) Oxime and 2,4-dinitrophenylhydrazone of aldehyde/ketone
5. Action of salivary amylase on starch
6. Effect of temperature on the action of salivary amylase on starch.
7. Differentiation between a reducing and a non-reducing sugar.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 1996.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry Orient-Longman, 1960.
3. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry, Universities Press.

Semester-V
Course No.: USECHI-506 (Skill Enhancement)
Title: SUMMER INTERNSHIP

Credits: 02 (Practical)
Maximum Marks: 50
Duration of examination: 2½ hours

Course learning outcomes:
After completing the internship, the students will develop professional ability through an appropriate training.

Summer Internship:

All students will undergo Internships/Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the summer term. Students will be provided with opportunities for internships with local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a variety of organizations so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability.

The internship shall be under a college teacher who will be designed as Internship Supervisor. After completion of summer internship, students will have to produce a report related to the work carried out by the student and duly signed by Internship Supervisor and College Principal. The Internship Report will be Evaluated Internally by a Board of Examiners set up by the Principal of the College.

Syllabus and courses of studies in the subject of Chemistry under CBCS as per NEP-2020

(For examinations to be held in the years May 2025, 2026 & 2027)

Semester-VI

Course No.: UMJCHT-601 (Major course)

Title: PHYSICAL CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)

Maximum Marks: 100 [75 (Theory) + 25 (Practical)]

Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Basic concepts in spectroscopy and photochemistry
- Physical Properties and Molecular structure
- Basic concepts in quantum mechanics

Unit-I: Spectroscopy **(12 Hours)**

Electromagnetic Radiation, Characterization, Quantization of energy, Regions of electromagnetic spectrum, Interaction of with electromagnetic radiation matter, Phenomenon related to radiation-Transmission, reflection, refraction, polarization, Width and intensity of spectral lines, Factors contributing to this effect: Collision broadening, Doppler broadening, Transition probability, Population of states and Path length of sample. Heisenberg's uncertainty principle and its applications.

Unit-II: Photochemistry **(11 Hours)**

Introduction, Photochemical reactions, Differences between thermochemical and Photochemical reactions, Laws of photochemistry, Quantum Yield, Examples of Photochemical Reaction, Concept of Florescence, Phosphorescence (Jablonski Diagram), Luminescence, Photosensitization and photosensitised reactions.

Unit-III: Physical Properties and Molecular structure **(11 Hours)**

Introduction, Optical Activity (Measurement, Cause of optical activity in a chemical compound), Dipole Moment , Structure of Molecules and dipole moment, Polarisation of molecules (Clausius–Mossotti Equation), Magnetic Susceptibilty, Determination of Magnetic Moment, Applications of Magnetic Susceptibility.

Unit-IV: Quantum Mechanics **(11 Hours)**

Introduction , Classical Mechanics, Black Body Radiations, (Kirchhoff's Law, Planck's Radiation Law), Photoelectric Effect, Heat Capacity of Solids, Quantum Mechanics (Definition), Bohr's Model of Atom , de Broglie Hypothesis, Compton Effect, Schrodinger Wave Equation, Postulates of quantum Mechanics, Particle in one dimensional box (Calculation of energies and expectation values).

Semester-VI
Course No.: UMJCHT-601 (Major course)
Title: PHYSICAL CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Rodgers, G.E. Inorganic and solid state chemistry, Cengage Learning India Ltd. (2008).
2. Barrow, G.M. Physical Chemistry Tata) McGraw-Hill (2007)
3. Castellan, G.W. Physical Chemistry 4th Ed. Narosa (2004)
4. P. W. Atkins, J de Paula, Physical Chemistry, 8th Ed, Oxford University Press, New Delhi (2006).
5. I. N. Levine, Physical Chemistry, 6th Ed, McGraw Hill Education (2011).

Practical : 01 Credit **Contact Hours : 30 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Concepts and applications of spectroscopy
- Colorimetry and its applications

Semester-VI
Course No.: UMJCHT-601 (Major course)
Title: PHYSICAL CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Suggested Experiments:

Spectroscopy

1. Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ and determine the λ_{max} values.
2. Study the pH-dependence of the UV-Vis spectrum (220-500 nm) of $K_2Cr_2O_7$
3. Analyse the given vibration-rotation spectrum of HCl

Colorimetry

1. Verify Lambert-Beer's law and determine the concentration of $KMnO_4/K_2Cr_2O_7$ in a solution of unknown concentration.
2. Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED :

1. Practical Physical Chemistry; Khosla, B.D. Garg, V.C. & Gulati, A.R. Chand & Co.; 2011.
2. Advanced physical Chemistry Experiments by J.N. Gurtu and A. Gurtu: Pragati Prakashan.
3. Advanced Practical Physical Chemistry by J.B. Yadav, Krishna's Publications.
4. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman
5. Experimental Physical Chemistry; R.C. Das and B. Behera, Tata McGraw Hill.
6. Experiments in Physical Chemistry by Shoemaker.
7. Practical Physical Chemistry by Viswanathan and Raghavan.

Semester-VI
Course No.: UMJCHT-602 (Major course)
Title: ORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Reactions of nitrogen containing organic compounds
- Chemistry of proteins and nucleic acids
- Heterocyclic chemistry

Unit-I: Nitrogen Containing Organic Compounds **(12 Hours)**
Preparation and chemical reactions of nitroalkanes. Mechanism of nucleophilic substitution in nitroarenes and their reduction in acidic, neutral and alkaline medium.
Reactivity, structure and nomenclature of amines. Separation of mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines. Amine salts as phase-transfer catalysts. Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles), reductive amination of aldehydes and ketones. Gabriel phthalimide reaction, Hofmann bromamide reaction. Reaction of amines, electrophilic aromatic substitution in aryl amines, reaction of amines with nitrous acid.

Unit-II: Chemistry of Proteins **(11 Hours)**
Classification of amino acids, Zwitter ion structure and isoelectric point. Overview of primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of peptides, determination of N-terminal amino acid (by DNFB and Edman method) and C–terminal amino acid (by thiohydantoin and with carboxypeptidase enzyme). Synthesis of simple peptides (upto dipeptides) by N-protection & C-activating groups, and Merrifield solid phase synthesis. Protein denaturation/ renaturation, Mechanism of enzyme action, factors affecting enzyme action.

Unit-III: Chemistry of Nucleic Acids **(11 Hours)**
Constituents of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.
Organic Synthesis via Enolates
Acidity of α-hydrogens, alkylation of diethyl malonate and ethyl acetoacetate, Claisen condensation, Keto-enol tautomerism of ethyl acetoacetate.

Semester-VI
Course No.: UMJCHT-602 (Major course)
Title: ORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Unit-IV: Heterocyclic Chemistry **(11 Hours)**

Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine, Chemical reactions with particular emphasis on the mechanism of electrophilic and nucleophilic substitution reaction in pyridine, Comparison of basicity of pyridine, piperidine and pyrrole. Introduction to condensed five and six membered heterocycles, Preparation and reactions (with mechanism) of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Nepieralski synthesis.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Organic Chemistry-P. Y. Bruice, 7th Edition, Pearson Education Pvt. Ltd., New Delhi (2013).
2. Heterocyclic Chemistry- R. K. Bansal, 3rd Edition, New- Age International, New Delhi, 2004.
3. McMurry, J.E. Fundamentals of Organic Chemistry, 7th Ed. Cengage Learning India Edition, 2013.
4. Sykes, P. A Guidebook to Mechanism in Organic Chemistry, Orient Longman, New Delhi (1988).

Semester-VI
Course No.: UMJCHT-602 (Major course)
Title: ORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

5. Stereochemistry-Conformation and Mechanism-P. S. Kalsi, Wiley-Eastern Ltd, New Delhi.
6. Morrison, R.T. & Boyd, R.N. Organic Chemistry, Pearson, 2010.
7. Bahl, A. &Bahl, B.S. Advanced Organic Chemistry, S. Chand, 2010.
8. Graham Solomons, T. W., Fryhle, C. B. & Snyder, S.A. Organic Chemistry, John Wiley & Sons (2014).
9. Organic Chemistry Volume-I, II- I. L. Finar, 6th Edition, ELBS London (2004).
10. Organic Chemistry-F. A. Carey, 4th Edition, McGraw Hill (2000).
11. Modern Organic Chemistry - R.O.C. Norman and D.J. Waddington, ELBS, 1983.
12. Understanding Organic reaction mechanisms - A. Jacobs, Cambridge Univ. Press, 1998.
13. Organic Chemistry - L. Ferguson, Von Nostrand, 1985.
14. Organic Chemistry - M. K. Jain, Nagin & Co., 1987.
15. Organic Chemistry- Mehta and Mehta, PHI Learning Pvt. Ltd, New Delhi, 2005.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Separation of organic compounds by chromatography
- Extraction of organic compounds from natural resources

Suggested Experiments:

[A] Separation using chromatographic techniques

i. To separate the mixture of amino acids using paper chromatography. Atleast two separations to be done using glycine, alanine, glutamicacid, lysine
ii. To identify and separate the sugars present in the given mixture by paper chromatography

[B] Extraction of organic compounds from natural resources

i. Isolation of casein from milk
ii. Isolation of lactose from milk
iii. Isolation of lycopene from tomatoes
iv. Isolation of caffeine from tea leaves

[C] Separation of Organic Compounds

To separate the organic mixture into individual components using water, acid, base and ether (atleast 3 mixtures to be analysed).

Semester-VI
Course No.: UMJCHT-602 (Major course)
Title: ORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Vogel, A.I. Elementary Practical Organic Chemistry, Part1: Small Scale Preparations, Pearson(2011).
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson(2012).
4. Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).
6. R.M. Felder, R.W. Rousseau: Elementary Principles of Chemical Processes, Wiley Publishers, New Delhi.
7. Vogel, A.I., Tatchell, A.R., Furnis, B.S., Hannaford, A.J. & Smith, P.W.G., Textbook of Practical Organic Chemistry, Prentice-Hall, 5th edition, 2012.
8. Advanced Organic Practical by N.K. Vishnoi.

Semester-VI

Course No.: UMJCHT-603 (Major Course)

Title: INORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)

Maximum Marks: 100 [75 (Theory) + 25 (Practical)]

Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Basic concepts in organometallic chemistry
- Chemistry of organometallic compounds
- Industrially Important Inorganic Materials
- Bio-inorganic chemistry

Unit-I: Organometallic Compounds-I **(11 Hours)**

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands. Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of CO to be discussed).

Unit-II: Organometallic Compounds-II **(11 Hours)**

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst).

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

Unit-III: Some Industrially Important Inorganic Materials **(11 Hours)**

Silicones, siloxanes, polymethylhydrosiloxanes, their applications. Phosphazenes, nature of bonding in triphosphazenes. Cement- manufacture, composition and setting. Glass manufacture, annealing, types and uses. Ceramics-definition, traditional and new ceramics, structure of ceramics. Inorganic fertilizers-essential nutrients for plants.

