ENGINEERING CHEMISTRY

Revised Syllabus for M.Sc. Applied Chemistry

(With effect from the Admitted batch of 2021-2022 Academic Year**)**

PROGRAM OBJECTIVES:

1. To provide the scientific skills and chemical knowledge to students essential to develop and apply the knowledge in chemical sciences for preparing them as chemists of exceptional skills and abilities.

2. To provide knowledge, application, skills in required areas of chemical education

3. To equip students with effective scientific communication skills

4. To encourage the pursuit of lifelong education

5. To develop each student into a committed individual with ethical and social responsibility

PROGRAM SPECIFIC OBJECTIVES:

The students who complete the M.Sc. Applied Chemistry course shall:

1. Have strong foundation in the fundamentals and applications of chemical knowledge and understanding

2. Have the abilities to think critically, logically and analytically and solve problem in the area of chemical sciences, materials, environmental aspects, medicines and energy

3. Have the abilities to carry out chemical experiments, record and analyze the results and design advanced models

4. Have the abilities to use modern library and information retrieving tools to obtain information and assimilate to generate concepts and apply them in challenging situations

5. Have the abilities to effectively communicate their knowledge and skills to other chemists and non-chemists in oral or written formats

6. Secure suitable employment in the areas of chemical industries like pharmaceutical, steel and metals, polymers, fuels and nuclear, environmental and pollution control, nanotechnology and composite materials, teaching and research, etc.

7. Have the personal attributes and ethical sensibilities to enable them to function as effective scientists and citizens

REGULATIONS

1. The duration of the course is for two academic years in four semesters. The nature of the course is full-time.

2. Candidates for the degree of Master of Science in Applied Chemistry shall be required to have passed the B.Sc with Chemistry / Applied Chemistry / Industrial Chemistry as one the subject of this university or any other university recognized by the academic council as equivalent thereto.

3. The course and scope of instruction shall be as defined in the syllabus prescribed. (Annexure-III)

4. Candidate who takes instruction shall be required to take examinations at the end of each semester as specified in Annexure-I.

5. Each candidate has to undergo an internship for a duration of four weeks during the fourth semester in any chemical industry/ R&D / organization/ or at the department at their own expense and have to submit project report.

6. A candidate shall be declared to have passed in any course if he /she secures not less than “E’’ grade in theory and not less than ‘’D’’ grade in the practical /Project, provided the result otherwise is with held. There is no minimum pass marks for internal assessment marks both theory as well as practical.

A candidate shall be deemed to have satisfied the minimum requirement for the award of thedegree of M.Sc. Applied Chemistry.

i. If he / she is declared to have passed all the subjects included in the scheme of instruction and examination and

ii. if he /she secures 5.0 CGPA in each of the semesters by the end of each semester Further, a candidate shall be permitted to choose any course(s) to appear for improvement in case the candidate fails to secure the minimum prescribed SGPA/CGPA to enable the candidate to pass at the end of any semester examinations. There shall not be any provision for the improvement of internal assessment marks in any theory or practical subjects in any year / semester of study. Grades and calculation of SGPA and CGPA are given in Annexure-II

7. The successful candidates in the M.Sc Applied Chemistry degree examination shall be arranged in the order in which they are registered for the examination in the following classes on the basis of the CGPA. However, students who pass in any supplementary examination shall not be awarded Distinction even if they obtain a CGPA of 8.0 or above, they shall be considered as First Class only.

First Class with Distinction – CGPA 7.0 or more

First Class – CGPA 6.0 or more but less than 7.0

Second Class/Pass – CGPA 5.0 or more but less than 6.0

8. The Question papersetting and valuation shall be as per the University regulations at the end of each semester.

9. The practical examinations shall be conducted and valued by both internal and external examiners at the end of each semester.

10. The viva- voce examination for Project Work shall be conducted by both internal and external examiners at the end of the completion of project and after submission of the Project Report by each of the candidates.

11. Each practical/ laboratory carries 70 marks for external evaluation process in which both the internal and external examiners conducts the examination. Out of these 70 marks 10 marks are allocated to Record and 10 marks allocated to Viva-voce examination of the student.

12. The Minimum attendance required by a candidate will be 75% of the total number for the working days in that semester. Provided that in special cases and for sufficient cause shown, the Vice-chancellor may, on the recommendation of the Principal and the Head of the department concerned, condone the deficiency in the average attendance to an extent of 9% for reasons such as ill health, if the application for condonation is submitted at the time of actual illness and is supported a certificate of an authorized medical officer approved by the Principal. However, 100% attendance should be maintained for all practicals/ labs/ Internship>

13. Each of the student has to study two MOOC courses from NPTEL/ SWAYAM/COURSERA etc. one in the third semester and the other in the fourth semester of the programme and the grade obtained should be submitted to the Department for incorporation in the marks list along with the Grade/ Course Completion Certificate. The Departmental Committee shall normalize the grade/ score obtained by the student and submit to the University along with Practical Examination Marks. The student has to complete each of these courses during the concerned semester period only.

14. Keeping in view of the objectives of National Educational Policy 2020 and the directives of the University, two value added courses have been included, one each in 3rd and 4th semesters of the course. Research Methodology in 3rd semester and Intellectual Property Rights in the 4th semester on par with that of other subjects of the course.

15. The University may, from time to time, revise, amend or change the regulations, scheme of examination and syllabus. In the case of students already undergoing the course, the changes will take effect from the beginning of the following academic year after the change are introduced and shall cover the part of the course that remains to be completed.

Annexure-I

Scheme of Instruction and Examination

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
Semester – I								
ACT1.1	InorganicChemistry-I	Theory	4-0-0	70	30	100	3 Hours	4
ACT1.2	OrganicChemistry-I	Theory	4-0-0	70	30	100	3 Hours	4
ACT1.3	PhysicalChemistry-I	Theory	4-0-0	70	30	100	3 Hours	4
ACT1.4	AnalyticalChemistry	Theory	4-0-0	70	30	100	3 Hours	4
ACP 1.5	Inorganic Chemistry Practical-I	Lab	0-0-6	70	30	100	3 Hours	3
ACP 1.6	Organic Chemistry Practical-I	Lab	0-0-6	70	30	100	3 Hours	3
ACP 1.7	PhysicalChemistry Practical-I	Lab	0-0-6	70	30	100	3 Hours	3
	Total		16-0-18	490	210	700		25
Semester –II								
ACT2.1	InorganicChemistry-II	Theory	4-0-0	70	30	100	3 Hours	4
ACT2.2	OrganicChemistry-II	Theory	4-0-0	70	30	100	3 Hours	4
ACT2.3	PhysicalChemistry-II	Theory	4-0-0	70	30	100	3 Hours	4
ACT2.4	Environmental Chemistry	Theory	4-0-0	70	30	100	3 Hours	4
ACP 2.5	Inorganic Chemistry Practical-II	Lab	0-0-6	70	30	100	3 Hours	3
ACP 2.6	OrganicChemistry Practical-II	Lab	0-0-6	70	30	100	3 Hours	3
ACP 2.7	PhysicalChemistry Practical-II	Lab	0-0-6	70	30	100	3 Hours	3
	Total		16-0-18	490	210	700		25
Semester–III								
ACT 3.1	Instrumental Methods of Analysis	Theory	4/0/0	70	30	100	3 Hours	4
ACT3.2	Organic Spectroscopy	Theory	4/0/0	70	30	100	3 Hours	4
ACT3.3	Organic Synthesis	Theory	4/0/0	70	30	100	3 Hours	4
ACT3.4 Elective	Medicinal Chemistry Energy Systems Surface Chemistry&Catalysis	Theory	4/0/0	70	30	100	3 Hours	4
ACT3.5	Research Methodology	Theory	4/0/0	70	30	100	3 Hours	2
ACT3.6	MOOCCourse	Theory	0/4/0 (Online)	100	-	100	As per the course	2
ACP3.7	Quantitative Analysis Practical-I	Lab	0/0/6	70	30	100	6 Hours	3
ACP3.8	OrganicChemistry Practical-III	Lab	0/0/6	70	30	100	6 Hours	3
	Total		20-4-12	590	210	800		26
Semester –IV								
ACT 4.1	Industries based on Organic Raw Materials	Theory	4/0/0	70	30	100	3 Hours	4

ACT4.2	Fine Chemicals	Theory	4/0/0	70	30	100	3 Hours	4
ACT4.3	Polymersand Plastics	Theory	4/0/0	70	30	100	3 Hours	4
ACT 4.4 Elective	Green Chemistry Quantum Chemistry Nuclear Chemistry	Theory	4/0/0	70	30	100	3 Hours	4
ACT 4.5	Intellectual Property Rights	Theory	4/0/0	70	30	100	3 Hours	2
ACT4.6	MOOC Course	Theory	0/4/0 (Online)	100	-	100	As per the course	2
ACP 4.6	Quantitative Analysis Practical-II	Lab	0/0/6	70	30	100	6 Hours	3
ACP 4.7	Applied Chemistry Practical	Lab	0/0/6	70	30	100	6 Hours	3
ACP 4.8	Project Work*	Internship	4weeks Full days on all working days	70	30	100	Project Report & Viva-Voce	8
	Total		20-4-12	590	210	800		34

*4 Weeks of Internship in Chemical industry/R&DOrganization/Department

Summary of Courses and Credits

Semester	No. of Theory Courses	No. of Practical Courses	No. of MOOC Courses	No. of Value Added Courses	No. of Projects	Total Marks	Total Credits
I	4	3	0	0	0	700	25
II	4	3	0	0	0	700	25
III	4	2	1	1	0	800	26
IV	4	2	1	1	1	800	34
TOTAL	16	10	2	2	1	3000	110

Total Credits : 100

Total Marks 3000

Annexure-II

S.No	Range ofMarks	Grade	Grade Points
1	> 90 ≤100	O	10.00
2	> 80 ≤90	A	9.00
3	> 70 ≤80	B	8.00
4	> 60 ≤70	C	7.00
5	> 50 ≤60	D	6.00
6	≥ 40 ≤50	E	5.00
7	< 39	F	0.00

Calculation of SGPA (Semester Grade Point Average) andCGPA (Cumulative Grade Point Average)

For example if a student gets the grades in one semester A,A,B,B,B,D in six subjects having credits 2(S1) 4(S2), 4(S3), 4(S4), 4(S5), 2(S6), respectively.

The SGPA is calculated as follows:

$$SGPA = \frac{9(A) \times 2(S1) + 9(A) \times 4(S2) + 8(B) \times 4(S3) + 8(B) \times 4(S4) + 8(B) \times 4S5) + 6(D) \times 2\ (S6)}{2(S1) + 4\ (S2) + 4(S3) + 4(S4) + 4(S5) + 2(S6)} = \frac{162}{20} = 8.10$$

A student securing 'F' grade there by securing 0.0 grade points has to appear and secure at least 'E' grade at the subsequent examination(s) in that subject.

If a student gets the grades in another semester D, A, B, C, A, E, A in seven subjects having credits 4(S1), 2(S2),4(S3), 2(S4), 4(S5), 4(S6), 2(S7) respectively.

$$SGPA = \frac{\{6(D)x4(S1) + 9(A)x2(S2) + 8(B)x4(S3) + 7(C)x2(S4) + 9(A)x4(S5) + 5(E)x4(S6) + 9(A)x2(S7)\}}{4(S1) + 2(S2) + 4(S3) + 2(S4) + 4(S5) + 4(S6) + 2(S7)} = \frac{162}{22} = 7.36$$

$$CGPA = \frac{(9X2 + 9X4 + 8X4 + 8X4 + 8X4 + 6X2 + 6X4 + 9X2 + 8X4 + 7X2 + 9X4 + 5X4 + 9X2)}{20 + 22} = \frac{324}{42} = 7.71$$

A candidate has to secure a minimum of 5.0 SGPA for a pass in each semester. Further, a candidate will be permitted to choose any course (s) to appear for improvement in case the candidate fails to secure the minimum prescribed SGPA/CGPA to enable the candidate to pass at the end of any semester examination.

Annexure-III

REVISED SYLLABUS FOR M.Sc. APPLIED CHEMISTRY

(with effective from 2021-22 admitted batch)

Semester-I

ACT 1.1: INORGANIC CHEMISTRY–I

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT1.1	InorganicChemistry-I	Theory	4-0-0 (60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To develop an insight into the basic knowledge of inorganic chemistry

CO 2: To understand chemical bonding, coordination compounds, f-block elements and their theories

CO 3: To apply the knowledge and understanding in the areas of chemical bonding, coordination compounds and f-block elements for solving existing challenges faced in various chemical and industrial areas

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:Identify the principles, structure and reactivity of selected coordination compounds LO 2: Interpret their electronic spectra and magnetic properties.

LO 3: Utilize the principles of transition metal coordination complexes in understanding functions of chemical systems.

Unit-I : Chemical Bonding (12 hours) : Hybridization, VSEPR-theory and its importance - Molecular orbital theory as applied to homonuclear and simple hetero nuclear diatomic molecules (non-mathematical approach only)-Fajan's rules for prediction of non-polar character, Electroneutrality principle and back bonding,

Unit -II : Inorganic Cage and Ring Compounds (12 hours) Preparation, structure and reactions of boranes, carboranes, metallocarboranes, boron–nitrogen ($H_3B_3N_3H_3$), phosphorus–nitrogen ($N_3P_3Cl_6$) and sulphurnitrogen (S_4N_4, (SN)x) cyclic compounds. Electron counting in boranes – Wades rules (Polyhedral skeletal electron pair theory). Isopoly and heteropoly acids.

Unit -III : Fundamentals of Coordination Compounds (12 hours) Theories of metal-ligand bond: Valence bond theory Geometries of coordination numbers, 4- tetrahedral and square planar and 6-octahedral. Limitations, Inner and outer orbital complexes-– Crystal field theory: Salient features, Splitting of metal orbitals in regular octahedral, square planar, tetrahedral, square pyramidal and trigonalbipyramidal geometries. Measurement of crystal field splitting energy, High spin and low spin octahedral complexes. Crystal field stabilization energy.

Unit -IV : Applications of Coordination Compounds (12 hours) Factors affecting the magnitude of crystal field splitting. Limitations of crystal field theory. Application of crystal field theory to account for spectral and magnetic properties of complexes. Jahn-Teller distortion. Introduction to Molecular orbital theory of complex compounds –Nephelauxetic effect. Pearson's concept of hard and soft acids and bases, Hard and soft acids and bases (HSAB) rule - Classification of metals and Ligands as class 'a' and class 'b'. Applications of HSAB rule - Predicting feasibility of a reaction and stability of compounds.

Unit -V : Chemistry of Lanthanides and Actinides (12 hours) Stable oxidation states-Lanthanide and actinide contraction-Absorption spectra of lanthanides and actinides and their magnetic properties-separation of Lanthanides and actinides, uses of lanthanides and their compounds.

Text Books:

1. Inorganic chemistry, principles of structure and reactivity, 4th Edition by James E. Huheey: Elleu A. Keiter: Richard L. Keiter.

2. Advanced inorganic chemistry by F. A. Cotton and G. Wilkinson IV Edition, John Wiley and Sons, New York, 1980.

3. Theoretical Inorganic Chemistry, II Edition by M. C. Day and J. Selbin, Affiliated East West press Pvt. Ltd., New Delhi.

4. Inorganic Chemistry by Shriver and Atkins, Oxford University Press (1999

5. Concepts and Models in Inorganic Chemistry byDoughlasMc Daniel.

6. Introductory Quantum Chemistry by A.K. Chandra (Tata McGrawhill)

7. Chemistry of Lanthanides by T. Healler, Chapman and Hall.

8. Chemical Applications of Group Theory by B.A. Cotton.

9. Inorganic Chemistry by J. E. Huheey, III Edition, Harper International Edition, 1983.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	L	M	H	L	M	M
CO 2	M	M	L	M	M	L	L
CO 3	L	M	M	L	M	M	M

L – LOW M- MEDIUM H-HIGH

ACT 1.2: ORGANIC CHEMISTRY–I

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT1.2	InorganicChemistry-I	Theory	4-0-0 (60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To develop an insightthe basic knowledge of organic chemistry

CO 2: To understand structure and reactivity, aromatic nucleophilicsubstution, stereochemistry, pericyclic reactions and heterocyclic compounds

CO 3: To apply the knowledge and understanding in the areas of structure and reactivity, aromatic nucleophilicsubstution, stereochemistry, pericyclic reactions and heterocyclic compoundsfor solving existing challenges faced in various chemical and industrial areas

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Identify the structure and reactivity, aromatic nucleophilicsubstution, stereochemistry, pericyclic reactions and heterocyclic compounds

LO 2: Interpret structure and reactivity, aromatic nucleophilicsubstution, stereochemistry, pericyclic reactions and heterocyclic compounds.

LO3: Utilize the principles structure and reactivity, aromatic nucleophilic substution, stereochemistry, pericyclic reactions and heterocyclic compounds in understanding functions of chemical systems.

Unit-I : Structure and Reactivity(12 hours) Properties of organic molecules – concept of Aromaticity – Types – Huckel and Craig's rules – Benzenoid and non benzenoid compounds – annulenes – Hetero annulenes – fullerenes (C 60) – Types of organic reactions – Mechanisms – Energy and Kinetic aspects – Reactive Intermediates: carbanions, carbonium ions, free radicals, carbenes, nitrenes– their formation stability and reactivity – Nucleophilic substitution at a saturated carbon atom – S_N1, S_N2 and S_Ni reactions. Elimination reactions E1, E2 and E1 c B- Elimination versus substitution.

Unit-II : Aromatic Nucleophilic Substitution (12 hours) The S_NAr, benzyne and $S_{RN}1$ mechanisms. Reactivity - Effect of substrate structure, leaving group and attacking nucleophile. The von Richter, Sommelet-Hauser and Smiles rearrangements. Addition to Carbon-Carbon Multiple Bonds: Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, estersandnitriles. Addition of Grignard reagents to carbonyl and unsaturated carb onyl compounds. Wittigreaction. Mechanism of condensation reactions involving enolate anions—Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbereactions.

Unit-III : Stereochemistry (12 hours) Conformational isomerism – cyclohexanes anddecalins – optical isomerism – optical activity – molecular asymmetry and dissymmetry. Enantio and diastereo selective synthesis. Chirality – optical isomerism in biphenyls ,allenes and spirans – optical isomerism in Nitrogen compounds . Geometrical isomerism – acylic and cyclic compounds.

Unit-IV: Pericyclic Reactions (12 hours) Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3- butadiene, 1,3,5- hexatrieneand allyl system. Classification of pericyclic reactions.FMO and PMO approach. Electrocyclic reactions — conrotatory and disrotatorymotions, 4n, 4n+2 and allyl systems.Cycloadditions — antarafacial and suprafacialadditions, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropicreactions. Sigmatropic rearrangements — suprafacial and antarafacial shifts of H, sigmatropic shiftsinvolving carbon moieties, 3,3- and 5,5- sigmatropic rearrangements. Claisen, Cope and aza-Goperearrangements. Enereaction

Unit-V: Chemistry of Heterocyclic Compounds (12 hours) Synthesis and reactivity of Benzofuran, Benzothiophene, Indole, Pyrimidine, Pyrazine, Oxazole, Quinoline and Isoquinoline

Text Books:

1. A guide book to mechanisms in Organic chemistry by Peter Sykes :ELBS.

2. Organic chemistry, Vol. I (6thEdn.) and Vol. II (5thEdn .) by I.L. Finar, ELBS.

3. Organic chemistry by Mukherjee, Singh and Kapoor, Vols. I.and II, Wiley Eastern

4. Reaction mechanism in Organic chemistry by Mukerjee and Singh, Macmillan India.

5. Advanced organic chemistry by Jerry March, Wiley Eastern.

6. Chemistry of Natural Products by K.W. Bentley (Editor).

7. Stereochemistry of carbon compounds by E.Eliel, McGraw –Hill.

8. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.

9. Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	L	M	H	M	L	M	M
CO 2	M	H	L	H	M	H	L
CO 3	M	M	M	L	M	M	M

L – LOW M- MEDIUM H-HIGH

ACT 1.3: PHYSICAL CHEMISTRY–I

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT1.3	Physical Chemistry	Theory	4-0-0 (60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To develop an insightthe basic knowledge of physical chemistry

CO 2: To understand solid state chemistry, chemical kinetics and thermodynamics for chemical systems

CO 3: To apply the knowledge and understanding in the areas of solid state chemistry, chemical kinetics and thermodynamicsfor solving existing challenges faced in various chemical and industrial areas

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:Identify the solid state chemistry, chemical kinetics and thermodynamics LO 2: Interpret solid state chemistry, chemical kinetics and thermodynamics

LO 3: Utilize the principles of solid state chemistry, chemical kinetics and thermodynamics

Unit-I : Fundamentals of Solid State Chemistry (12 hours) Introduction, classification, laws of crystallography, crystallographic systems, space lattice, types of lattices, Brags Equation, Fourier synthesis, X-ray spectrometer, lane photograph, Rotating crystal method, Powder method, Neutron Diffraction, Heat capacities of solids, Molar heat capacities, application, quantum theories of specific heats (Einstein Equation, Debye equation) Born Hager cycle, cohesive energy Ionic crystal. Properties of solids, Rhedogical plastic flow and elastic its glass transition temperature.

Unit-II : Advances in Solid State Chemistry (12 hours) Defects in solids-point defects- linear defects-Frenkel&Schotky defect (Mathematical derivations). Band theory of solids- semiconductors – Extrinsic & Intrinsic non stochiometric, organic semiconductors, p-n junction, rectifiers, transistors, metal purification by zone refining, preparation of single crystals of Si &Ge (Czochralski crystal pulling method) doping, Integrated circuits.