Unit-IV Bio-Inorganic Chemistry **(12 Hours)**

Essential and Trace elements in biological systems, Deficiency and toxic effects of metal ions, Chelation therapy. Na+/ K+ ion pump, metalloporphyrins with reference to Haemoglobin and Myoglobin. Vitamin B12, Copper-containing metalloenzymes, superoxide dismutase (SOD);

Semester-VI
Course No.: UMJCHT-603 (Major Course)
Title: INORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

their structure and mechanism of action.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Lee, J.D., "Concise, Inorganic Chemistry", Oxford University Press, 2008, India, 5th ed.
1. Puri, B.R., Sharma, L.R., and Kalia, K.C., "Principles of Inorganic Chemistry", Vishal Publishing Co., India, 2020, 33rd edition.
2. Basic Organometallic Chemistry: Concepts, Syntheses and Applications 2nd Edition, B.D. Gupta and A. J. Elias, 2nd Edition, Universities Press.
3. Organometallic Chemistry- R.C. Mehrotra. and A. Singh. New Age international.
4. The Organometallic Chemistry of the Transition Metals by Robert H. Crabtree, Wiley-VCH.
5. Basic Organometallic Chemistry. Concept. synthesis and Applications. B.D. Gupta and A. Elias. University Press.
6. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M. Berg, University Science Books.

Semester-VI
Course No.: UMJCHT-603 (Major Course)
Title: INORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

7. Inorganic Materials of Industrial Importance, Rose Philo K.J. by Vishal Publishing Co.
8. Industrial Inorganic Chemistry, 2nd Completely Revised Edition. K. H. Büchel, H. H. Moretto, Wiley-VCH.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Gravimetric method for estimation
- Quantitative estimation using volumetric methods

Suggested Experiments:

1. Gravimetric Analysis:
   i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
   ii. Estimation of copper as CuSCN
   iii. Estimation of iron as Fe2O3 by precipitating iron as Fe(OH)3.
   iv. Estimation of Al (III) by precipitating with oxine and weighing as Al(oxine)3 (aluminium oxinate
2. Precipitation titrations involving $AgNO_3$.
3. Quantitative Analysis (Volumetric Analysis)
   i. Determination of acetic acid in Commercial vinegar using NaOH.
   ii. Estimation of calcium content in Chalk as calcium oxalate by permanganometry.
   iii. Estimation of ferrous and ferric ions by dichromate method.
   iv. Estimation of copper iodometrically using thiosulphate.
4. Any other experiment introduced by the Teacher.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

Semester-VI
Course No.: UMJCHT-603 (Major Course)
Title: INORGANIC CHEMISTRY-III

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

BOOKS RECOMMENDED:

1. Vogel's Textbook of Quantitative Inorganic analysis .4th Edition Longman Group limited.
2. A Text Book of Quantitative inorganic Analysis: A. I. Vogal.
3. Applied Analytical Chemistry: Vermani.
4. Commercial Methods of Analysis: Shell & Biffen .
5. Standard methods of chemical analysis by W. W Scaff, Technical Press.

Semester-VI
Course No.: UMJCHT-604 (Major Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Green chemistry and its role in chemical synthesis
- Future trends in green chemistry

Unit-I: Introduction to Green Chemistry **(10 Hours)**
Twelve principles of Green Chemistry, Green Chemistry- needs and goals, Limitations/Obstacles in the pursuit of the goals of Green Chemistry.

Unit-II: Principles of Green Chemistry and Designing a Chemical Synthesis (12 Hours)
Green solvents- supercritical fluids, water as a solvent for organic reactions, ionic liquids, Energy requirement for the reactions- alternative source of energy: use of microwave and ultrasonic energy, careful use of protecting groups, catalysis and green chemistry, comparison of homogeneous and heterogeneous catalysis, biocatalysts, asymmetric catalysis and photo catalysis. Strengthening and development of analytical techniques to prevent generation of hazardous substances in chemical processes.

Unit-III: Examples of Green Synthesis/Reactions and some real world cases (12 Hours)
Green synthesis of adipic acid, disodium iminodiacetate (alternative to Strecker synthesis). Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents, Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: sonochemical Simmons-Smith reaction. Surfactants for carbon dioxide- replacing smog producing and ozone depleting solvents with carbon dioxide, Development of fully recyclable carpet: Cradle to Cradle Carpeting.

Unit-IV: Future Trends in Green Chemistry **(11 Hours)**
Oxidation reagents and catalysis; Biomimetic, multifunctional reagents; Proliferation of solventless reactions; co-crystal controlled solid state synthesis, Green Chemistry in sustainable development.

Semester-VI
Course No.: UMJCHT-604 (Major Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Ahluwalia, V. K. and Kidwai M. R.*New trends in green chemistry*, Anamalaya Publisher, 2005.
2. Ahluwalia, V. K. *Green Chemistry: A Textbook*, Alpha Science International Ltd., 2013.
3. Lancaster, M. *Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.*
4. Ryan, M.A. and Tinnesand, M. *An Introduction to Green Chemistry,* ACS, Washington, 2002.
5. Matlack, A.S. *An Introduction to Green Chemistry*, Marcel Dekker, 2001.

Semester-VI
Course No.: UMJCHT-604 (Major Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical processes and reactions involving green chemistry

Syllabus for Tutorial:

1. Preparation of biodiesel from vegetable/waste cooking oil from renewable resources (using renewable resources).
2. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide (use of enzymes).
3. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice (using alternate solvents).
4. Mechanochemical solvent free synthesis of azomethines (avoiding solvents).
5. Photoreduction of benzophenone to benzopinacol in the presence of sunlight (use of alternate energy).
6. Synthesis of Tris(acetylacetonato) manganese (III) without the use of any buffer (avoiding waste).

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (Time Duration: 1½ hour)

BOOKS RECOMMENDED:

1. Anastas, P.T and Werner J.C. *Green Chemistry: Theory and Practice,* Oxford University, 1998.
2. Kirchoff, M. and Ryan, M.A. Greener approaches to undergraduate chemistry experiment, ACS, Washington DC, 2002.
3. Sharma, R.K.; Sidhwani, I.T. and Choudhari, M.K.I.K. *Green Chemistry Experiment.* A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore, 2013.
4. Cann M.C and Connelly, *M.E. Real world case in Green Chemistry*, ACS, 2008.

Semester-VI
Course No.: UMICHT-605 (Minor Course)
Title: PHYSICAL CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical equilibrium and phase equilibrium
- Electrochemistry

Unit-I: Chemical Equilibrium **(11 Hours)**
Introduction , State of chemical equilibrium , Law of mass action, Law of chemical equilibrium, Thermodynamic derivation of the law of chemical equilibrium, , Types of equilibrium constants , Relationship between K_p and K_c , Application of equilibrium constants, Van't Hoff Reaction Isotherm, Le Chatlier's Principle, Applications of Le Chatlier's Principle, Clausius-Clapeyron Equation.

Unit-II: Phase Equilibrium **(12 Hours)**
Introduction , Phase, Component , Degree of freedom, Criteria for Phase Equilibrium, Thermodynamic derivation of phase rule, Phase Diagram, One Component system, phase diagram of water, Sulphur, Freezing Mixtures.
Immiscible liquids, Steam Distillation, Partially miscible liquids (Upper and Lower Critical Solution Temperature), Effect of temperature on Critical Solution Temperature, Nernst Distribution Law, Introduction, thermodynamic derivation of law and its applications.

Unit-III: Electrochemistry-I **(11 Hours)**
Introduction, Electrolytic Conductance, Conductance, Cell constant, Specific conductivity, Equivalent conductivity, Molar conductivity and their relation with specific conductivity , Variation of different types of conductivities with dilution.
Arrhenius theory of ionisation , Ostwald's dilution law, Debye-Huckel-Onsager equation, Anomalous behaviour of strong electrolytes, Kohlrausch's Law, Transport Number, Determination of transport number (Hittorf's and Moving Boundary Method), Conductometric titrations.

Unit-IV: Electrochemistry-II **(11 Hours)**
Electrochemical Cell, Electrolytic Cell, EMF of a cell, Reversible and Irreversible Cell, Types of electrodes, Relationship between electrical energy and chemical energy, Measurement of electrode potentials (Zinc and copper electrodes), Electrochemical series, Applications, Nernst Equation for measuring EMF of a cell, Conentration Cells (definition and examples only), Liquid Junction Potential (definition only), Potentiometric titrations.

Semester-VI
Course No.: UMICHT-605 (Minor Course)
Title: PHYSICAL CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Rodgers, G.E. Inorganic and solid state chemistry, Cengage Learning India Ltd., (2008).
2. Barrow, G.M. Physical Chemistry Tata McGraw-Hill, (2007).
3. Castellan, G.W. Physical Chemistry 4th Ed. Narosa, (2004).
4. P. W. Atkins, J de Paula, Physical Chemistry, 8th Ed, Oxford University Press, New Delhi, (2006).
5. I. N. Levine, Physical Chemistry, 6th Ed, McGraw Hill Education, (2011).

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Different phases of a substance.
- Miscibility of two liquids
- Conductance of the different electrolytic solutions

Semester-VI
Course No.: UMICHT-605 (Minor Course)
Title: PHYSICAL CHEMISTRY-I

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Suggested Experiments:

1. Determination of critical solution temperature and composition of phenol-water system.
2. Effect of impurities on critical solution temperature on phenol-water system.
3. Construction of phase diagrams.
4. Determination of cell constant.
5. Determination of equivalent conductivity, degree of dissociation and dissociation of a weak acid.
6. Determination of equivalent conductivity of a strong electrolyte and hence verify Debye-Huckel Onsager Equation.
7. Conductometric Titrations of Strong acid, weak acids and their different combinations.
8. Potentiometric Titrations of Strong acid, weak acids and their different combinations..

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. UGC Advanced Physical Chemistry, J.N. Gurtu, A. Gurtu, Pragati Prakashan.
2. Advanced Practical Chemistry, Singh, Yadav, Siddiqui, Pragati Prakashan.
3. Advanced Practical Physical Chemistry, J.B. Yadav, God Publishing House, Krishna Prakash Media Ltd.
4. Advanced Physical Chemistry Experiments, J.N. Gurtu, A. Gurtu, Pragati Prakashan.

Semester-VII
Course No.: UMJCHT-701 (Major Course)
Title: PHYSICAL CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Schrodinger equation, quantum mechanical results and approximation methods
- Chemical bonding and Huckel's MO theory

Unit-I: Exact quantum mechanical results **(12 Hours)**
Schrodinger equation and the postulates of quantum mechanics, Operator concept, Some properties of quantum mechanical operators, Linear, Hermitian and Unitary operators, Commutator and their properties, Operators for different observables, Schrodinger wave equation for Hydrogen like atoms in spherical polar coordinates, Separation into three equations, Quantum numbers and their importance, Radial and Angular wave functions (Spherical Harmonics).
Complete solution of Schrodinger equation for the following model systems: One dimensional Simple Harmonic Oscillator & the Rigid Rotator, Calculation of various average values for the above systems, Concept of Tunneling, Numericals.

Unit-II: Approximation methods **(10 Hours)**
Approximation methods, The Variation method, Linear variation principle, Perturbation method–postulates and calculation of first order perturbation (non-degenerate), Application of variation method and perturbation method to Helium atom (Ground state energy), Numericals.

Unit-III: Chemical Bonding **(12 Hours)**
Molecular orbital theory (Homonuclear and Heteronuclear diatomics), LCAO-MO approximation, Molecular orbital treatment of H_2^+ molecular ion and H_2 molecule, Calculation of energy levels from wave functions, Comparison of experimental and theoretical results, Physical picture of bonding and anti-bonding wave function, Valence bond treatment of H_2 molecule, Comparison of MO and VB methods, Numericals.