Unit-III : Fundamentals of Chemical Kinetics (12 hours) Introduction, order, molecular its rate constant specific reaction rate, zeroth order first order second order third order rate equations (with suitable gaseous phase and liquid phase reaction determination of order of reactions (method of integrations, Time to complete definite fraction of the reactions, differential method, isolation method) opposing, reactions Hydrogen-bromine, hydrogen- chlorine reactions, consecutive reactions photolysis of acetaldehyde.

Unit-IV : Advances in Chemical Kinetics(12 hours) Theories of reaction rates-(collision and transition state teas). Fast reaction Flow systems Stoppers flow method Effect of substitute Hemet equations Taft equation primary and secondary salt effects, effect of dielectric constant of solvent, ion – ion interaction, catalysis, Acid – base Enzyme catalysis. Oscillating reactions, Autocatalysis, chemical chaos

Unit-V : Laws of Thermodynamics: (12 hours) Thermodynamic Reversibility, HeatCapacities and Heats of Reactions;Entropy Changes in Chemical Reactions; Thermodynamic Equations of State; Free Energy and Partial Molar Properties:Gibbs-Helmholtz Equations; Fugacity and Activity; Phase Equilibria; Partial Molar Quantities; Third Law of Thermodynamics: Absolute Entropy of Solids, Liquids and Gases; Cryoscopic evaluation of Absolute Entropy of Solids.

TEXT BOOKS:

1. Solid state chemistry by Kittel.
2. Chemical Kinetics- Laidiler.
3. Physical Chemistry, R. S. Berry, S. A. Rice and J. Ross, (2ndEdn), Oxford, 2007.
4. Physical Chemistry, P. Atkins and Julia de Paula, (9thEdn), Oxford, 2011.
5. Physical Chemistry, R. J.Silbey, R.A. Alberty and M. G. Bawendi, Wiley (4thEdn), 2006.
6. Thermodynamics for Chemists,S. Glasstone,East-West, 2007

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CO 2	M	L	M	L	M	H	L
CO 3	H	M	M	M	M	M	M

L – LOW M- MEDIUM H-HIGH

ACT 1.4: ANALYTICAL CHEMISTRY

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT1.4	Analytical Chemistry	Theory	4-0-0 (60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To develop an insightthe basic knowledge of analytical chemistry

CO 2: To understand errors, statistics and sampling, volumetric and gravimetric analysis, applied analysis, electroanalytical methods

CO 3: To apply the knowledge and understanding in the areas of errors, statistics and sampling, volumetric and gravimetric analysis, applied analysis, electroanalytical methodsfor solving existing challenges faced in various chemical and industrial areas

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:Identify the errors, statistics and sampling, volumetric and gravimetric analysis, applied analysis, electroanalytical methods

LO 2: Interpret errors, statistics and sampling, volumetric and gravimetric analysis, applied analysis, electroanalytical methods.

LO 3: Utilize the principles of errors, statistics and sampling, volumetric and gravimetric analysis, applied analysis, electroanalytical methods

Unit-I : Errors, Statistics and Sampling (12 hours) Accuracy and precision, Error, types of error, systematic and random errors, minimization of errors, mean and standard deviations, reliability of results, confidence interval, comparison of results, student T test, F test, Comparison of two samples (Paired T test), Sampling , the basis of sampling, sampling procedure, sampling statistics.

Unit-II : Theory of Volumetric and Gravimetric Analysis (12 hours) Introduction, Titrimetric analysis, classifications of reactions in titrimetric analysis, standard solutions, preparation of standard solutions, primary and secondary standards, Indicators, theory of indicators, Acid–base titrations in non-aqueous media.Gravimetric Analysis, Impurities in precipitates, Gravimetric calculations, precipitation equilibria (Solubility product, common ion effect, stoichiometry), organic precipitation.

Unit-III : ComplexometricEquilibria (12 hours) Introduction, Titration curves, Types of EDTA titrations, Methods of End Point Detection, Types of Complexometric Titrations (a) Direct Titration (b) Back Titration (c) Replacement titration (d) Indirect Titration (e) Applications of Complexometric Titrations

Unit-IV : Applied Analysis (12 hours) Analytical procedures involved in environmental monitoring. Water quality - BOD, COD, and DO - Air pollution monitoring sampling, collection of air pollutants-SO_2, and NO_2 - Analysis of metals, alloys and minerals: Analysis of brass and steel. Analysis of limestone

Unit-V : Electroanalytical methods: (12 hours) Basic principle, instrumentation, and applications of Polargraphy,Cyclic voltammetry, anodic stripping voltametry, amperometry, and conductometry

Text Books:

1. Analytical Chemistry Principles and Techniques, L.G. Hargis, Prentice Hall, USA.

2. Instrumental methods of analysis, H.H. Willard, L.L. Merritt, Jr., J.A. Dean and F.A. Settle, Jr., Van Nostrand Reinhold Co., New York

3. Principles of instrumental analysis, D.A. Skoog, W.B. Saunders Co., New York.

4. Vogel A I; Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS

5. Vogel A I, Textbook of Practical Organic Chemistry, A. R. Tatchell, John Wiley

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CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	H	L	M	H
CO 2	M	L	L	M	M	H	M
CO 3	H	M	H	L	M	M	L
L – LOW	M- MEDIUM		H-HIGH				

ACP 1.5: INORGANIC CHEMISTRY PRACTICAL - I

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT1.5	Inorganic Chemistry-I Practical-1	Lab	4-0-0 (90)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To develop an insightinto the preparation of inorganic complexes

CO 2: To understand the process of preparation of inorganic complexes

CO 3: To acquire skills in the preparation of inorganic complexes

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:Prepare various inorganic complexes

LO 2: Develop skill in handling apparatus, measure the quantities and carryout the reaction and analyze the product formed

LO 3: Applies the skill in preparing novel complexes

Synthesis of Inorganic Complexes and their Characterization

Preparation of selectedinorganic complex compounds and their characterization Some suggested complex compounds

(1) $VO(acac)_2$

(2) $TiO(C_9H_8NO)_2.2H_2O$

(3) cis-$K[Cr(C_2O_4)_2(H_2O)_2]$

(4) $Na[Cr(NH_3)_2(SCN)_4]$

(7) $[Co(NH_3)_6][Co(NO_2)_6]$

(8) cis-$[Co(trien)(NO_2)_2]Cl.H_2O$

(9) $Hg[Co(SCN)_4]$

(10) $[Co(Py)_2Cl_2]$

(5) $Mn(acac)_3$ (11) $[Ni(NH_3)_6]Cl_2$

(6) $K_3[Fe(C_2O_4)_3]$ (12) $Ni(dmg)_2$

Text Books:

1. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham,ELBS

2. Synthesis and Characterization of Inorganic Compounds, W. L. Jolly, Prentice Hall

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	H	M	L	M	H
CO 2	M	L	M	M	M	L	M
CO 3	H	M	H	L	M	M	H
L – LOW	M- MEDIUM		H-HIGH				

ACP 1.6: ORGANIC CHEMISTRY PRACTICAL - I

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT1.1	Inorganic Chemistry-I Practical	LAB	4-0-0 (90)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To develop an insightinto the preparation of organic compounds in various reactions CO 2: To understand the process of preparation of organic through various reactions

CO 3: To acquire skills in the preparation of organic compounds, their separation, purification and identification

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:Prepare various organic compounds using various reactions

LO 2: Develop skill in handling apparatus, measure the quantities and carryout the reaction, separate the products, purify them and analyze the products formed

LO 3: Applies the skill in preparing novel organic moieties

Synthesis of Organic compounds

Synthesis, purification and characterization of about ten organic compounds involving one or two stages.

List of some suggested compounds

1. β - Napthyl methyl ether from β -Naphthol
2. m-dinitrobenzene from Nitrobenzene
3. Azodye from primary amine
4. Aromatic acid from ester
5. Benzanilide from aniline
6. p-nitroaniline from Acetanilide
7. p-Bromo acetanilide from aniline
8. Phthalimide from phthalic acid
9. 1,2,3-Tribromo benzene from aniline
10. Benzanilide from Benzophenone

Text Books:

1. A Textbook of Practical Organic Chemistry by A. I. Vogel, ELBS and Longman group.

2. Practical Organic Chemistry by Mann and Saunders, ELBS and Longman group.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	H	M	H	M	M
CO 2	M	L	M	M	M	L	L
CO 3	H	M	H	L	H	M	M
L – LOW	M- MEDIUM		H-HIGH				

ACP 1.7: PHYSICAL CHEMISTRY PRACTICAL - I

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP 1.7	Physical Chemistry Practical-I	Lab	0-0-6(90)	70	30	100	3 Hours	3

Course Objectives:

CO 1: To develop an insightinto the measurement of various quantitative characteristics of chemical systems

CO 2: To understand the process of measurement of various chemical systems

CO 3: To acquire skills in the setting up of apparatus, measurement, recording and interpretation of results related to various quantitative characteristics

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:Set up of apparatus, measurement, recording and interpretation of results related to various quantitative characteristics

LO 2: Develop skill in setting up of apparatus, measurement, recording and interpretation of results related to various quantitative characteristics

LO 3: Applies the skill in measuring the properties of other novel systems

1. Critical Solution temperature of phenol-water system; effect of Electrolyte.

2. Equilibrium constant of KI $+I_2$®KI_3.

3. Hydrolysis of an ester – A Kinetic study.

4. Dimerisation constant of benzoic acid by the distribution method (Benzene –water system)

5. Inversion of Sucrose –A kinetic study.

6. Conductometric titration of mixture of weak and strong acid with sodium hydroxide.

7. Determination of solubility product of a sparingly soluble salt by conductometric method.

Text Books:

1. Practical Physical Chemistry by Alexander .

2. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	M	M	M
CO 2	M	L	L	M	L	L	L
CO 3	H	M	M	L	M	M	M

L – LOW M- MEDIUM H-HIGH

Semester-II

ACT 2.1: INORGANIC CHEMISTRY–II

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT2.1	Inorganic Chemistry-II	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of metal-ligand equilibria, electronic spectra, ligand substitution reactions in octahedral and square planar complexes, electron transfer reactions in coordination complexes

CO 2: To understand metal-ligand equilibria, electronic spectra, ligand substitution reactions in octahedral and square planar complexes, electron transfer reactions in coordination complexes

CO 3: To apply the knowledge and understanding in the areas of metal-ligand equilibria, electronic spectra, ligand substitution reactions in octahedral and square planar complexes, electron transfer reactions in coordination complexes

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:Explain metal-ligand equilibria, electronic spectra, ligand substitution reactions in octahedral and square planar complexes, electron transfer reactions in coordination complexes

LO 2: Apply metal-ligand equilibria, electronic spectra, ligand substitution reactions in octahedral and square planar complexes, electron transfer reactions in coordination complexes

LO 3: Evaluate the metal-ligand equilibria, electronic spectra, ligand substitution reactions in octahedral and square planar complexes, electron transfer reactions in coordination complexes

Unit-I : Metal-ligand Equilibria in Solution (12 hours) Stability of binary metal complexes-thermodynamic stability and kinetic stability. Step wise and overall formation constants and their interaction, trends in stepwise stability constants. Factors influencing the stability of metal complexes with reference to metal and the ligand. Chelate effect and its thermodynamic origin. Macrocyclic effect of crown ethers and cryptates.Determination of stability constants of metal complexes-Spectrophotometric and potentiometric methods.