Unit-IV: HMO method and its applications **(11 Hours)**
Huckel's MO theory of conjugated systems; Application to Ethylene, Butadiene, Cyclobutadiene, Allyl systems (Allyl cation, Allyl radical and Allyl anion), Cyclopropenyl systems (Cyclopropenylcation, Cyclopropenylradical and Cyclopropenylcarbanion). Calculation of properties- Delocalization energy, Electron density and Bond order, Numericals.

Semester-VII
Course No.: UMJCHT-701 (Major Course)
Title: PHYSICAL CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Angular momentum and coupling scheme
- Atomic term symbols

Syllabus for Tutorials

General theory of angular momentum, Eigen functions and Eigen values of angular momentum operators, Ladder operators, Commutation relations, Spin angular momentum, Anti-symmetry and Pauli's principle.

Russell-Saunders and jj-coupling schemes, Slater determinant, Vector model of the atom, Atomic term symbols, Term separation of p^n configurations, Spin-orbit coupling, Zeeman splitting, Virial theorem, Numericals.

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Semester-VII
Course No.: UMJCHT-701 (Major Course)
Title: PHYSICAL CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (Time Duration: 1½ hour)

BOOKS RECOMMENDED

1. Physical Chemistry, P. W. Atkins, J. de Paula, Oxford, Tenth Edition, 2014.
2. Introduction to Quantum Chemistry, A. K. Chandra, McGraw Hill, Fourth Edition, 2001.
3. Quantum Chemistry, Ira. N. Levine, Pearson, Seventh Edition, 2016.
4. Molecular Quantum Mechanics, P. W. Atkins and R. S. Friedmann, Oxford, Fifth Edition, 2012.
5. Quantum Chemistry and Spectroscopy by T. Engel and P. Reid, Pearson, Third Edition, 2018.
6. Quantum Chemistry, J. P. Lowe and K. A. Peterson, Academic Press, Third Edition, 2005.
7. Physical Chemistry by R. J. Silby, R. A. Alberty and M. G. Bawendi, Wiley, Fourth Edition, 2004.
8. Quantum Chemistry by D. A. McQuarrie, Viva Books Pvt. Ltd, New Delhi, 2011.
9. Mathematics for Physical Chemistry, R. G. Mortimer, Third Edition, Elsevier, 2005.
10. Elementary Quantum Chemistry, F. L. Pilar, Second Edition, Dover Publication Inc., New York, 2001.
11. Physical Chemistry: A Molecular Approach, D. A McQuarrie and J. D. Simon, Univ. Science Books, Third Edition 2001.

Semester-VII
Course No.: UMJCHT-702 (Major Course)
Title: ORGANIC CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Stereochemistry in organic chemistry
- Reaction mechanism involving aliphatic nucleophilic substitution and free radical reactions.

Unit–I: Stereochemistry **(11 Hours)**
Molecular Chirality, Absolute configuration, Molecules with more than one chiral center, Threo- and erythro- isomers. Methods of resolution, Optical purity, Enantiotopic and diastereotopic atoms, Groups and faces, Chirality in Biphenyls, Allenes and Spiranes. Effect of conformation on reactivity (Addition & Elimination reactions).

Unit–II: Reaction Mechanism: Structure and Reactivity **(12 Hours)**
Types of mechanisms, Kinetic and thermodynamic control, Curtin-Hammett principle, Potential energy diagrams, Transition states and intermediates, Methods of determining mechanisms, Isotope effects, Effect of structure on reactivity-Resonance and field effects, Steric effect, Qualitative treatment, The Hammett equation and linear free energy relationship, Substituent and reaction constants.

Unit–III: Nucleophilic Substitutions **(11 Hours)**
The S_N2, S_N1 and SET mechanisms, The neighbouring group mechanism, Neighbouring group participation by σ and π bonds, Classical and non-classical carbocations, Phenonium ions, Norbornyl system, The S_Ni mechanism.
Reactivity effects of substrate structure, Attacking nucleophile, Leaving group and reaction medium, Phase transfer catalysis.

Unit-IV: Free Radical Reactions **(11 Hours)**
Mechanism of free-radical reactions, Neighbouring group assistance, The effect of solvent and attacking radicals on reactivity, Allylic halogenations (NBS), Oxidation of aldehydes to carboxylic acids, Auto-oxidation, Sandmeyer, Barton and Hunsdiecker reactions.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Semester-VII
Course No.: UMJCHT-702 (Major Course)
Title: ORGANIC CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Advanced Organic Chemistry, Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford (2000).
3. Advance Organic Chemistry, Part-A: Structure & Mechanism (Fifth Edition), F.A. Carey & R.J. Sundberg, Published by Springer Science (2007).
4. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
5. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Corell University Press.
6. Organic Chemistry, R.T. Morrison & R.N. Boyd, Prentice Hall.
7. Stereochemistry of Organic Compounds, D. Nasipuri (3rd Edition), New Age International (P) Limited, New Delhi (2014).
8. Organic Synthesis, Michael B. Smith, McGraw Hill Education.
9. Steric and Stereoelectronic Effect in Organic Chemistry, V. K. Yadav, Springer Singapore (2016).
10. Modern Methods of Organic Chemistry, William Carruthers and Liancoldham, Cambridge University Press (4th edition, 2015).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5th Edition, 2007).

Semester-VII
Course No.: UMJCHT-702 (Major Course)
Title: ORGANIC CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Quantitative analysis of organic compounds
- Organic syntheses

Suggested Experiments:

Quantitative Analysis
Identification of a single organic compound by chemical tests and checking of purity by TLC.

Organic Syntheses
Acetylation: Acetylation of $-NH_2$ group.
Synthesis of oximes of carbonyl compounds.
Aldol condensation: Benzaldehyde and acetone.
Nitration of Acetanilide.
Picrates of Naphthalene and β-naphthol.
Any other experiment introduced by the concerned teacher.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Experiments and techniques in Organic Chemistry, D. Pasto, C. Johnson and M.Miller, Prentice Hall.
2. Handbook of Organic Analysis-Qualitative and Quantitative, H. Clark, Adward Arnold.
3. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
4. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.

Semester-VII
Course No.: UMJCHT-703 (Major Course)
Title: INORGANIC CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Concept of group theory in chemistry and its applications
- Stereochemistry and bonding in main group compounds
- Theories of bonding in transition metal complexes
- Metal-ligand equilibria in solution

Unit-I: Concept of Group theory in Chemistry and its Applications (12 Hours)
Symmetry elements and symmetry operations, Definitions of group, Subgroup, Point symmetry groups, Schonfilies symbols, Multiplication table, Conjugacy relation and classes, Representation of symmetry operations by matrices, Character of a representation, Reducible & irreducible representation, Derivation of Character tables for C_{2v}, C_{3v}, C_{2h}, Application of Group theory in Infrared and Raman Spectroscopy.

Unit-II: Stereochemistry and Bonding in Main Group Compounds (11 Hours)
VSEPR, Walsh diagram (tri- and penta atomic molecules), Bent rule and energetics of hybridization, dπ-pπ bonds, Chemistry of inorganic rings and cages, Borazines, Polyhedral boranes, Carboranes, Metalloboranes and Metallocarboranes.

Unit-III: Theories of Bonding in Transition Metal Complexes-II (11 Hours)
Shortcomings in crystal field theory, Crystal field splitting in O_h, T_d, D_{4h} and C_{4v} systems, Structural effects of crystal field splitting, Variation of ionic ratio, Lattice energy, Molecular orbital theory, MO energy level diagrams for octahedral, tetrahedral and square planar complexes, π- bonding and M.O. theory, Variation of Δo with the π- acceptor and σ-donor ligand.

Unit-IV: Metal-Ligand Equilibria in Solution (11 Hours)
Stepwise 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, Formation of colored complexes in solution in different metal to ligand ratios, Calculation of stability constant of a complex formed in 1:1 metal to ligand ratio by spectrophotometric method, Determination of ε.

Semester-VII
Course No.: UMJCHT-703 (Major Course)
Title: INORGANIC CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Analytical applications of complex equilibria, J. Inczedy, Halsted Press: New York, NY (1976).
2. Solution Equilibria, F. R. Hartley, C. Burgess & R. M. Alcock, Prentice-Hall: Europe (1980).
3. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
4. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley
5. Advanced Inorganic Chemistry, J. D. Lee.
6. Comprehensive Coordination Chemistry, G. Wilkinson, R.D. Gillars and J.A. McCleverty, Pergamon.
7. Ligand Field Theory and its Applications, Brian N. Figgis and Michael A. Hitchman, Wiley-VCH.
8. Inorganic Chemistry by Catherine Housecroft and A G Sharpe Prentice Hall; 2nd edition, (2004-11-18).
9. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Prentice Hall (4th Edition), 2010.
10. Inorganic Chemistry, A.G. Sharpe, Pearson, India, 3rd edition, (2002).

Semester-VII
Course No.: UMJCHT-703 (Major Course)
Title: INORGANIC CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Separation and quantitative estimation of two metal ions
- Synthesis of some coordination complexes

Suggested Experiments:

1. Separation and quantitative estimation of two metal ions

i. Cu-Ni: Estimation of both by gravimetric method
ii. Ba-Cu: Estimation of Ba gravimetrically and Cu volumetrically
iii. Ag-Cu, Estimation of Ag gravimetrically and Cu volumetrically
iv. Cu-Zn: Estimation of both by gravimetric method
v. Ni-Zn: Estimation of both by gravimetric method
vi. Cu-Fe: Estimation of both by gravimetric method
vii. Ca-Mg: Estimation of both by titrating against EDTA solution
viii. Zn-Mg: Estimation of both by titrating against EDTA solution

2. To determine the total hardness of water (due to presence of Ca2+ and Mg2+ salts)

3. Methods of preparation of the following:

i. Bis(acetylacetonato)copper(II)
ii. Tris(acetylacetonato)iron(III)
iii. Tris(acetylacetonato)manganese(III)
iv. Bis(ethylenediammine)dioxolatocobolt(III) chloride dihydrate

4. Any other experiment introduced by the teacher.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Vogel's Qualitative Inorganic Analysis, 7th Edn., Pearson Education Ltd.

Semester-VII
Course No.: UMJCHT-703 (Major Course)
Title: INORGANIC CHEMISTRY-IV

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

2. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edn., Longman Group Limited, London.
3. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic press.
4. Synthesis and Characterization of Inorganic Compounds, William L. Jolly, Prentice Hall.

Semester-VII
Course No.: UMJCHT-704 (Major Course)
Title: PRINCIPLES OF SPECTROSCOPY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Microwave and vibrational spectroscopy
- Raman and Nuclear Magnetic Resonance spectroscopy
- X-ray and neutron diffraction

Unit-I: Microwave Spectroscopy **(12 Hours)**
The classification of molecules on the basis of moment of inertia, Interaction of radiation with rotating molecule, Rotational spectra of diatomic molecules: the rigid diatomic molecule, the intensities of spectral lines, the effect of isotopic substitution, determination of bond length and/or atomic masses from microwave data, the non-rigid rotator, the spectrum of non-rigid rotator, Energy levels and spectra of linear polyatomic molecules, Chemical analysis by microwave spectroscopy, Numericals.

Unit-II: Vibrational Spectroscopy **(11 Hours)**
Vibrating diatomic molecule: the energy of a diatomic molecule, the simple Harmonic oscillator, the Anharmonic oscillator, Selection rules, overtones and combination bands, dissociation energies from vibrational spectra, Vibrational-rotational spectra, P, Q and R branches, Breakdown of Born-Oppenheimer approximation, Vibrations of polyatomic molecules: Fundamental vibrations and their symmetry, Influence of rotation on the spectra of polyatomic molecules: linear molecules, the influence of nuclear spin, Numericals.

Unit-III **(11 Hours)**
(a) Raman Spectroscopy
Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra of linear molecules, Vibrational Raman spectra: Raman activity of vibrations, Rule of Mutual exclusion, Vibrational Raman spectra, Selection rules, Numericals.
(b) Nuclear Magnetic Resonance Spectroscopy
Nuclear spin, Nuclear Magnetic resonance, Saturation, Chemical shift and its measurements, Factors affecting chemical shift, Deshielding, Spin-spin interactions, Factors affecting coupling constant, Basic idea about NMR instrument, FT NMR, Advantages of FT NMR.

Unit-IV: Diffraction Techniques **(11 Hours)**
***X-ray diffraction*:** X-rays and their generation, Diffraction of X-rays, Crystal systems and Bravais lattice, Lattice planes, Miller indices and directions, d-spacing formulae, index reflections, Identifications of unit cells from systematic absences in diffraction pattern,

Semester-VII
Course No.: UMJCHT-704 (Major Course)
Title: PRINCIPLES OF SPECTROSCOPY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Debye-Scherrer method of X-ray structural analysis of crystals, Intensities of X-ray reflections: Scattering of X-rays by an atom and by a crystal, Structure factor and its relation to intensity and electron density, Uses of Powder X-ray diffraction, Numericals
Neutron diffraction: General introduction, Magnetic structure analysis, Uses of Neutron diffraction

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:
Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
2. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E.M. McCash, Tata McGraw Hill.
4. Solid State Chemistry and its applications, A.R. West, John Wiley & Sons.
5. Solid State Chemistry: An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd., UK.
6. Atomic and molecular spectroscopy- Basic concepts and applications. Rita Kakkar, Cambridge Press, 2017.

Semester-VII
Course No.: UMJCHT-704 (Major Course)
Title: PRINCIPLES OF SPECTROSCOPY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Interpretation of XRD data to determine structural parameters

Syllabus for Tutorials:

1. Determine the crystallite using Debye-Scherrer equation and William-Hall method from the XRD data of a known nano-crystalline compound. Also determine lattice strain.
2. Assign the Bravais lattice (Primitive, Body-centred or Face-centred) to the given compound if XRD data is given on the basis of systematic absences.
3. Analysis of IR spectra of some known compounds.
4. Determination of moment of inertia and bond lengths of some known compounds by the analysis of Microwave spectra.

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks

BOOKS RECOMMENDED:

1. Solid State Chemistry and its applications, A.R. West, John Wiley & Sons.
2. Solid State Chemistry: An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd., UK.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E.M. McCash, Tata McGraw Hill.

Semester-VII

Course No.: UMJCHT-705 (Major Course)

Title: RESEARCH METHODOLOGY AND RESEARCH ETHICS

Credits: 03 (Theory) + 01 (Tutorial)

Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]

Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Course Learning Outcomes:

After completing this course content, student will be able to:

- define research and know about the feature of a good research
- know about the objectives, need and scope of research
- explain different types of research
- know about the various approaches to research
- clarify various stages involved in research process
- identifying and define the research problem
- explain the source and criteria of a good research problem
- understand the concept of research design
- understand the different types of research design used for conducting different types of researches
- define primary and secondary data
- know about the various methods of primary data collection
- explore the different sources of secondary data, and
- apply the appropriate method for data collection

Theory: 03 Credits **Contact Hours: 45 Hours**

Unit I: Research Methodology-I **(12 Hours)**

Foundation of Research: Definition and characteristics of research, meaning, objectives and nature of research, importance of research, relevance of research and restrictions in research, research process, difference between research method and research process.

Scientific Method: Steps in scientific method, distinction between scientific method and non-scientific method.

Research Problem: Importance of formulating a research problem, source of research problems, consideration in selecting research problem, steps in formulation of research problem.

Research design: Meaning and definition of research design, and importance of research design, types of research designs, characteristics of scientific method, concept and importance of research – features of a good research design.

Unit-II: Research Methodology-II **(11 Hours)**

Literature review: Importance of review and main components of literature review.

Hypothesis: Meaning, nature and characteristics, significance of hypothesis, types of hypothesis, sources of hypothesis, characteristics of good hypothesis.

Semester-VII
Course No.: UMJCHT-705 (Major Course)
Title: RESEARCH METHODOLOGY AND RESEARCH ETHICS

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Sampling: Aims of sampling, characteristics of good sample, basis of sampling, advantages of sampling, limitations of sampling, sampling technique or methods, probability sampling methods, sample design and choice of sampling, sampling frame, sampling error, sample size.

Unit-III: Research Methodology-III **(11 Hours)**

Distinction between primary data and secondary data, data collection procedure for primary data methods of data collection.

Data Analysis: Data preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentage), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of interpretation of data.

Report Writing: Discussion, conclusion, referencing and various formats for reference writing, bibliography, thesis writing, thesis formats of publications in research journals including subject classification, impact factor, citation index.

Paper Writing: Layout of a research paper, impact factor of journals, when and where to publish?

Unit-IV: Philosophy, ethics and scientific conduct **(11 Hours)**

Introduction to Philosophy: Definition nature and scope, concept, branches.

Ethics: Definition moral philosophy, nature of moral judgements and reactions, ethical issues related to publishing, plagiarism and self-plagiarism.

Ethics with respect to science and research. Intellectual and research integrity. Scientific misconducts: falsification, fabrication and plagiarism. Redundant publications: duplicate and overlapping publications, selective reporting and misrepresentation of data.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Semester-VII
Course No.: UMJCHT-705 (Major Course)
Title: RESEARCH METHODOLOGY AND RESEARCH ETHICS

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Research Methodology, C.R. Kothari, Newage Publication.
2. Management Research Methodology, Krishnaswamy, Sirakumar, Pearson.
3. Research Methodology, Zeikmund, Cengage.
4. Research Methodology, Paneer Selvam, PH1.
5. Research Methodology, Prasanta Sarangi, Taxmann A Text Book of Research Methodology.
6. Donald Cooper & Pamela Schindler, TMGH, 9th ed., Business Research Methods – Alan.
7. Bryman & Emma Bell, Oxford University Press, Research Methodology – C.R. Kothar.
8. Panneerselvam, R.X. and Stephens, J. Theory and Problems of Statistics, Tat Mc-Graw Hill Publishing Company, New Delhi.
9. Bhandarkar, P.L. and Wilkinson, T.S. Methodology and Techniques of Social Research.
10. Dublin, Robert, Theory Building New York; MacMillan Publishing Co., Quoted in W. Emory.
11. Business Research Methods, Gupta, S.P. Statistical Method, Sultan Chand and Sons, New Delhi.
12. Kothari, C.R. Research Methodology-Methods and Techniques, Whishwa Prakashan, New Delhi.

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Syllabus for Tutorials:

- Open access publications and initiatives.
- Online resources to check publisher copyright and self archiving policies.
- Software tools to identify predatory publications.

Semester-VII
Course No.: UMJCHT-705 (Major Course)
Title: RESEARCH METHODOLOGY AND RESEARCH ETHICS

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

- Journal finder.
- Journals in the field of Chemistry.
- When and where to publish? Ethical issues related to publishing.
- Use of plagiarism software like Turnitin, Urkund and other open source software tools.
- Data bases:
  - Indexing databases.
  - Citation databases: Web of Science, Scopus, etc.
- Impact factor of journals as per Journal Citation Report, SNIP, SJR, IPP, Cite Score.
- Metrics: h-index, g index, i10 index, almetrics.
- Use of Encyclopaedias, Research Guides, Handbook etc., Academic Databases.
- Use of tools/techniques for research: Methods to search required information effectively.
- Reference Management Software like Zotero/Mendeley.
- Software for paper formatting like LaTeX/MS Office.
- Review of some literature.

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks

Semester-VII
Course No.: UMICHT-706 (Minor Course)
Title: PRINCIPLES OF SPECTROSCOPY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Microwave and vibrational spectroscopy
- Raman and Nuclear Magnetic Resonance spectroscopy
- X-ray and neutron diffraction

Unit-I: Microwave Spectroscopy **(12 Hours)**
The classification of molecules on the basis of moment of inertia, Rotational spectra of diatomic molecules: the rigid diatomic molecule, the intensities of spectral lines, the effect of isotopic substitution, determination of bond length and/or atomic masses from microwave data, Numericals.

Unit-II: Vibrational Spectroscopy **(11 Hours)**
Vibrating diatomic molecule: the energy of a diatomic molecule, the simple Harmonic oscillator, the Anharmonic oscillator, Selection rules, overtones and combination bands, dissociation energies from vibrational spectra, Vibrational-rotational spectra, P, Q and R branches, Vibrations of polyatomic molecules: Fundamental vibrations and their symmetry, Numericals.

Unit-III **(11 Hours)**
(c) Raman Spectroscopy
Quantum theory of Raman effect, Classical theory of Raman effect, Pure rotational Raman spectra of linear molecules, Rule of Mutual exclusion, Selection rules, Numericals.
(d) Nuclear Magnetic Resonance Spectroscopy
Nuclear spin, Nuclear Magnetic resonance, Saturation, Chemical shift and its measurements, Factors affecting chemical shift, Deshielding, Spin-spin interactions, Factors affecting coupling constant.

Unit-IV: Diffraction Techniques **(11 Hours)**
***X-ray diffraction*:** X-rays and their generation, Diffraction of X-rays, Crystal systems and Bravais lattice, Lattice planes, Miller indices and directions, d-spacing formulae, index reflections, Identifications of unit cells from systematic absences in diffraction pattern, Debye-Scherrer method of X-ray structural analysis of crystals, Numericals.

Semester-VII
Course No.: UMICHT-706 (Minor Course)
Title: PRINCIPLES OF SPECTROSCOPY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of 2 questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill.
2. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E.M. McCash, Tata McGraw Hill.
4. Solid State Chemistry and its applications, A.R. West, John Wiley & Sons.
5. Solid State Chemistry: An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd., UK.
6. Atomic and molecular spectroscopy- Basic concepts and applications. Rita Kakkar, Cambridge Press, 2017.

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:

After completing this course contents, students will be able to understand

- Interpretation of XRD data to determine structural parameters

Semester-VII
Course No.: UMICHT-706 (Minor Course)
Title: PRINCIPLES OF SPECTROSCOPY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Syllabus for Tutorials:

1. Determine the d-spacing between different sets of planes of a given known compound from Intensity versus 2θ XRD data. Also index the given reflections when crystal structure of the given compound is provided.
2. Determine the crystallite using Debye-Scherrer equation and William-Hall method from the XRD data of a known nano-crystalline compound. Also determine lattice strain.
3. Assign the Bravais lattice (Primitive, Body-centred or Face-centred) to the given compound if XRD data is given on the basis of systematic absences.
4. Analysis of IR spectra of some known compounds.
5. Determination of moment of inertia and bond lengths of some known compounds by the analysis of Microwave spectra.