Unit-II : Electronic Spectra of Metal Complexes (12 hours) Term symbols – Russell – Sanders (L-S) coupling – derivation of term symbols for various configurations. Spectroscopic ground states Hund's rules to determine ordering of energy levels, Hole formalism. Selection rules- Spin selection rule and Laporte selection rule. Breakdown of selection rules.Orgel diagrams for d1 to d9 systems. Tanabe-Sugano diagrams for d2 and d6 octahedral systems. Charge transfer Spectra.

Unit-III : Ligand Substitution Reactions in Octahedral Complexes (12 hours) Transition state or activated complex –substrate –Attacking reagents: Electrophilic reagents, Nucleophilic reagents –Types of substitution of reactions (S_N) -Electrophilic or metal substitution reactions (SE). S_N1or dissociation mechanism; S_N2or association or displacement mechanism. Acid and base hydrolysis reactions of cobalt (III) complexes

Unit- 1V : Ligand Substitution Reactions in Square Planar Complexes (12 hours) The trans effect –uses of trans effect –different theories of trans effect – mechanism and the factors involved in the substitution reactions in square planar complexes

Unit-V : Electron Transfer Reactions in Coordination Complexes (12 hours) Mechanism of one electron transfer reactions –Inner sphere (atom or group transfer) mechanism –outer sphere (or Electron transfer) mechanism .Structure and bonding in some binuclear metal atom clusters

Text Books:

1. Inorganic chemistry, principles of structure and reactivity, 4thEdition by James E. Huheey: Elleu A. keiter: Richard L. Keiter.

2. Advanced inorganic chemistry by F.A.Cotton and G. Wilkinson IV Edition, John Wiley and Sons, New York, 1980.

3. Theoretical Inorganic Chemistry, II Edition by M.C. Day and J. Selbin, Affiliated EastWest press Pvt. Ltd., New Delhi.

4. Inorganic Chemistry by Shriver and Atkins, Oxford University Press (1999

5. Concepts and Models in Inorganic Chemistry byDoughlasMc Daniel.

6. Introductory Quantum Chemistry by A.K. chandra (Tata McGrawhill)

7. Chemistry of Lanthanides by T. Healler, chapman and Hall.

8. Chemical Applications of Group Theory by B.A. Cotton.

9. Inorganic Chemistry by J.E. Huheey, III Edition, Harper International Edition, 1983.

Mapping of PO/CO

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CO 2	M	L	M	M	M	L	L
CO 3	H	M	H	L	H	M	M

L – LOW M- MEDIUM H-HIGH

ACT 2.2: ORGANIC CHEMISTRY–II

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT2.2	OrganicChemistry-II	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of aliphatic and aromatic substitution, mechanisms, photochemistry and natural products, enzymes and lipids

CO 2: To understand Toacquire the basic knowledge of aliphatic and aromatic substitution, mechanisms, photochemistry and natural products, enzymes and lipids

CO 3: To apply Toacquire the basic knowledge of aliphatic and aromatic substitution, mechanisms, photochemistry and natural products, enzymes and lipids

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain To acquire the basic knowledge of aliphatic and aromatic substitution, mechanisms, photochemistry and natural products, enzymes and lipids

LO 2: Apply To acquire the basic knowledge of aliphatic and aromatic substitution, mechanisms, photochemistry and natural products, enzymes and lipids

LO 3: EvaluateTo acquire the basic knowledge of aliphatic and aromatic substitution, mechanisms, photochemistry and natural products, enzymes and lipids

Unit-I : Aliphatic and Aromatic Electrophilic Substitution: (12 hours) Bimolecular mechanisms- SE2 and SEi. The SE1 mechanism, electrophilic substitution accompanied by double bond shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.TheHaloform reaction and Haller-Bauer reaction AromaticElectrophilicSubstitution: The arenium ion mechanism, orientation and reactivity, energy profile diagrams. Theortho, para, meta orientations. Quantitative treatment of reactivity in substrates and electrophiles. Diazoniumcoupling, Vilsmeirreaction, Gattermann- Kochreaction.

Unit-II : Mechanisms of Named Reactions and Rearrangements: (1 2 hours) Favorskii, Wagner-Meerwein, Neber, Hofmann, Schmidt, Lossen, Curtius,Beckmann, Baeyer- Villiger, Fries,Stevens, Wittig rearrangements - Michael and Mannich reactions-Pinacol- Pinacolone, Baylis-Hillman reaction, Biginelli reaction.

Free Radical Reactions: Basic concept of free radical formation, their stability and their reactions. Polymerization ,Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation,coupling of alkynes and arylation of aromatic compounds by diazonium salts. Sandmeyer reaction.Free radical rearrangement. Hunsdieckerreaction.

Unit-III : Organic Photochemistry: (12 hours) Jablonski diagram-cis-trans isomerism, Paterno-Buchi reaction, Norrish Type I and II reactions-Barton reaction- photoreduction of ketones - di-pi methane rearrangement. photochemistry of arenes.

Unit-IV : Chemistry of Natural Products:(12 hours) Classification, Isolation, synthesis and structural elucidation of the following.

Terpenoids : Camphor, α Pinene and Santonin

Alkaloids : Nicotine, Quinine and Atropine.

Purines : Caffeine

Steroids : Cholesterol

Unit-V : Bio-Organic Chemistry: (12 hours) Enzymes:Introduction, enzymes, mechanism of enzyme action, kinds of reactions catalysed by enzymes, co-enzymes, biomimetic chemistry and biotechnological applications of enzymes

Lipids: Lipid classification, brief account of the chemical properties and structure of lipids (without structure elucidation) & biological role of the following: fatty acids, acyl glycerols, phospholipids, plasmalogens, sphingolipids, glycolipids, steroids, eicosanoids - prostaglandins, thromboxanes, &leukotrienes, leptin and visfatin.

Text Books:

1. A Guide book to Mechanisms in Organic Chemistry by Peter Sykes :ELBS.
2. Organic chemistry, Vol. I (6thEdn.) and Vol. II (5thEdn .) by I.L. Finar, ELBS.
3. Organic chemistry by Mukherjee, Singh and Kapoor, Vols. I.and II, Wiley Eastern
4. Reaction mechanism in Organic chemistry by Mukerjee and Singh, Macmillan India.
5. Advanced organic chemistry by Jerry March, Wiley Eastern.
6. Chemistry of Natural Products by K.W. Bentley (Editor).
7. Stereochemistry of carbon compounds by E.Eliel, McGraw –Hill.
8. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.
9. Biochemistry; Voet, D. and Voet, J.G. [Eds.] 3rd Ed. Jhon Wiley and sons, (1999)
10. Principles of Biochemistry; Smith et al., McGarw Hill (1986).

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	L	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 2.3: PHYSICAL CHEMISTRY–II

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT2.3	Physical Chemistry-II	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of photochemistry, electrochemistry, catalysis and molecular spectroscopy

CO 2: Tounderstand photochemistry, electrochemistry, catalysis and molecular spectroscopy

CO 3: To apply photochemistry, electrochemistry, catalysis and molecular spectroscopy

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain photochemistry, electrochemistry, catalysis and molecular spectroscopy LO 2: Apply photochemistry, electrochemistry, catalysis and molecular spectroscopy LO 3: Evaluatephotochemistry, electrochemistry, catalysis and molecular spectroscopy

Unit-I : Photochemistry: (12 hours) Consequences of light absorption – quantum yield and its determinations – fluorescence , phosphorescence and sensitized fluorescence – photolysis of aldehydes and ketones photochemical reactions between hydrogen and halogens – photosynthesis – flash photolysis

Unit-II : Electrochemistry: (12 hours) Interionic attraction theory of Debye and Huclel – Onsagor's modification - determination of activity coefficients from EMF 's of reversible cells – concentration cells with and with out transference, liquid junction potentials – applicability to hydration numbers – determination of thermodynamic data from EMF measurements – primary cells fuel cells – photoelectrochemical cells .

Unit-III : Surface Chemistry: (12 hours) Adsorption of gages by solids – Langmuir, Freundlich and B-E-T isotherms – applicability to heterogeneous catalysis – determination of surface area of adsorbents – Electrokinetic phenomena – Donnan membrane equilibrium – emulsions .

Unit-IV : Catalysis: (12 hours) Homogneous and Heterogeneous catalysis, Theories of catalysis, Acid – base catalysis , Autocatalysis, Enzyme catalysis, Activated complex theory Michaelis – Menten catalysis and its mechanism.

Unit-V : Molecular Spectroscopy: (12 hours) Electromagnetic radiation – rotation and vibration of diatomic molecules- selection rules – rotation of polyatomic molecules – microwave spectroscopy – vibration of polyatomic molecules infrared and Raman spectroscopy

Text Books:

1. Physical chemistry – S. Glasstone (Macmillan)
2. Physical chemistry – W.J. Moore (Orient Longmans)
3. Physical chemistry – G.M. Barrow (McGraw – Hill)
4. Physical chemistry - S.A. Maron –Prutton (Collier – Macmillan)
5. Physical chemistry – G.W. Castellan (Addison – Wesley)

6. Thermodynamics – N.V.Rao (Macmillan)
7. Molecular Spectroscopy –C.N. B.anwell (Tata McGraw-Hill)

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	L	M
CO 3	H	M	M	L	M	M	H
L – LOW	M- MEDIUM		H-HIGH				

ACP 2.5: INORGANIC CHEMISTRY PRACTICAL - II

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP2.5	Inorganic Chemistry Practical-II	Lab	0-0-6(90)	70	30	100	3 Hours	3

Course Objectives:

CO 1: To develop an insightinto the analysis of inorganic salt mixtures

CO 2: To understand the process of analysis of inorganic salt mixtures

CO 3: To acquire skills in the analysis of inorganic salt mixtures

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1:analyse of inorganic salt mixtures

LO 2: Develop skill in analysis of inorganic salt mixtures

LO 3: Apply the skill in the analysis of new inorganic salt mixtures

Analysis of inorganic salt mixtures

(minimum four mixtures)

Semi-micro qualitative analysis of six radical mixtures containing one interfering radical and one less familiar cationeach .

Study of Systematic procedure Spot tests.