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks

BOOKS RECOMMENDED

1. Solid State Chemistry and its applications, A.R. West, John Wiley & Sons.
2. Solid State Chemistry: An Introduction, L. Smart and E. Moore, Nelson Thrones Ltd., UK.
3. Fundamentals of molecular spectroscopy, C.N. Banwell and E.M. McCash, Tata McGraw Hill.

Semester-VIII
Course No.: UMJCHT-801 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Course learning outcomes:

After completing this course contents, students will be able to understand

- Chemical kinetics using various theories of bimolecular and unimolecular reactions
- Surface chemistry, electrochemistry and micelles

Theory: 03 Credits **Contact Hours: 45 Hours**

Unit-I: Chemical Dynamics **(12 Hours)**

Ionic reactions, Kinetic salt effects, Kinetic and thermodynamic control of reactions, Steady state kinetics, Photochemical and thermal reaction between hydrogen and bromine, Photochemical reaction between hydrogen and chlorine, Pyrolysis of acetaldehyde, Decomposition of ethane, Decomposition of nitrogen pentoxide, Formation and decomposition of phosgene, Oscillatory reactions (Belousov-Zhabotinsky reaction), Homogeneous catalysis, Kinetics of enzyme reactions, Theories of unimolecular reactions: Lindemann-Christiansen, Hinshelwood, Numericals.

Unit-II: Surface Chemistry **(11 Hours)**

Surface tension and surface free energy, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Nature and thermodynamics of liquid interfaces: Surface thermodynamic quantities for a pure substance, The total surface energy, Adsorption and its types, Adsorption isotherms, Freundlich and Langmuir adsorption isotherms, BET equation, Determination of surface area, Gibbs adsorption equation, Surface films on liquids, Catalytic activity at surfaces, Numericals.

Unit–III: Electrochemistry-I **(11 Hours)**

Debye-Huckel limiting law, Debye-Huckel-Onsager treatment and its extension, Debye-Huckel-Bjerrum equation, Thermodynamics of electrified interfaces, Lippman equation, Method of determination of surface excess, Structure of electrified interfaces: Helmholtz-Perrin, Guoy-Chapman and Stern models, Over potential, Exchange current density, Butler-Volmer equation, Tafel plot, Electrocatalysis, Numericals.

Unit–IV: Electrochemistry-II and Micelles **(11 Hours)**

Analogies between semiconductor and electrolyte, Structure of semiconductor-electrolyte interface, The diffuse charge region inside an intrinsic semiconductor (The Garrett-Brattain Space), Differential capacity due to space charge.

Polarography: Theory and working of polarography, Ilkovic equation, Half wave potential and its significance, Overvoltage.

Semester-VIII
Course No.: UMJCHT-801 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Micelles

Surface active agents, Classification of surface active agents, Micellization, Hydrophobic interaction, Critical micellar concentration (CMC), Factors affecting the CMC of surfactants, Counter ion binding of micelles, Thermodynamics of micellization-phase separation and mass action models, Solubilisation, Micro emulsion, Reverse micelles.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Chemical Kinetics, K.J. Laidler, Pearson, 3rd Edition.
3. Physical Chemistry of Surfaces, A.W. Adamson, John Wiley and sons, 5th Edition.
4. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
5. Modern Electrochemistry Vol. 1, Vol. 2A and Vol. 2B, J.O.M. Bockris and A.K.N. Reddy, Plenum.

Semester-VIII
Course No.: UMJCHT-801 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical : 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical kinetics and adsorption
- Use of conductivity meter in practical applications

Suggested Experiments:

Chemical Kinetics

i) Determination of the rate constant and order of hydrolysis of ester catalysed by an acid in aqueous medium.
ii) Determination of the effect of (a) Change of media (micellar media) (b) Change of concentration of reactants on the velocity constant of hydrolysis of an ester..
iii) To study the kinetics of reaction between potassium persulphate and potassium iodide and (a) Determine the rate constant and order of the reaction (b) Study the influence of ionic strength on the rate constant.

Adsorption

i) Study the adsorption of oxalic acid on charcoal and hence check the validity of Langmuir adsorption isotherm and classical adsorption isotherm.

Conductivity meter

i) Determine the equivalent conductivity of a weak electrolyte at different concentrations, and hence determine the dissociation constant of the electrolyte.
ii) Determine the equivalent conductivity of a strong electrolyte at several concentrations and hence verify the Onsagar's equation.
iii) Determine the strength of strong and weak acid and their mixture using conductivity meter.
iv) Study of kinetics of ester by sodium hydroxide using conductivity meter.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

Semester-VIII
Course No.: UMJCHT-801 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

BOOKS RECOMMENDED:

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry by Viswanathan and Raghavan.
6. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.

Semester-VIII
Course No.: UMJCHT-802 (Major Course)
Title: ORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Course learning outcomes:

After completing this course contents, students will be able to understand

- Aromatic electrophilic & nucleophilic substitutions
- Addition of carbon-carbon multiple bonds
- Addition to carbon-hetero multiple bonds & rearrangements
- Pericyclic reactions

Theory: 03 Credits **Contact Hours: 45 Hours**

Unit-I: Aromatic Electrophilic & Nucleophilic Substitutions (12 Hours)

The arenium ion mechanism, orientation and reactivity in substituted benzenes, energy profile diagrams, The ortho/para ratio, ipso attack, Orientation in other ring systems (hydrocarbons and heterocyclic compounds), Friedel-Crafts reaction of alkenes and alcohol substrates, Vilsmier reaction.

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

Unit -II: Addition of Carbon-Carbon Multiple Bonds (11 Hours)

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, Regio- and chemoselectivity, Orientation and reactivity, Addition to cyclopropane ring, Regioselective hydroboration of asymmetric olefins, Michael reaction, Sharpless asymmetric epoxidation.

Elimination Reactions

The E2, E1 and E1cB mechanisms, Regioselectivity of E1 and E2 eliminations, Base and stereoelectronic effect on E2/S_N2 competition; Orientation of the double bond, Reactivity: Effects of substrate structures, Attacking base, the leaving group and the reaction medium, Mechanism and orientation in pyrolytic eliminations, Peterson olefination.

Unit -III: Addition to Carbon-Hetero Multiple Bonds & Rearrangements (11 Hours)

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles [LAH, $NaBH_4$, BH_3, DIBAL-H], Addition of Grignard, carbonyl and unsaturated carbonyl compounds, Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel and Claisen Condensations.

Stevens, Arndt-Eistert synthesis, Neber, Baeyer-Villiger.

Unit –IV: Pericyclic Reactions (11 Hours)

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene and 1,3,5-hexatriene system, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams,

Semester-VIII
Course No.: UMJCHT-802 (Major Course)
Title: ORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

FMO and PMO approach, Electrocyclic reactions-conrotatory and disrotatory motions, 4n and 4n+2 systems, Cycloadditions: Antrafacial and suprafacial additions, 4n and 4n+2 systems, 1,3-dipolar cycloadditions, Sigmatropic rearrangements-suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, Claisen, Cope and Ene reaction.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford (2000).
3. Advance Organic Chemistry, Part-A: Structure & Mechanism (Fifth Edition), F.A. Carey & R.J. Sundberg, Published by Springer Science (2007).
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.
6. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
7. Advanced Organic Chemistry: Reaction Mechanisms, Reinhard Bruckner, Academic Press, USA.

Semester-VIII
Course No.: UMJCHT-802 (Major Course)
Title: ORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

8. Pericyclic reactions by Ian Flemmings, University Oxford Press, 2nd Edition, 2015.
9. Modern Methods of Organic Chemistry, William Carruthers and Liancoldham, Cambridge University Press (4th edition), 2015.
10. Polar rearrangements, Laurence M. Harwood, Oxford Science Publications, Oxford University Press (1992).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5th Edition), 2007.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Organic Synthesis and Reaction monitoring by TLC
- Separation and identification of organic compounds from two component mixture

Suggested Experiments:

Organic Synthesis and Reaction monitoring by TLC:
Sandmeyer reaction: p-Chlorotoluene from p-toluidine. Knoevenagel Condensation: Synthesis of cinnamic acid.

a. Friedel Crafts Reaction: β-Benzoyl propionic acid from succinic anhydride and benzene. Aromatic electrophilic substitutions: Synthesis of 4-nitroaniline from anilide. Beckmann rearrangement of acetophenone and benzophenone oximes.
b. Separation and identification of organic compounds from two component mixture.

Any other experiment introduced by the concerned teacher.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Experiments and techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
2. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
3. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.

Semester-VIII
Course No.: UMJCHT-803 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Mechanism of substitution reactions in octahedral and square planar transition metal complexes
- Magnetic properties of transition metal complexes
- Electronic spectra of transition metal complexes

Unit-I: Mechanism of Substitution Reactions in Octahedral and square planar Transition Metal Complexes

(12 Hours)

Energy profile of a substitution reaction, Inert and labile complexes, Factors affecting the inert and labile nature, Calculation of CFAE (Crystal field activation energy), Mechanism of nucleophilic substitution reactions in octahedral complexes SN^1 or dissociation and SN^2 or association (or displacement) mechanisms, Acid hydrolysis, SN^1 conjugate base mechanism for base hydrolysis of octahedral complexes, Evidence of SN^1 CB mechanism, Anation reaction, Decarboxylation reaction in octahedral complex and Substitution reaction without breakage of metal to ligand bond.

Unit-II: Mechanism of Substitution Reactions in Square Planar Complexes and Electron Transfer (or Oxidation-Reduction) Reaction **(11 Hours)**

Mechanism of substitution reactions in Pt(II) complexes, Factors effecting the reactivity of square
planar complexes, Trans-effect, Theories of trans-effect-Grinberg's electrostatic polarization theory and Chatt and Orgel pi-bonding theory, Application of trans-effect to synthesis of complexes, Reductions -oxidation reaction, One electron transfer reaction, Outer sphere, Inner sphere redox reaction, Marcus Hush theory.

Unit-III: Magnetic Properties of Transition Metal Complexes **(11 Hours)**

Magnetic properties of transition metal complexes and lanthanides, Spin-orbit coupling and susceptibility of transition metal ions and rare earths, Magnetic moments of metal complexes with crystal field terms of A, E and T symmetry, T.I.P, Intramolecular effects, Antiferromagnetism and ferromagnetism of metal complexes, Super paramagnetism, High and low spin equilibria, Anomalous magnetic moments, Magnetic exchange coupling and spin crossover.

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Semester-VIII
Course No.: UMJCHT-803 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Unit-IV: Electronic Spectra of Transition Metal Complexes **(11 Hours)**

Spectroscopic ground states, Term symbol, Splitting of terms by ligands, Rules for electronic transitions, Correlation diagrams, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1 –d9), Calculation of Dq, B and β Parameters, Nephelauxetic effect and Jahnteller Effect, Charge transfer spectra.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Inorganic Reaction Mechanism, F. Basolo & G. Pearson.
2. Inorganic Reaction Mechanism, J. O. Edwards.
3. Selected Topics in Inorganic Chemistry, Malik, Madan & Tuli.
4. Mechanism of Inorganic Reactions, D. Katakis & G. Gordon, John Wiley & Sons: N.Y. (1987).
2. Ligand Substitution Processes, H. Langford & H.B. Gray, W.A. Benjamin, Inc. New York
3. Magnetochemistry by R.L. Carlin, Springer Verlag.
4. Magnetism and Transition Metal Complexes, F. E. Mabbs & D. J. Machin, Chapman and Hall: U.K. (1973).

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Semester-VIII
Course No.: UMJCHT-803 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

5. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley.
6. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
7. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
8. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J. A. McCleverty, Pergamon.
9. Inorganic Chemistry – Principles of Structure & Reactivity, J.E. Huheey, Elllen A Keiter & Richard L Keiter, IV Edition (2005)
10. Introduction to metal pi-complex chemistry, M. Tsutsui, M. N. Levy, A. Nakamura, Springer
11. Inorganic Chemistry, Gary L. Miessler, Donald A. Tarr, Prentice Hall (4th Edition), 2010.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Volumetric analysis
- Commercial analysis
- Green methods of preparation of coordination complexes

Suggested Experiments:

1. Volumetric Analysis:
Potassium iodate titrations: Determination of iodide, hydrazine, antimony (III) and arsenic (III)

2. Commercial Analysis:
i) Determination of available chlorine in bleaching powder
ii) Determination of Oxygen in hydrogen peroxide.
iii) Determination of Boric acid in borax.

3. Green methods of preparation of the following:
i) trans-dichlorobis(ethylenediammine)cobalt(III) chloride
ii) Vanadyl acetylacetonate
iii) cis-Potassiun diaquadioxalatochromate(III) dihydrate
iv) trans- Potassiun diaquadioxalatochromate(III) dehydrate

4. Any other experiment introduced by the Teacher.

Semester-VIII
Course No.: UMJCHT-803 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Synthesis and Characterization of Inorganic Compounds, William L. Jolly, Prentice Hall.
2. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edn., Longman Group Limited, London.
3. A text Book of Quantitative Inorganic Analysis: A.I. Vogal.
4. Applied Analytical Chemistry: Vermani.
5. Commercial Methods of Analysis: Shell & Biffen
6. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge
7. Inorganic Synthesis, MC Graw Hill.
8. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic Press.
9. Standard methods of chemical analysis by W.W. Scaff, Technical Press.

Semester-VIII
Course No.: UMJCHT-804 (Major Course)
Title: APPLICATIONS OF SPECTROSCOPY IN ORGANIC CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Use of IR, 1H,Carbon-13 NMR and mass spectroscopic techniques in organic chemistry

Unit–I: Infrared Spectroscopy **(11 Hours)**
Basic principles, 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 vibrational frequencies, Overtones, Combination bands and Fermi resonance.

Unit–II: Nuclear Magnetic Resonance Spectroscopy **(12 Hours)**
General introduction and definition, Excitation & Relaxation, Pulsed Experiments, Chemical shift, Spin-spin Coupling, Shielding mechanism, Chemical shift values and correlation for protons bonded to carbon and other nuclei. Complex spin-spin interaction between two, three, four and five nuclei (first order spectra), Virtual coupling, Hindered rotation, Karplus curve-variation of coupling constant with dihedral angle, Chemical exchange, Effect of deuteration. Simplification of complex spectra: Nuclear magnetic double resonance, Contact shift reagents, Solvent effects, Fourier transform techniques, Nuclear overhauser effect (NOE).

Unit-III: Carbon-13 NMR Spectroscopy **(11 Hours)**
General considerations, Factors influencing carbon shifts, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), DEPT, APT.
Proton-Proton Correlation through coupling [COSY], Proton-Heteronucleus Correlation [HETCOR and H, C COSY], Carbon-Carbon Correlation [2D-INADEQUATE and C,C COSY].

Unit-IV: Mass Spectrometry **(11 Hours)**
Introduction, Ion production – EI, CI, FD and FAB, Factors affecting fragmentation of organic compounds, Molecular ion peak, Metastable peak, McLafferty rearrangement, Nitrogen rule, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Semester-VIII

Course No.: UMJCHT-804 (Major Course)

Title: APPLICATIONS OF SPECTROSCOPY IN ORGANIC CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)

Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]

Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
2. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley & Sons (2005).
3. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley (1992).
4. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, (6th Edition) Tata McGraw Hill Education (2011).
5. Organic Spectroscopy, William Kemp; Palgrave USA (2008).
6. Introduction to spectroscopy 94th edition, Donald L. Pavia, Gary M. Lampman, George S. Kriz and James R. Vyvyan, Brooks/Cole, Cangage Learning (2009).
7. Comprehensive chiroptical spectroscopy: Applications in stereochemical analysis of synthetic compounds, natural products and biomolecules, Vol. 2, John Wiley & sons (2012).
8. Application of Mass spectrometry to Organic Chemistry, R. I. Reed, Academic Press London & New York.
9. Organic Structural Spectroscopy, J.B. Lambert, H.F. Shurvell, D.A. Lightner & R.G. Cooks, Prentice-Hall International, UK (1998).

Semester-VIII
Course No.: UMJCHT-804 (Major Course)
Title: APPLICATIONS OF SPECTROSCOPY IN ORGANIC CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Practical: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical equilibrium and phase equilibrium
- Electrochemistry

Syllabus for Tutorials:

a. Identification of some organic compounds by the analysis of available spectral data (UV, IR, NMR & MS).

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (Time Duration: 1½ hour)

BOOKS RECOMMENDED:

1. Organic Structures from Spectra (4th ed.), L.D. Field, S. Sternhell & J.R. Kalman, Wiley.

Semester-VIII
Course No.: UMICHT-805 (Minor Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Green chemistry and its role in chemical synthesis
- Future trends in green chemistry

Unit-I: Introduction to Green Chemistry (10 Hours)
Twelve principles of Green Chemistry, Green Chemistry- needs and goals, Limitations/Obstacles in the pursuit of the goals of Green Chemistry.

Unit-II: Principles of Green Chemistry and Designing a Chemical Synthesis (12Hours)
Green solvents- supercritical fluids, water as a solvent for organic reactions, ionic liquids, Energy requirement for the reactions- alternative source of energy: use of microwave and ultrasonic energy, careful use of protecting groups, catalysis and green chemistry, comparison of homogeneous and heterogeneous catalysis, biocatalysts, asymmetric catalysis and photo catalysis. Strengthening and development of analytical techniques to prevent generation of hazardous substances in chemical processes.

Unit-III: Examples of Green Synthesis/Reactions and some real world cases (12 Hours)
Green synthesis of adipic acid, disodium iminodiacetate (alternative to Strecker synthesis). Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents, Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: sonochemical Simmons-Smith reaction. Surfactants for carbon dioxide- replacing smog producing and ozone depleting solvents with carbon dioxide, Development of fully recyclable carpet: Cradle to Cradle Carpeting.

Unit-IV: Future Trends in Green Chemistry (11 Hours)
Oxidation reagents and catalysis; Biomimetic, multifunctional reagents; Proliferation of solventless reactions; co-crystal controlled solid state synthesis, Green Chemistry in sustainable development.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Semester-VIII
Course No.: UMICHT-805 (Minor Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Ahluwalia, V. K. and Kidwai M. R.*New trends in green chemistry*, Anamalaya Publisher, 2005.
2. Ahluwalia, V. K. *Green Chemistry: A Textbook*, Alpha Science International Ltd., 2013.
3. Lancaster, M. *Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.*
4. Ryan, M.A. and Tinnesand, M. *An Introduction to Green Chemistry,* ACS, Washington, 2002.
5. Matlack, A.S. *An Introduction to Green Chemistry*, Marcel Dekker, 2001.

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical processes and reactions involving green chemistry

Syllabus for Tutorial:

1. Preparation of biodiesel from vegetable/waste cooking oil from renewable resources (using renewable resources).

Semester-VIII
Course No.: UMICHT-805 (Minor Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

2. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide (use of enzymes).
3. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice (using alternate solvents).
4. Mechanochemical solvent free synthesis of azomethines (avoiding solvents).
5. Photoreduction of benzophenone to benzopinacol in the presence of sunlight (use of alternate energy).
6. Synthesis of Tris(acetylacetonato) manganese (III) without the use of any buffer (avoiding waste).

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (Time Duration: 1½ hour)

BOOKS RECOMMENDED:

1. Anastas, P.T and Werner J.C. *Green Chemistry: Theory and Practice,* Oxford University, 1998.
2. Kirchoff, M. and Ryan, M.A. Greener approaches to undergraduate chemistry experiment, ACS, Washington DC, 2002.
3. Sharma, R.K.; Sidhwani, I.T. and Choudhari, M.K.I.K. *Green Chemistry Experiment.* A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore, 2013.
4. Cann M.C and Connelly, *M.E. Real world case in Green Chemistry*, ACS, 2008.

Semester-VIII
Course No.: UMJCHT-806 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical kinetics using various theories of bimolecular and unimolecular reactions
- Surface chemistry, electrochemistry and micelles

Theory: 03 Credits **Contact Hours: 45 Hours**

Unit-I: Chemical Dynamics **(12 Hours)**
Ionic reactions, Kinetic salt effects, Kinetic and thermodynamic control of reactions, Steady state kinetics, Photochemical and thermal reaction between hydrogen and bromine, Photochemical reaction between hydrogen and chlorine, Pyrolysis of acetaldehyde, Decomposition of ethane, Decomposition of nitrogen pentoxide, Formation and decomposition of phosgene, Oscillatory reactions (Belousov-Zhabotinsky reaction), Homogeneous catalysis, Kinetics of enzyme reactions, Theories of unimolecular reactions: Lindemann-Christiansen, Hinshelwood, Numericals.

Unit-II: Surface Chemistry **(11 Hours)**
Surface tension and surface free energy, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Nature and thermodynamics of liquid interfaces: Surface thermodynamic quantities for a pure substance, The total surface energy, Adsorption and its types, Adsorption isotherms, Freundlich and Langmuir adsorption isotherms, BET equation, Determination of surface area, Gibbs adsorption equation, Surface films on liquids, Catalytic activity at surfaces, Numericals.

Unit–III: Electrochemistry-I **(11 Hours)**
Debye-Huckel limiting law, Debye-Huckel-Onsager treatment and its extension, Debye-Huckel-Bjerrum equation, Thermodynamics of electrified interfaces, Lippman equation, Method of determination of surface excess, Structure of electrified interfaces: Helmholtz-Perrin, Guoy-Chapman and Stern models, Over potential, Exchange current density, Butler-Volmer equation, Tafel plot, Electrocatalysis, Numericals.

Unit–IV: Electrochemistry-II and Micelles **(11 Hours)**
Analogies between semiconductor and electrolyte, Structure of semiconductor-electrolyte interface, The diffuse charge region inside an intrinsic semiconductor (The Garrett-Brattain Space), Differential capacity due to space charge.
Polarography: Theory and working of polarography, Ilkovic equation, Half wave potential and its significance, Overvoltage.