Text Books

text book of Practical Inorganic Chemistry by AI Vogel, ELBS 2.Laboratory manual of Engineering Chemistry by Dr Sudha rani

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	M	M	M
CO 2	M	L	H	M	H	L	L
CO 3	H	M	M	L	M	M	M
L – LOW	M- MEDIUM		H-HIGH				

ACP 2.6: ORGANIC CHEMISTRY PRACTICAL - II

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP2.6	Organic Chemistry Practical-II	Lab	0-0-6(90)	70	30	100	3 Hours	3

Course Objectives:

CO 1: To develop an insightinto the identification of organic compounds by systematic analysis

CO 2: To understand the process of identification of organic compounds by systematic analysis

CO 3: To acquire skills in the identification of organic compounds by systematic analysis

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Identify an organic compounds by systematic analysis

LO 2: Develop skill in identification of organic compounds by systematic analysis

LO 3: Apply the skill in the identification of new organic compounds by systematic analysis

Identification of the unknown organic compounds

Systematic identification of organic compounds –preliminary tests, detection of extra elements, solubility, common functional group tests (determination of functional group/s in a single compound, if present),preparation of two rational derivatives

The given organic compound be identified by comparingthe melting point /Boiling point of the compound and the melting points of its derivatives with the literature

List of suggested compounds

Glucose, fructose, benzaldehyde, p-anisaldehyde, p-chlorobenzaldehyde, acetophenone, phenol, cresols, naphthols, esters, p-chlorobenzoic acid, aniline, p-tolune, p-anisidine, p- chloroaniline, diphenyl amine, N,N-dimethylaniline, benzamide, p-bromoacetanilide, naphthalene and anthracene.

TEXT BOOKS

1. A. I. Vogel, A Textbook of Practical Organic Chemistry, ELBS and Longman group.

2. F. G. Mann and B. C. Saunders, Practical Organic Chemistry, ELBS and Longman group.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	H	L
CO 3	H	M	M	L	M	M	M

L – LOW M- MEDIUM H-HIGH

ACP 2.7: PHYSICAL CHEMISTRY PRACTICAL - II

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP2.7	Physical Chemistry Practical-II	Lab	0-0-6(90)	70	30	100	3 Hours	3

Course Objectives:

CO 1: To develop an insightinto the various experimental techniques related to distribution, heat of a reaction, adsorption, binary mixtures, phase diagrams

CO 2: To understand the process of various experimental techniques related to distribution, heat of a reaction, adsorption, binary mixtures, phase diagrams

CO 3: To acquire skills in the various experimental techniques related to distribution, heat of a reaction, adsorption, binary mixtures, phase diagrams

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Carryout various experimental techniques related to distribution, heat of a reaction, adsorption, binary mixtures, phase diagrams

LO 2: Develop skill in various experimental techniques related to distribution, heat of a reaction, adsorption, binary mixtures, phase diagrams

LO 3: Apply the skill in various experimental techniques related to distribution, heat of a reaction, adsorption, binary mixtures, phase diagrams for various new systems

List of Experiments:

1. Formula of Cuprammoniumcation –distrubition method.
2. Heat of Neutralisation .
3. Heat of solution.
4. Study of the adsorption of oxalic acid on charcoal.
5. Study of binary liquid mixture involving azeotrope .
6. Study of a two component system involving eutectic or compound formation .
7. Phase diagram of a three component system (chloroform –acetic acid – water)

Text Books:

1. Practical Physical Chemistry by Alexander

2. Vogel's Textbook of Quantitative Analysis, revised, J. Bassett, R. C. Denney, G. H. Jeffery and J. Mendham, ELBS

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CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
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L – LOW M- MEDIUM H-HIGH

SEMESTER-III

ACT 3.1: INSTRUMENTAL METHODS OF ANALYSIS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 3.1	Instrumental Methods of Analysis	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire basic knowledge of various instrumental methods of analysis

CO 2: To understand various instrumental methods of analysis

CO 3: To applyvarious instrumental methods of analysis

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain visible spectrophotometry, chromatography, ion-exchange, thermal and image analysis techniques

LO 2: Apply visible spectrophotometry, chromatography, ion-exchange, thermal and image analysis techniques

LO 3:Evaluatevisible spectrophotometry, chromatography, ion-exchange, thermal and image analysis techniques

Unit I: UV-Visible Spectrophotometry: (12 hours) Principle, Beer -Lambert Law, instrumentation,advantages, applications and limitations of Spectrophotometery, single and double beamspectrophotometersAtomic absorption spectrometery (AAS), Flame photometry (AES)- Basic principles, theory, instrumentation and applications

Unit II: : Chromatography: (12 hours) Chromatography :Introduction to chromatography, Basic principles, instrumentation and Applications ofdifferent chromatography techniques (TLC, column chromatography, paper chromatography, Gas chromatography and HPLC).

Unit III: : Ion-Exchange Methods: (12 hours)

General discussion, Typical synthetic Cation and Anionexchange resins. Action of ion exchange resins. Ion-exchange equilibria, Ion-exchange capacity, Determination of cation and anion exchange capacity, Columnoperation and ion exchange chromatography

Unit IV: Thermal Methods of Analysis (12 hours) Principles, Instrumentation, Comparison andinterpretation of TGA and DTG curves, TGA curves of mixtures, Factors affectingTGA curves, Applications of TGA. Differential Thermal Analysis and DifferentialScanning Calorimetry - Principles, Instrumentation and quantitative aspects of DTAand DSC curves; Interpretation of DTA and DSC curves.

Unit V: Image Analysis Techniques: (12 hours) Principle & applications of Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy and X-ray Diffraction Analysis.

Text Books:

1. Vogel's Text book of quantitative chemical analysis; G. H. Jeffery et. al. Addison Wesley Longman

2. Instrumental methods of analysis, H.H. Willard, L.L. Merritt, Jr., J.A. Dean and F.A. Settle, Jr., Van Nostrand Reinhold Co., New York

3. Modern analytical chemistry; David Harvey; McGraw Hill

4. Principles and practice of analytical chemistry; F. W. Fifield& D. Kealey, BlackwellScience

5. Automatic methods of analysis, M. Valcarcel, M. D. Luque de Castro, Elsevier, Vol. 9

6. Principles of Instrumental Analysis, Skoog, Holler and Wieman, Harcount Asia,

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CO 3	H	M	M	L	M	H	H

L – LOW M- MEDIUM H-HIGH

ACT 3.2: ORGANIC SPECTROSCOPY

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT3.2	Organic Spectroscopy	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire basic knowledge of spectroscopic techniques for organic analysis

CO 2: To understand various spectroscopic techniques for organic analysis

CO 3: To applyvarious spectroscopic techniques for organic analysis

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain IR, UV, NMR and Mass spectroscopic techniques and their instrumentation for organic analysis

LO 2: Apply visible IR, UV, NMR and Mass spectroscopic techniques and their instrumentation for organic analysis

LO 3: EvaluateIR, UV, NMR and Mass spectroscopic techniques and their instrumentation for organic analysis

Unit I: Infrared Spectroscopy: (12 hours) Units of frequency, wave length and wave number-molecular vibrations-modes.Factors influencing vibrational frequencies of organic molecules.Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance.Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines.Detailed study of vibrational frequencies of carbonyl compounds (ketones, afdehydes, esters, amides, acids, anhydrides, lactones, lactams and conjugated carbonyl compounds). Interpretation of spectra.

Unit II: Ultraviolet Spectroscopy: (12 hours) Introduction ,the absorption laws, measurement of the spectrum, chromophores, standard works of reference, definitions, applications of UV spectroscopy to conjugated dienes,trienes, unsaturated carbonyl compounds and aromatic compounds. Optical rotatory dispersion and circular dichroism: Phenomena of ORD and CD. Classification of ORD and CD Curves; Cotton effect curves and their application to stereochemical problems; the Octant rule and its application to alicyclic ketones.

Unit III: NMR Spectroscopy: (12 hours) Nuclear Magnetic Resonance - Introduction , basic principles, the chemical shift, the intensity of NMR signals - factors affecting the chemical shifts- spin-spin coupling. some simple splitting patterns- the magnitude of coupling constants-first order spectrum-interpretation of spectra . Chemical shift reagents- nuclearOverhauser effect (NOE).The Fourier transform technique. Structure determination of organic compounds by 1 H NMR spectra.

Unit IV: Multinuclear ^{1}H NMR and ^{13}C NMR: (12 hours) Proton coupled, off resonance decoupled, proton noise decoupled ^{13}C NMR spectra. Assignment of chemical shifts, additively effect, characteristic chemical shifts of common organic compounds and functional groups, The DEPT experiment.2D NMRtechniques :1H – 1H COSY, 1H – 13C COSY – HMBC, and NOESY.

Unit V: Mass Spectroscopy: (12 hours) Basic principles, mass analyzers, ionization methods: EI, CI, FAB, MALDI, ES. Liquid chromatography and mass spectrometry, types of ions and fragmentations, even electron rule, nitrogen rule, isotope abundance, McLafferty rearrangement.Organic structure elucidation, techniques of ion production, ion and daughter ions, molecular ion and isotope abundance. Nitrogen rule energetics of fragmentation, metastable ions, common fragmentation pathways, fragmentation pattern of common chemical classes. Interpretation of spectra .

Text Books:

1. Spectroscopic methods in Organic chemistry , Forth Edition D.Mwilliams and I.Flemings Tata –McGraw Hill , New Delhi
2. Organic Spectroscopy ,W.Kemp ,ELBS Macmillan
3. Applications of absorption of Spectroscopy of Organic compounds J.R.Dyer, prentice Hall of India ,New Delhi ,1984 .
3. Spectrometric identification of Organic Compounds , Sixth Edition, R.M Silverstein ;F.X.Webster ,Johne Willey ,Singapore.
4. D. L. Pavia, G. M. Lampman and G. S. Kriz, Introduction to Spectroscopy, 2ndEdn, Saunders
5. C. N. Banwell, Fundamentals of Molecular Spectroscopy, 4th Edition Tata McGraw Hill, 2016
6. A. Carrington and Machlachlon, Magnetic Resonance, Harper & Row, 1967.
7. G. M. Barrow, Introduction to Molecular Spectroscopy, McGraw Hill, 1964.
8. J. MichealHollas, Modern Spectroscopy, 4th Edition, Wiley India Pvt Ltd, 2010
9. Harald Gunther, NMR Spectroscopy: Basic Principles, Concepts and Applications inChemistry, 2nd Edition, Wiley India Pvt Ltd, 2010

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CO 1	H	M	M	M	M	M	M
CO 2	M	L	H	M	H	L	L
CO 3	H	M	M	L	M	M	M
L – LOW	M- MEDIUM		H-HIGH				

ACT 3.3: ORGANIC SYNTHESIS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT3.3	Organic Synthesis	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire knowledge offormation of C-C, C=C bonds, synthetic applications, oxidation and reduction, design of organic synthesis and organometallic chemistry

CO 2: To understand formation of C-C, C=C bonds, synthetic applications, oxidation and reduction, design of organic synthesis and organometallic chemistry

CO 3: To apply formation of C-C, C=C bonds, synthetic applications, oxidation and reduction, design of organic synthesis and organometallic chemistry

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain formation of C-C, C=C bonds, synthetic applications, oxidation and reduction, design of organic synthesis and organometallic chemistry

LO 2: Apply formation of C-C, C=C bonds, synthetic applications, oxidation and reduction, design of organic synthesis and organometallic chemistry

LO 3: Evaluateformation of C-C, C=C bonds, synthetic applications, oxidation and reduction, design of organic synthesis and organometallic chemistry

Unit I: Formation of Carbon–Carbon Single Bonds and Double Bonds: (12 hours) Alkylation via enolate, the enamine and related reactions, Umpolung (dipole inversion) – the Aldol reaction – Applications of Organo-palladium, Organo-nickel and Organo-copper reagents –Phosphorous and Sulphur ylides - â-Elimination reactions, Pyrolyticsyn eliminations, Sulphoxide–sulphenate Rearrangement - the Wittig and related reactions- alkenes from Arylsulphonylhydrazones – Claisen rearrangement of allyl vinyl ethers.