Semester-VIII
Course No.: UMJCHT-806 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Micelles

Surface active agents, Classification of surface active agents, Micellization, Hydrophobic interaction, Critical micellar concentration (CMC), Factors affecting the CMC of surfactants, Counter ion binding of micelles, Thermodynamics of micellization-phase separation and mass action models, Solubilisation, Micro emulsion, Reverse micelles.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Chemical Kinetics, K.J. Laidler, Pearson, 3rd Edition.
3. Physical Chemistry of Surfaces, A.W. Adamson, John Wiley and sons, 5th Edition.
4. Micelles, Theoretical and Applied Aspects, V. Moroi, Plenum.
5. Modern Electrochemistry Vol. 1, Vol. 2A and Vol. 2B, J.O.M. Bockris and A.K.N. Reddy, Plenum.

Semester-VIII
Course No.: UMJCHT-806 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Practical : 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical kinetics and adsorption
- Use of conductivity meter in practical applications

Suggested Experiments:

Chemical Kinetics

i) Determination of the rate constant and order of hydrolysis of ester catalysed by an acid in aqueous medium.
ii) Determination of the effect of (a) Change of media (micellar media) (b) Change of concentration of reactants on the velocity constant of hydrolysis of an ester.
iii) To study the kinetics of reaction between potassium persulphate and potassium iodide and (a) Determine the rate constant and order of the reaction (b) Study the influence of ionic strength on the rate constant.

Adsorption

i) Study the adsorption of oxalic acid on charcoal and hence check the validity of Langmuir adsorption isotherm and classical adsorption isotherm.

Conductivity meter

i) Determine the equivalent conductivity of a weak electrolyte at different concentrations, and hence determine the dissociation constant of the electrolyte.
ii) Determine the equivalent conductivity of a strong electrolyte at several concentrations and hence verify the Onsagar's equation.
iii) Determine the strength of strong and weak acid and their mixture using conductivity meter.
iv) Study of kinetics of ester by sodium hydroxide using conductivity meter.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

Semester-VIII
Course No.: UMJCHT-806 (Major Course)
Title: PHYSICAL CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

BOOKS RECOMMENDED:

1. Practical Physical Chemistry, A. M. James and F. E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B. P. Levitt, Longman.
3. Experimental Physical Chemistry, R. C. Das and B. Behera, Tata McGraw Hill.
4. Experiments in Physical Chemistry by Shoemaker.
5. Practical Physical Chemistry by Viswanathan and Raghavan.
6. Advanced Practical Physical Chemistry by J. B. Yadav, Goel Publishing House.

Semester-VIII
Course No.: UMJCHT-807 (Major Course)
Title: ORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Course learning outcomes:

After completing this course contents, students will be able to understand

- Aromatic electrophilic & nucleophilic substitutions
- Addition of carbon-carbon multiple bonds
- Addition to carbon-hetero multiple bonds & rearrangements
- Pericyclic reactions

Theory: 03 Credits **Contact Hours: 45 Hours**

Unit-I: Aromatic Electrophilic & Nucleophilic Substitutions (12 Hours)

The arenium ion mechanism, orientation and reactivity in substituted benzenes, energy profile diagrams, The ortho/para ratio, ipso attack, Orientation in other ring systems (hydrocarbons and heterocyclic compounds), Friedel-Crafts reaction of alkenes and alcohol substrates, Vilsmier reaction.

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

Unit -II: Addition of Carbon-Carbon Multiple Bonds (11 Hours)

Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, Regio- and chemoselectivity, Orientation and reactivity, Addition to cyclopropane ring, Regioselective hydroboration of asymmetric olefins, Michael reaction, Sharpless asymmetric epoxidation.

Elimination Reactions

The E2, E1 and E1cB mechanisms, Regioselectivity of E1 and E2 eliminations, Base and stereoelectronic effect on E2/S_N2 competition; Orientation of the double bond, Reactivity: Effects of substrate structures, Attacking base, the leaving group and the reaction medium, Mechanism and orientation in pyrolytic eliminations, Peterson olefination.

Unit -III: Addition to Carbon-Hetero Multiple Bonds & Rearrangements (11 Hours)

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles [LAH, $NaBH_4$, BH_3, DIBAL-H], Addition of Grignard, carbonyl and unsaturated carbonyl compounds, Mechanism of condensation reactions involving enolates – Aldol, Knoevenagel and Claisen Condensations.

Stevens, Arndt-Eistert synthesis, Neber, Baeyer-Villiger.

Unit –IV: Pericyclic Reactions (11 Hours)

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3-butadiene and 1,3,5-hexatriene system, Classification of pericyclic reactions, Woodward-Hoffmann correlation diagrams,

Semester-VIII
Course No.: UMJCHT-807 (Major Course)
Title: ORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

FMO and PMO approach, Electrocyclic reactions-conrotatory and disrotatory motions, 4n and 4n+2 systems, Cycloadditions: Antrafacial and suprafacial additions, 4n and 4n+2 systems, 1,3-dipolar cycloadditions, Sigmatropic rearrangements-suprafacial and antrafacial shifts of H, Sigmatropic shifts involving carbon moieties, Claisen, Cope and Ene reaction.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Organic Chemistry, Jonathan Clayden, Nick Greeves, Stuart Warren, Peter Wothers, Oxford (2000).
3. Advance Organic Chemistry, Part-A: Structure & Mechanism (Fifth Edition), F.A. Carey & R.J. Sundberg, Published by Springer Science (2007).
4. Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N. Boyd, Prentice-Hall.
6. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
7. Advanced Organic Chemistry: Reaction Mechanisms, Reinhard Bruckner, Academic Press, USA.

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Semester-VIII
Course No.: UMJCHT-807 (Major Course)
Title: ORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

8. Pericyclic reactions by Ian Flemmings, University Oxford Press, 2nd Edition, 2015.
9. Modern Methods of Organic Chemistry, William Carruthers and Liancoldham, Cambridge University Press (4th edition), 2015.
10. Polar rearrangements, Laurence M. Harwood, Oxford Science Publications, Oxford University Press (1992).
11. Organic Chemistry, Stanley H. Pine, Tata McGraw Hill (5th Edition), 2007.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Organic Synthesis and Reaction monitoring by TLC
- Separation and identification of organic compounds from two component mixture

Suggested Experiments:

Organic Synthesis and Reaction monitoring by TLC:
Sandmeyer reaction: p-Chlorotoluene from p-toluidine. Knoevenagel Condensation: Synthesis of cinnamic acid.

a. Friedel Crafts Reaction: β-Benzoyl propionic acid from succinic anhydride and benzene. Aromatic electrophilic substitutions: Synthesis of 4-nitroaniline from anilide. Beckmann rearrangement of acetophenone and benzophenone oximes.
b. Separation and identification of organic compounds from two component mixture.

Any other experiment introduced by the concerned teacher.

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Experiments and techniques in Organic Chemistry, D. Pasto, C. Johnson and M. Miller, Prentice Hall.
2. Vogel's Textbook of Practical Organic Chemistry, A.R. Tatchell, John Wiley.
3. Monograph on Green Chemistry by Green Chemistry Task Force Committee, DST.

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Semester-VIII
Course No.: UMJCHT-808 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Mechanism of substitution reactions in octahedral and square planar transition metal complexes
- Magnetic properties of transition metal complexes
- Electronic spectra of transition metal complexes

Unit-I: Mechanism of Substitution Reactions in Octahedral and square planar Transition Metal Complexes

(12 Hours)

Energy profile of a substitution reaction, Inert and labile complexes, Factors affecting the inert and labile nature, Calculation of CFAE (Crystal field activation energy), Mechanism of nucleophilic substitution reactions in octahedral complexes SN^1 or dissociation and SN^2 or association (or displacement) mechanisms, Acid hydrolysis, SN^1 conjugate base mechanism for base hydrolysis of octahedral complexes, Evidence of SN^1 CB mechanism, Anation reaction, Decarboxylation reaction in octahedral complex and Substitution reaction without breakage of metal to ligand bond.

Unit-II: Mechanism of Substitution Reactions in Square Planar Complexes and Electron Transfer (or Oxidation-Reduction) Reaction **(11 Hours)**

Mechanism of substitution reactions in Pt(II) complexes, Factors effecting the reactivity of square
planar complexes, Trans-effect, Theories of trans-effect-Grinberg's electrostatic polarization theory and Chatt and Orgel pi-bonding theory, Application of trans-effect to synthesis of complexes, Reductions -oxidation reaction, One electron transfer reaction, Outer sphere, Inner sphere redox reaction, Marcus Hush theory.

Unit-III: Magnetic Properties of Transition Metal Complexes **(11 Hours)**

Magnetic properties of transition metal complexes and lanthanides, Spin-orbit coupling and susceptibility of transition metal ions and rare earths, Magnetic moments of metal complexes with crystal field terms of A, E and T symmetry, T.I.P, Intramolecular effects, Antiferromagnetism and ferromagnetism of metal complexes, Super paramagnetism, High and low spin equilibria, Anomalous magnetic moments, Magnetic exchange coupling and spin crossover.

Semester-VIII
Course No.: UMJCHT-808 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

Unit-IV: Electronic Spectra of Transition Metal Complexes (11 Hours)

Spectroscopic ground states, Term symbol, Splitting of terms by ligands, Rules for electronic transitions, Correlation diagrams, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d1 –d9), Calculation of Dq, B and β Parameters, Nephelauxetic effect and Jahnteller Effect, Charge transfer spectra.

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Inorganic Reaction Mechanism, F. Basolo & G. Pearson.
2. Inorganic Reaction Mechanism, J. O. Edwards.
3. Selected Topics in Inorganic Chemistry, Malik, Madan & Tuli.
4. Mechanism of Inorganic Reactions, D. Katakis & G. Gordon, John Wiley & Sons: N.Y. (1987).
2. Ligand Substitution Processes, H. Langford & H.B. Gray, W.A. Benjamin, Inc. New York
3. Magnetochemistry by R.L. Carlin, Springer Verlag.
4. Magnetism and Transition Metal Complexes, F. E. Mabbs & D. J. Machin, Chapman and Hall: U.K. (1973).

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Semester-VIII
Course No.: UMJCHT-808 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

5. Advanced Inorganic Chemistry, F.A. Cotton and G. Wilkinson, John Wiley.
6. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
7. Chemistry of the Elements, N.N. Greenwood and A. Earnshaw, Pergamon.
8. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and J. A. McCleverty, Pergamon.
9. Inorganic Chemistry – Principles of Structure & Reactivity, J.E. Huheey, Elllen A Keiter & Richard L Keiter, IV Edition (2005)
10. Introduction to metal pi-complex chemistry, M. Tsutsui, M. N. Levy, A. Nakamura, Springer
11. Inorganic Chemistry, Gary L. Miessler, Donald A: Tarr, Prentice Hall (4th Edition), 2010.

Practical: 01 Credit **Contact Hours: 30 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Volumetric analysis
- Commercial analysis
- Green methods of preparation of coordination complexes

Suggested Experiments:

1. Volumetric Analysis:
Potassium iodate titrations: Determination of iodide, hydrazine, antimony (III) and arsenic (III)

2. Commercial Analysis:
i) Determination of available chlorine in bleaching powder
ii) Determination of Oxygen in hydrogen peroxide.
iii) Determination of Boric acid in borax.

3. Green methods of preparation of the following:
i) trans-dichlorobis(ethylenediammine)cobalt(III) chloride
ii) Vanadyl acetylacetonate
iii) cis-Potassiun diaquadioxalatochromate(III) dihydrate
iv) trans- Potassiun diaquadioxalatochromate(III) dehydrate

4. Any other experiment introduced by the Teacher.

Semester-VIII
Course No.: UMJCHT-808 (Major Course)
Title: INORGANIC CHEMISTRY-V

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 2½ Hours (Practical)

NOTE FOR PAPER SETTING:

EVALUATION OF PRACTICALS:

Daily evaluation of practical records/viva-voce etc.	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (10 marks = practical assessment + 5 marks= viva-voce examination)

BOOKS RECOMMENDED:

1. Synthesis and Characterization of Inorganic Compounds, William L. Jolly, Prentice Hall.
2. Vogel's Textbook of Quantitative Inorganic Analysis, 4th Edn., Longman Group Limited, London.
3. A text Book of Quantitative Inorganic Analysis: A.I. Vogal.
4. Applied Analytical Chemistry: Vermani.
5. Commercial Methods of Analysis: Shell & Biffen
6. Experimental Inorganic Chemistry by W.G. Palmer, Cambridge
7. Inorganic Synthesis, MC Graw Hill.
8. Handbook of Preparative Inorganic chemistry Vol. I and II, Academic Press.
9. Standard methods of chemical analysis by W.W. Scaff, Technical Press.

Semester-VIII
Course No.: UMJCHT-809 (Major Course)
Title: APPLICATIONS OF SPECTROSCOPY IN ORGANIC CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Use of IR, 1H,Carbon-13 NMR and mass spectroscopic techniques in organic chemistry

Unit–I: Infrared Spectroscopy **(11 Hours)**
Basic principles, 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 vibrational frequencies, Overtones, Combination bands and Fermi resonance.

Unit–II: Nuclear Magnetic Resonance Spectroscopy **(12 Hours)**
General introduction and definition, Excitation & Relaxation, Pulsed Experiments, Chemical shift, Spin-spin Coupling, Shielding mechanism, Chemical shift values and correlation for protons bonded to carbon and other nuclei. Complex spin-spin interaction between two, three, four and five nuclei (first order spectra), Virtual coupling, Hindered rotation, Karplus curve-variation of coupling constant with dihedral angle, Chemical exchange, Effect of deuteration. Simplification of complex spectra: Nuclear magnetic double resonance, Contact shift reagents, Solvent effects, Fourier transform techniques, Nuclear overhauser effect (NOE).

Unit-III: Carbon-13 NMR Spectroscopy **(11 Hours)**
General considerations, Factors influencing carbon shifts, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), DEPT, APT.
Proton-Proton Correlation through coupling [COSY], Proton-Heteronucleus Correlation [HETCOR and H, C COSY], Carbon-Carbon Correlation [2D-INADEQUATE and C,C COSY].

Unit-IV: Mass Spectrometry **(11 Hours)**
Introduction, Ion production – EI, CI, FD and FAB, Factors affecting fragmentation of organic compounds, Molecular ion peak, Metastable peak, McLafferty rearrangement, Nitrogen rule, Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Semester-VIII
Course No.: UMJCHT-809 (Major Course)
Title: APPLICATIONS OF SPECTROSCOPY IN ORGANIC CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

NOTE FOR PAPER SETTING:

Note for paper setter for End Semester Examination:

The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.

Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.

The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:

The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.

The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:

Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.

Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
2. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley & Sons (2005).
3. Introduction to NMR Spectroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley (1992).
4. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, (6th Edition) Tata McGraw Hill Education (2011).
5. Organic Spectroscopy, William Kemp; Palgrave USA (2008).
6. Introduction to spectroscopy 94th edition, Donald L. Pavia, Gary M. Lampman, George S. Kriz and James R. Vyvyan, Brooks/Cole, Cangage Learning (2009).
7. Comprehensive chiroptical spectroscopy: Applications in stereochemical analysis of synthetic compounds, natural products and biomolecules, Vol. 2, John Wiley & sons (2012).
8. Application of Mass spectrometry to Organic Chemistry, R. I. Reed, Academic Press London & New York.
9. Organic Structural Spectroscopy, J.B. Lambert, H.F. Shurvell, D.A. Lightner & R.G. Cooks, Prentice-Hall International, UK (1998).

Semester-VIII
Course No.: UMJCHT-809 (Major Course)
Title: APPLICATIONS OF SPECTROSCOPY IN ORGANIC CHEMISTRY

Credits: 03 (Theory) + 01 (Tutorial)
Maximum Marks: 100 [75 (Theory) + 25 (Tutorial)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Practical: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical equilibrium and phase equilibrium
- Electrochemistry

Syllabus for Tutorials:

a. Identification of some organic compounds by the analysis of available spectral data (UV, IR, NMR & MS).

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (Time Duration: 1½ hour)

BOOKS RECOMMENDED:

1. Organic Structures from Spectra (4th ed.), L.D. Field, S. Sternhell & J.R. Kalman, Wiley.

Semester-VIII
Course No.: UMICHT-810 (Minor Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Theory: 03 Credits **Contact Hours: 45 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Green chemistry and its role in chemical synthesis
- Future trends in green chemistry

Unit-I: Introduction to Green Chemistry (10 Hours)
Twelve principles of Green Chemistry, Green Chemistry- needs and goals, Limitations/Obstacles in the pursuit of the goals of Green Chemistry.

Unit-II: Principles of Green Chemistry and Designing a Chemical Synthesis (12Hours)
Green solvents- supercritical fluids, water as a solvent for organic reactions, ionic liquids, Energy requirement for the reactions- alternative source of energy: use of microwave and ultrasonic energy, careful use of protecting groups, catalysis and green chemistry, comparison of homogeneous and heterogeneous catalysis, biocatalysts, asymmetric catalysis and photo catalysis. Strengthening and development of analytical techniques to prevent generation of hazardous substances in chemical processes.

Unit-III: Examples of Green Synthesis/Reactions and some real world cases (12 Hours)
Green synthesis of adipic acid, disodium iminodiacetate (alternative to Strecker synthesis). Microwave assisted reactions in water: Hofmann Elimination, methyl benzoate to benzoic acid, oxidation of toluene and alcohols; microwave assisted reactions in organic solvents, Diels-Alder reaction and Decarboxylation reaction. Ultrasound assisted reactions: sonochemical Simmons-Smith reaction. Surfactants for carbon dioxide- replacing smog producing and ozone depleting solvents with carbon dioxide, Development of fully recyclable carpet: Cradle to Cradle Carpeting.

Unit-IV: Future Trends in Green Chemistry (11 Hours)
Oxidation reagents and catalysis; Biomimetic, multifunctional reagents; Proliferation of solventless reactions; co-crystal controlled solid state synthesis, Green Chemistry in sustainable development.

NOTE FOR PAPER SETTING:
Note for paper setter for End Semester Examination:
The question paper will be of **60 marks**. There shall be **2 Sections** in the question paper with pattern as follows:

Semester-VIII
Course No.: UMICHT-810 (Minor Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

Section-A shall comprise of **4** short answer type questions of (**3** marks each) with one question from each unit. The students have to attempt all the questions from Section-A.
Section-B shall comprise of a total of **8** questions with two questions selected from each unit. Each question shall be of **12 marks**. The students have to attempt **4** questions be selecting only one question from each unit.
The numerical problems should not exceed more than 20% of the maximum marks.

Note for paper setter for Mid Semester Examination:
The Mid Semester Examination shall be conducted by the course coordinator after completion of **50%** of the syllabus.
The question paper will be of **15** marks and duration of examination shall be 1½ hour. There shall be **2** sections in the question paper with pattern as follows:
Section-A shall comprise of **3** questions (of **4** marks each) and the students are required to attempt any two questions.
Section-B shall comprise of **2** questions (of **7** marks each) and the students are required to attempt any one question.

BOOKS RECOMMENDED:

1. Ahluwalia, V. K. and Kidwai M. R.*New trends in green chemistry*, Anamalaya Publisher, 2005.
2. Ahluwalia, V. K. *Green Chemistry: A Textbook*, Alpha Science International Ltd., 2013.
3. Lancaster, M. *Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.*
4. Ryan, M.A. and Tinnesand, M. *An Introduction to Green Chemistry,* ACS, Washington, 2002.
5. Matlack, A.S. *An Introduction to Green Chemistry*, Marcel Dekker, 2001.

Tutorial: 01 Credit **Contact Hours: 15 Hours**

Course learning outcomes:
After completing this course contents, students will be able to understand

- Chemical processes and reactions involving green chemistry

Syllabus for Tutorial:

1. Preparation of biodiesel from vegetable/waste cooking oil from renewable resources (using renewable resources).

Semester-VIII
Course No.: UMICHT-810 (Minor Course)
Title: GREEN CHEMISTRY TECHNOLOGY

Credits: 03 (Theory) + 01 (Practical)
Maximum Marks: 100 [75 (Theory) + 25 (Practical)]
Duration of Examination: 3 Hours (Theory) and 1½ Hour (Tutorial)

2. Benzoin condensation using thiamine hydrochloride as a catalyst instead of cyanide (use of enzymes).
3. Extraction of D-limonene from orange peel using liquid CO_2 prepared from dry ice (using alternate solvents).
4. Mechanochemical solvent free synthesis of azomethines (avoiding solvents).
5. Photoreduction of benzophenone to benzopinacol in the presence of sunlight (use of alternate energy).
6. Synthesis of Tris(acetylacetonato) manganese (III) without the use of any buffer (avoiding waste).

NOTE FOR PAPER SETTING:

EVALUATION OF TUTORIALS:

Continuous assessment	10 marks	
Final examination (to be conducted by the course coordinator internally)	100 % Syllabus	15 marks (Time Duration: 1½ hour)

BOOKS RECOMMENDED:

1. Anastas, P.T and Werner J.C. *Green Chemistry: Theory and Practice,* Oxford University, 1998.
2. Kirchoff, M. and Ryan, M.A. Greener approaches to undergraduate chemistry experiment, ACS, Washington DC, 2002.
3. Sharma, R.K.; Sidhwani, I.T. and Choudhari, M.K.I.K. *Green Chemistry Experiment.* A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore, 2013.
4. Cann M.C and Connelly, *M.E. Real world case in Green Chemistry*, ACS, 2008.

Semester-VIII
Course No.: UMJCHP-811 (Major Course)
Title: RESEARCH PROJECT AS DISSERTATION

Credits: 12 (Practical)
Maximum Marks: 300
Duration of Examination: 6 hours

Course learning outcomes:
After completing the research project, the research outcomes of the project work will be published in peer reviewed journal/s and/or presented in conferences/seminars or patented.

Research Project work (12 credits) shall be started at the beginning of 7th Semester.

There shall be a Project Synopsis in the programme based on the major area/subject. The permanent faculty with Ph.D and research experience (as per UGC guidelines) shall be the research project supervisor after being recognized by the Departmental Research Committee (DRC) of the Nodal Department. The college offering FYUGP with Research should have its own College Research Committee (CRC) for each discipline with atleast one member from any University of the region. The project report/dissertation shall be evaluated by the external expert from other University/Colleges to be nominated by the Principal out of the panel supplied by the CRC.

Project proposal to be scrutinized by the College Research Committee for the concerned subject.

In the 8th Semester, Evaluation of Dissertation and Viva-Voce shall be in the blended mode (online/offline) as per the convenience of the examiner. The Dissertation evaluation shall be carried out by an external expert.

Research Project = 12 credits
[Dissertation = 08 credits (200 marks); Viva/presentation = 04 credits (100 marks)]

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