Unit II: Synthetic Applications of OrganoBoranes and Organo Silanes (12 hours) Organo Boranes: Preparation of organoboranesviz hydroboration with BH_3–THF, Dicylohexylborane, Disiamylborane, Thexylborane, 9-BBN and Di-isopinocampheylborane. Functional group transformations of organoboranes: oxidation, protonolysis and rearrangements, Formation of carbon-carbon bonds vizorganoboranescarbonylation, the cyanoborate process and reaction of alkenylboranes. OrganoSilanes: Synthetic applications of trimethylsilylchloride, dimethyl–t-butylsilyl chloride, trimethylsilylcyanide, trimethylsilyliodide and trimethylsilyltriflate. Synthetic applications of á-silylcarbanions and â-silylcarboniumions.

Unit III: Oxidation and Reduction: (12 hours) Oxidations of hydrocarbons, alkenes, alcohols aldehydes and ketones oxidative coupling reactions. Use of $Pb(OAc)_4$,NBS, CrO_3, SeO_2, MnO_2,Alkoxyluphonium salts, $KMnO_4$,OsO_4, RuO_4, Peracid and Tl(III)nitrate.Metal based and non-metal based oxidations of alcohols (chromium, manganese, silver, ruthenium, DMSO, and hypervalent iodine). (b) Peracidsoxidation of alkenes and carbonyls. (c) Alkenes to diols (manganese, osmium based), alkenes to carbonyls with bond cleavage (manganese, ruthenium, and lead based, ozonolysis), and alkenes to alcohols/ carbonyls without bond cleavage (hydroboration-oxidation, Wacker oxidation, and selenium based allylic oxidation). (d) Asymmetric epoxidations (Sharpless, Jacobsen, and Shi epoxidations) and Sharpless asymmetric dihydroxylation.

Reduction: (a) Catalytic homogeneous and heterogeneous hydrogenation, Wilkinson catalyst. (b) Metal based reductions using Li/Na in liquid ammonia, sodium, magnesium, zinc, titanium, and samarium. (c) Hydride transfer reagents: NaBH4, L-selectride, K-selectride, Luche reduction, LiAlH4, DIBAL-H, Red-Al, Trialkylsilanes, and Trialkylstannane. (d) Enantioselective reductions (Chiral Boranes, Corey-Bakshi-Shibata) and Noyori asymmetric hydrogenation.Catalytic hydrogenation (homogeneous and heterogeneous), Reduction by dissolving metals, Reduction by Hydride Transfer Reagents, Reduction with Hydrazine and Diimide, Selectivity in reduction of nitroso and nitro compounds, Reductive cleavage .

Unit IV: Design of Organic Synthesis (12 hours) Concepts of Linear Synthesis and Convergent Synthesis - Basic principles and terminology of retrosynthesis - the disconnection approach, synthesis of aromatic compounds, one group and two group C-X disconnections, one group C-C and two group C-C disconnections, amine and alkene synthesis, important strategies of retrosynthesis, functional group transposition, important functional group interconversions Protecting groups: Protection and deprotection of hydroxy, carboxyl, carbonyl, carboxy amino groups and carbon-carbon multiple bonds; chemo- and regioselective protection and deprotection; illustration of protection and deprotection in synthesis.

Unit-V : Organometallic Chemistry: (12 hours) Introduction to organometallic compounds, the 18 electron rule, types of ligands (neutral, spectator ligands, alkenes and alkynes), metal-metal bonds, metal carbonyls , reactions of organometallic compounds (ligand substitution reactions), metal clusters Catalytic reactions of organometallic compounds and isolobal analogy, Sandwich compounds and IR applications in the organometallic compounds.

TEXT BOOKS

1. W.Carruthers & Lain Coldham, Modern Methods of Organic Synthesis, Cambridge
2. H. O. House, Modern Synthetic Reactions, W A Benzamin,
3. Robert E, Ireland, Organic Synthesis, Prentice Hall
4. S. WarrenDesigning Organic Synthesis, Wiley
5. S. Warren & P. Wyatt, Workbook for Organic Synthesis - The disconnection Approach (2nd Edition), Wiley

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 3.4 Elective: MEDICINAL CHEMISTRY

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 3.4 Elective	Medicinal Chemistry	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: Toacquire basic knowledge of drug design, pharmacokinetics and pharmacodynamics, and various classes of drugs

CO 2: To understand drug design, pharmacokinetics and pharmacodynamics, and various classes of drugs

CO 3: To applydrug design, pharmacokinetics and pharmacodynamics, and various classes of drugs

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain drug design, pharmacokinetics and pharmacodynamics, and various classes of drugs

LO 2: Apply drug design, pharmacokinetics and pharmacodynamics, and various classes of drugs

LO 3: Evaluatedrug design, pharmacokinetics and pharmacodynamics, and various classes of drugs

Unit I: Drug Design (12 hours) Development of new drugs, procedures followed in drug design,concepts of lead compound and lead modification, concepts of pro-drugs and soft- drugs, structure activity relationship (SAR), factors affecting bioactivity, resonance,inductive effect, isosterism, bio-isosterism, spatial considerations. Theories of drugactivity: occupancy theory, rate theory, induced fit theory. Quantitative structureactivity relationship.History and development of QSAR.Concepts of drug receptors.Elementary treatment of drug receptor interactions.Physico-chemical parameters:lipophilicity, partition coefficient, electronic ionization constants, steric, Shelton andsurface activity parameters and redox potentials. Free-Wilson analysis, Hanschanalysis, relationships between Free-Wilson and Hansch analysis.LD-50, ED-50.

Unit II: Pharmacokinetics and Pharmacodynamics (12 hours) Introduction to drug absorption, disposition, elimination usingpharmacokinetics, important pharmacokinetic parameters in defining drug dispositionand in therapeutics. Mention of uses of pharmacokinetics in drug development process.Introduction, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides, membrane active drugs, drug metabolism, xenobiotics, biotransformation, significance of drug metabolism in medicinalchemistry.

Unit III: Antineoplastic Agents: (12 hours) Introduction, cancer chemotherapy, special problems, role ofalkylating agents and antimetabolites in treatment of cancer. Mention of carcinolyticantibiotics and mitotic inhibitors.Synthesis of mechlorethamine, cyclophosphamide, melphalan, uracil, mustards and 6-mercaptopurine. Recent development in cancer chemotherapy. Hormone and naturalproducts.

Unit IV: Cardiovascular Drugs:(12 hours) Introduction, cardiovascular diseases, drug inhibitors ofperipheral sympathetic function, central intervention of cardiovascular output. Directacting arteriolar dilators.Synthesis of amyl nitrate, sorbitrate, verapamil, methyldopa,atenolol, oxyprenolol.

Unit V: Local Anti-infective Drugs and Antibiotics (12 hours) Introduction and general mode of action.Synthesis of sulphonamides, furazolidone, nalidixic acid, ciprofloxacin, dapsone, amino salicylic acid, isoniazid, ethionamide, griseofulvin and chloroquin. Cell wall biosynthesis, inhibitors, â-lactam rings, antibiotics inhibitingprotein synthesis. Synthesis of penicillin G, amoxycillin, chloramphenicol, cephalosporin, tetracyclin and streptomycin.

TEXT BOOKS

1. Introduction to Medicinal Chemistry, AGringuage, Wiley-VCH.

2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed Robert F.Dorge.

3. An Introduction to Drug Design, S. S. Pandeya and J. R. Dimmock, New Age International.

7. 4: Burger's Medicinal Chemistry and Drug Discovery, Vol-1 (Chapter.-9 and Ch-14), Ed. M. E. Wolff, John Wiley.

4. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.

5. The Organic Chemistry of Drug Design and Drug Action, R. B. Silverman, Academic Press.

8. 7 Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.

9. Textbook of Organic Medicinal and Pharmaceutical Chemistry (11th ed.)- Wilson and Gisvold's.

10. Introduction to medicinal chemistry, Alex Gringauz-1996

11. A Book of Medicinal Chemistry; (second edition) D. Srirm and P. Yogeswari, published by pearson education.

Mapping of PO/CO

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CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 3.4 Elective: ENERGY SYSTEMS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 3.4 Elective	Energy Systems	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire basic knowledge of thermal energy, chemical energy, batteries, fuel cells, solar energy and other sources of energy

CO 2: To understand thermal energy, chemical energy, batteries, fuel cells, solar energy and other sources of energy

CO 3: To applythermal energy, chemical energy, batteries, fuel cells, solar energy and other sources of energy to novel applications

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain thermal energy, chemical energy, batteries, fuel cells, solar energy and other sources of energy

LO 2: Apply thermal energy, chemical energy, batteries, fuel cells, solar energy and other sources of energy

LO 3: Evaluatethermal energy, chemical energy, batteries, fuel cells, solar energy and other sources of energy

Unit I: Thermal Energy (12 hours) Coal-Ranking of coal –analysis (proximate and ultimate) calorific value and determination (Bomb calorimeter method) COKE –Manufacture –Otto Hoffmann ' s process – Applications.

Unit II: Chemical Energy (12 hours) a) Electrode potential and cells: Introduction, Nernst equation , classification of cells- primary, secondary and concentration cells, reference electrodes–calomel electrode and Ag/AgCl electrode, ion-selective electrode- glass electrode, determination of pH using glass electrode, applications of these electrodes in determining strength of acids, bases and red-ox reactions, numerical problems,Energy storage devices : Primary cells – Carbon Zinc cells –Alkaline cells –Lithium cells - Secondary cells.

b) Batteries -Basic concepts, battery characteristics, classification of batteries– primary, secondary and reserve batteries, modern batteries - construction, working and applications of zinc–air, nickel-metal hydride , Li-MnO_2 batteries, Lead acid batteries and Nickel –Cadmium Batteries. Advances in Batteries. Lead acid storage devises – Lithium –ion batteries . Reserve batteries –silver chloride cell –Fused Electrolyte cell0

Unit III: Fuel Cells (12 hours) Introduction –development –principle – advantages –limitations .Components of a Fuel cell – Alkaline Fuel cells – molten carbonate Fuel cells – Phosphoric acid Fuel cells –ion exchange membrane Fuel cells –Biochemical Fuel cells-Advances in Fuel and bio fuel cells

Unit IV: Nuclear Energy (12 hours) Fission and fusion –Power reactors – Atomic pile-Breeder reactors applications-Disposal of Radioactive wastes.

Unit V: Solar Energy (12 hours) Introduction – production of electricity using solar energy –photovoltaic cells (Solar cells) power from Indirect solar energy –Hydropower Biomass energy –wind power Applications. Photovoltaic cells: Production of solar grade silicon, physical and chemical properties of silicon relevant to photovoltaic's, doping of silicon, construction and working of a PV- cell and uses. Advances in photovoltaic cells

Unit V: Other Sources of Energy (12 hours) Wind Energy, Geothermal energy, Tidal power - Introduction production Applications – Developments in Energy Sources

TEXT BOOKS

1. A text book of Engineering Chemistry by S.S.Dara –S.Chand&Co.New Delhi

2. Engineering Chemistry by B.Sivasankar- The McGraw Hill

3. A text book of Engineering Chemistry by B.K.Sharma –Krishnaprakasan, Meerut.

4. Nuclear Chemistry – Principles and Applications by G R Choppin and J Rydberg

Mapping of PO/CO

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CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 3.4 Elective : SURFACE CHEMISTRY& CATALYSIS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 3.4 Elective	Surface Chemistry & Catalysis	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire basic knowledge of surface phenomena, adsorption, surface active agents, heterogeneous catalysis and catalyst characterization

CO 2: To understand surface phenomena, adsorption, surface active agents, heterogeneous catalysis and catalyst characterization

CO 3: To apply surface phenomena, adsorption, surface active agents, heterogeneous catalysis and catalyst characterization

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain surface phenomena, adsorption, surface active agents, heterogeneous catalysis and catalyst characterization

LO 2: Apply surface phenomena, adsorption, surface active agents, heterogeneous catalysis and catalyst characterization

LO 3: Evaluate surface phenomena, adsorption, surface active agents, heterogeneous catalysis and catalyst characterization

Unit I: Surface Phenomena: (12 hours) Structure of clean surfaces; Notation of surface structure; Structure of adsorbate layers; Stepped surfaces; Surface relaxation and reconstruction; Dynamics and energetics of surfaces.

Unit II: Adsorption: (12 hours) Adsorption: (a)Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation), (b) Adsorption at interfaces- at solid/ liquid, liquid/gas and liquid/liquid interfaces; Gibbs adsorption isotherm, effect of electrolyte on the surface energy of ionic surfactants, estimation of surface area (BET equation), surface films on liquids (Electro-kinetic phenomenon), catalytic activity at surfaces.

Unit III: Surface Active Agents: (12 hours) General structural features and behavior of surfactants; classification of surface active agents, micellization, hydrophobic interaction, critical micellar concentration (CMC), factors affecting the CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization - phase separation and mass action models, solubilization, micro emulsion, reverse micelles.

Unit IV: Heterogeneous Catalysis: (12 hours) Adsorption isotherms, surface area, pore size and acid strength measurements; acidic/ basic sites; Porous solids; Catalysis by metals/metal-oxides, semiconductors and solid acids; Supported metal catalysts; Catalyst preparation, deactivation and regeneration. Model catalysts: Ammonia synthesis; Hydrogenation of carbon monoxide; Hydrocarbon conversion.

Unit I: Catalyst Characterisation: (12 hours) Instrumental methods of catalyst characterization: Diffraction and thermal methods; spectroscopic and microscopic techniques.

TEXT BOOKS:

1. D.K. Chakrabarty and B. Viswanathan, Heterogeneous Catalysis, New Age, 2008.

2. G.A. Somorjai, Y. Li , Introduction to Surface Chemistry and Catalysis, Wiley, 2010.

3. Physical chemistry of surfaces by Arthur W. Adamson 1990

4. Chemical kinetics and catalysis by R.I. Masel, Wiley-Interscience, 2001.

5. The chemical physics of surfaces by Roy S. Morrison, S. Roy, 1990.

Mapping of PO/CO

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CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 3.5: RESEARCH METHODOLOGY

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 3.5	Research Methodology	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of introduction to research, literature review, research proposal, data collection and research report preparation and research evaluation

CO 2: To understand introduction to research, literature review, research proposal, data collection and research report preparation and research evaluation

CO 3: To apply introduction to research, literature review, research proposal, data collection and research report preparation and research evaluation

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain introduction to research, literature review, research proposal, data collection and research report preparation and research evaluation

LO 2: Apply introduction to research, literature review, research proposal, data collection and research report preparation and research evaluation

LO 3: Evaluateintroduction to research, literature review, research proposal, data collection and research report preparation and research evaluation

Unit I: Introduction to Research: (12 hours) Meaning of research problem, Sources of research problem, CriteriaCharacteristics of a good research problem, Errors in selecting a research problem, Scopeand objectives of research problem.Approaches of investigation of solutions for research problem, data collection, analysis,interpretation, Necessary instrumentations

Unit II: Literature Review and Research Gaps: (12 hours) Survey of Literature including Patents – Chemical Nomenclature – Primary and Secondary sources including Reviews, Treatises and Monographs - Abstraction of a Research Paper – Possible ways of getting familiar with Current literature – Art of Literature Review and Writing Review Articles

Unit III: Research Problem and Research Proposal: (12 hours) Identification of Research Problem – Factors influencing selection of problems Statement and Development of a Research Problem – Analysis and Interpretation of Research Proposal and Finalization of a Research Topic

Unit IV: Errors, Statistics and Sampling Techniques: (12 hours) Classification of Errors, Accuracy, Precision; Minimization of Errors, Mean Deviation, Standard Deviation, Distribution of Random Errors. The basics of Sampling, Sampling Procedure, Sampling Statistics, Sampling Physical State, Crushing and Grinding, Hazards in sampling

Unit V: Research Report and Publication of Results: (12 hours) Effective technical writing, how to write a Research Report (Dissertation/ Thesis), Research Paper Writing - Developing a Research Report, Format of Research Report, Presentation and Assessment by a Review Committee - Plagiarism and Ethical issues - Evaluation of Research

Text Books:

1. Wayne Goddard and Stuart Melville - Research Methodology: An Introduction

2. Ranjit Kumar, Research Methodology: A Step by Step Guide for beginners 2nd Edition

3. C R Kothari - Research Methodology: Methods and Techniques (2nd Revised Edition) New Age International (P) Limited, Publishers, New Delhi, 1990

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M
L – LOW	M- MEDIUM		H-HIGH				

ACT 3.6: MOOC COURSE

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT3.6	MOOC Course	ONLINE	0-4-0(60)	100	-	100	As per thecourse	3

Course Objectives:

CO 1: To acquire the basic knowledge of an advanced area in chemistry through MOOC programmes offered by NPTEL-SWAYAM/ COURSERA, etc.

CO 2: To appreciatethe advantages of learning by online mode CO 3: To advance the knowledge in the areas of interest

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Successfully complete the course as per his/ her choice LO 2: Produce his/ her continuous performance report

LO3: Produce his mastery of the course by providing the pass certificate with the grade/score awarded by MOOC Course Organiser

NOTE: The Student has to submit the E-verifiable certificate given by NPTEL to the Department to award marks

Reference: https://nptel.ac.in/about_nptel.html#E regarding certification process

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CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M
L – LOW	M- MEDIUM		H-HIGH				

ACP3.7: QUANTITATIVE ANALYSIS PRACTICAL -I

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP 3.7	Quantitative Analysis Practical - I	Lab	0-0-6(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of quantitative analysis of vanadium, cerium, iron, copper, chromium, calcium, zinc and chlorides by various analytical methods

CO 2: To understand quantitative analysis of vanadium, cerium, iron, copper, chromium, calcium, zinc and chlorides by various analytical methods

CO 3: To apply quantitative analysis of vanadium, cerium, iron, copper, chromium, calcium, zinc and chlorides by various analytical methods

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain quantitative analysis of vanadium, cerium, iron, copper, chromium, calcium, zinc and chlorides by various analytical methods

LO 2: Apply quantitative analysis of vanadium, cerium, iron, copper, chromium, calcium, zinc and chlorides by various analytical methods

LO 3: Acquire skill in quantitative analysis of vanadium, cerium, iron, copper, chromium, calcium, zinc and chlorides by various analytical methods systematically and accurately

VOLUMETRIC ANALYSIS

1. Preparation of vanadium(V) from ammonium metavanadate and standardisation of vanadium(V) with iron(II)

2. Preparation of cerium (IV) sulphate from cerium(IV) oxide and standardization of cerium (IV) sulphate with iron(II)

3. Determination of iron(III) by photo chemical reduction method.

4. Determination of iron(III) and iron(II) present in a synthetic mixture (stannous chloride method).

5. Determination of copper(II) present in a brass sample (iodometric method)

6. Determination of chromium(IV)present in a sample of potassium dichromate.

7. Determination of calcium hardness and magnesium hardness of water sample.

8. Determination of zinc byferrocyanide.

9. Determination of chloride in a sample of water(silver nitrate method).

TEXT BOOKS

1. A text book of Practical Inorganic Chemistry by AI Vogel, ELBS

2. Laboratory manual of Engineering Chemistry by Dr Sudha rani

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CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACP3.8: ORGANIC CHEMISTRY PRACTICAL -III

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP 3.7	Organic Chemistry Practical-II	Lab	0-0-6(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of separation of an organic binary mixture and identify each of the compound by following systematic procedure

CO 2: To understand separation of an organic binary mixture and identify each of the compound by following systematic procedure

CO 3: To apply separation of given unknown organic binary mixture and identify each of the compound by following systematic procedure

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain the procedure and chemistry for separation of an organic binary mixture and identify each of the compound by following systematic procedure

LO 2: Apply separation of given unknown organic binary mixture and identify each of the compound by following systematic procedure

LO 3: Acquire skill in the separation of an organic binary mixture and identify each of the compound by following systematic procedure

Organic Mixture Analysis

1. Separation of organic compounds of a binary mixture (minimum of four mixtures)

2. Systematic identification of the separated organic compounds by functional group analysis, chemical reaction and derivatisation

3. Separation of a mixture of organic compounds by Thin Layer Chromatography and Column Chromatography

Text Books

1. A.I. Vogel - A Text book of practical organic chemistry, ELBS.

2. Raj K Bansal- Laboratory Manual of Organic Chemistry

3. F.G. Mann and B. C. Saunders - Practical Organic Chemistry, Longman, London

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CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

SEMESTER - IV

ACT 4.1: INDUSTRIES BASED ON ORGANIC RAW MATERIALS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 4.1	Industries based on Organic Raw Materials	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of starch, cellulose, pulp, paper, oils, soaps, detergents, surface coatings, food processing and food by-products

CO 2: To understand the chemistry of starch, cellulose, pulp, paper, oils, soaps, detergents, surface coatings, food processing and food by-products

CO 3: To apply starch, cellulose, pulp, paper, oils, soaps, detergents, surface coatings, food processing and food by-products

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain starch, cellulose, pulp, paper, oils, soaps, detergents, surface coatings, food processing and food by-products

LO 2: Apply starch, cellulose, pulp, paper, oils, soaps, detergents, surface coatings, food processing and food by-products

LO 3: Evaluatestarch, cellulose, pulp, paper, oils, soaps, detergents, surface coatings, food processing and food by-products

Unit I: Starch: (12 hours) Structure, Chemical and Physical properties of polysaccharides.Structure of starch. Manufacture of starch and dextrin . Hydrolysis of starch to edible and industrial glucose- applications of starch: textile sizing and fermentation industries- Manufacture of Industrial Alcohol-Manufacture of Vitamin C from glucose.

Unit II: Cellulose, Pulp and Paper (12 hours) Composition of wood - Structure, Chemical and Physical properties ofcellulose. Sources and uses of cellulose. Enzymatic and chemical hydrolysis of cellulose- conversion of cellulose to alcohol. Industrialpreparation of chemical cellulose. Cellulose derivatives : cellulose nitrate, cellulose acetate andcarboxy methylcellulose. Different methods of wood pulping: Manufacture and cases of different qualities of paper products like cardboard, Bond paper, newsprint, writing paper, tissue paper and filter paper.

Unit III: Oils, Fats and Waxes (12 hours) Introduction-Sourcesof Animal fats and oils-Classification : Vegetable, animal and mineral oils – Manufacture of Vegetable oils, Chemical properties and uses – Extraction and processingof Vegetable oils, hydrogenation of oils-Industrial production of cotton seed and soya been oils. Chemical modification of fats and oils: Isomerization. transesterification and interestirications. Waxes :Introduction- Classification , properties and uses of waxes.

Unit IV: Soaps, Detergents and Surface Coatings (12 hours) Soaps: Manufacture, Raw materials, typical soaps, Glycerin recovery from soap manufacture Detergents: Classification of surfactants- Raw materials ,Manufacture – Biodegradability of Detergents. Surface Coatings: Paints – Drying oils, Pigments, Pigment extenders - Special paints – Varnishes – Lacquers. Industrial coatings- properties and uses.

Unit V: Food Processing and Food By-products (12 hours) Introduction-Types of Food processing: refining and milling, canning, concentration, freezing, drying, pasteurization and sterilization, fermentation, irradiation.Food Byproducts: Introduction- Manufacture and properties of Leather, gelatin and adhesives- animal glues, synthetic resins.

TEXT BOOKS:

1. Shreve's Chemical process industries by GEORGE T.AUSTIN 2 .Industrial chemistry by B.K.SHARMA.

3. Engineering chemistry by S SDARA.

4. Organic chemistry, Vol. I (6thEdn.) and Vol. II (5thEdn .) by I.L. Finar, ELBS.

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CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 4.2: FINE CHEMICALS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT4.2	Fine Chemicals	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of chemistry of dyes, fragrances and flavours, agrochemicals, Vitamins, Minerals and Toxic chemicals

CO 2: To understand chemistry of dyes, fragrances and flavours, agrochemicals, Vitamins, Minerals and Toxic chemicals

CO 3: To apply chemistry of dyes, fragrances and flavours, agrochemicals, Vitamins, Minerals and Toxic chemicals

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain chemistry of dyes, fragrances and flavours, agrochemicals, Vitamins, Minerals and Toxic chemicals

LO 2: Apply chemistry of dyes, fragrances and flavours, agrochemicals, Vitamins, Minerals and Toxic chemicals

LO 3: Evaluatechemistry of dyes, fragrances and flavours, agrochemicals, Vitamins, Minerals and Toxic chemicals

Unit I: Chemistry of Dyes: (12 hours) Introduction – Dye intermediates - Unit processes in the preparation of dye intermediates – Structural features of a dye (Chromophores and Auxochromes) – Bathochromic and Hypsochromic effects – Diazotization and coupling – colour and chemical constitution (Witt's theory, Armstrong theory &Modern theory); Classificationof dyes.

Synthesis and Application of the following dyes: Naphthol Yellow S. Naphthol green Y. Methyl orange, Bismark Brown, Congo Red, Phenolphthalein, Fluorescein,Rhodamine B, Indophenol blue, Phenylene blue, Methylene blue, Quinoline blue, Alizarin, Indigo (Indigotin), Thioindigo.

Unit II: Chemistry of Perfumes and Flavours: (12 hours) Perfumes: Theory of olfaction and mechanism, relation between perfumes and phermones, classification of perfumes, chemistry, manufacture and isolation of the following compounds –Citral, Geraniol, Nerol, Linalool, citronellol, jasmone, civetone and Muskone.

Flavours: The difference between perfumes and flavours, classification of flavour compounds, chemistry of species and oleoresins, pepper, ginger, aniseed, cuminseed, Coriander, Cellery and cardamon, Chemistry of some major flavours like coffee, tea, cocoa, onion. Assessment of flavours and blending of flavours. Chemistry and application of flavour compounds: Menthol,Piperitone, Vanillin, Eugenol, monosodium glutamate and carvone

Unit III: Chemistry of Agrochemicals: (12 hours) Insecticides: DDT, BHC,Aldrin, Endosulfon; Herbicides: 2,4-dichloro phenoxyacetic acid; Fungicides: Boardeaux mixture, Copper oxychloride; Rodenticides: Warfarin, Sodium monofluoroacetate, Zinc phosphide; Plant-Growth Modifiers:Growth Regulators,Second- Growth Inhibitors and Defoliants and Yield Stimulators

Unit IV : Chemistry of Vitamins: (12 hours) Classification, functions, requirements, distribution in foods, loss during processing, effects of deficiency and characteristic properties of vitamins – B1(Thiamine), B2(Riboflavin), B3(Pantothenic acid), B6(pyridoxine), B12(Cyanocobalamine), H(Biotin), P(Rutin), C(ascorbic acid), A(Retinol),D (Calciferol), E(Tocopherol), K(naphthoquinone), Folic acid(PGA) andNiacin - Methods for the determination of Water soluble vitamins:B1,B2, B3,B6,B12,Cand folic acid and fat soluble vitamins: A,D,E and K by visible spectrophotmetric technique only.

Unit V: Chemistry of Essential Minerals, Toxic Metals: (12 hours) Classification, functions, requirements, distribution in foods, loss during processing, effects of deficiency and characteristic properties of Essential Minerals: Calcium, Magnesium, Sodium, Potassium, Calcium, Phosphorous, Iron, Zinc, Copper, Manganese, Selenium, Iodine and chloride. Toxic Metals and their Toxic mechanism: Arsenic, Cadmium, Lead, Mercury, Chromium, Nickel

Text Books:

1. Medicinal Chemistry, A. Burger,3rdEdn ., Wiley, 1970.
2. Chemistry of pesticides, N.M. Melnikov, Residue Reviews, Vol.36, Springer Verlag, New York , 1971.
3. Future for insecticides , R.C. Netealr, J.J.Mckalvery, Jr. John Wiley &Sons, New York, 1976.
4. Pesticide processes Encyclopedia, Marshal Sitting Hoyes Data Corporation, U.S.A.., 1977.
5. Synthetic Organic Chemistry, O.P. Agarwal,10thedition , Publishing House, Meerut, 1994.
6. Chemical process industries by R.N.Shreeve.
7. The Chemistry of Synthetic Dyes, Academic Press.
8. I. L. Finar , Organic Chemistry , Vol. I. Ch. 31 Dyes, Longman.
9. Gilman,Organic Chemistry , An Advanced Treatise Vol. III Ch., 4.Organic Dyes . Wiley (1953).
10. Juster, Colour and Chemical constitution J. Chem. Educ., 3:596 (1962).

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 4.3: POLYMERS AND PLASTICS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 4.3	Polymers and Plastics	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of polymers, mechanism and kinetics of polymerisation, analysing and testing of polymers, compounding of plastics and polymer composites, Rubbers, Elastomers and Adhesives

CO 2: To understand polymers, mechanism and kinetics of polymerisation, analysing and testing of polymers, compounding of plastics and polymer composites, Rubbers, Elastomers and Adhesives

CO 3: To applypolymers, mechanism and kinetics of polymerisation, analysing and testing of polymers, compounding of plastics and polymer composites, Rubbers, Elastomers and Adhesives

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain polymers, mechanism and kinetics of polymerisation, analysing and testing of polymers, compounding of plastics and polymer composites, Rubbers, Elastomers and Adhesives

LO 2: Apply polymers, mechanism and kinetics of polymerisation, analysing and testing of polymers, compounding of plastics and polymer composites, Rubbers, Elastomers and Adhesives

LO3: Evaluate polymers, mechanism and kinetics of polymerisation, analysing and testing of polymers, compounding of plastics and polymer composites, Rubbers, Elastomers and Adhesives

Unit I: Introduction to Polymers: (12 hours) Basic concepts Nomenclature- Degree of polymerization – polymerisation process – Classification of polymerization reactions – Difference between thermoplastics and thermosets. Types of polymerization – Addition and step growth. Copolymerisation- Block copolymerisation – Graft copolymerisation. Stereo isomers – isotactic, atactic and syndyotactic polymers Zeigler-Natta catalysis.

Unit II: Mechanism and Kinetics of Polymerisation (12 hours) Mechanism of polymerization – free radical and ionic. Heterogeneous polymerization Kinetics of polymer reaction – addition – Free-radical , cationic and Anionic polymerization. Condensation polymerization – acid catalysed condensation reactions.

Unit III: Analysing and Testing of Polymers (12 hours) Weight average and number average molecular weights of polymers ratio of M_w and M_n. - Determination of molecular weight of polymers by Cryoscopy – Light scattering – X-ray scattering – Viscosity – Ultra centrifuge and gel permeation chromatographic methods.

Unit IV: Compounding of Plastics and Polymer Composites (12 hours) Compounding of plastics – Additives: Stabilizers, anti oxidants, flame retardants, smoke suppressants - Physical Properties Modification: Plasticizers, Lubricants, Nucleating, processing, mould release, curing, antifogging, coupling and anti-microbial agents - Fabrication techniques of plastic - Polymer composites

Unit V: Rubbers, Elastomers and Adhesives (12 hours) Origin and chemical nature of natural rubber – Direct processing of Latex – Compounding of rubber – Fabrication of rubber – Vulcanization of rubber. Elastomers – Manufacture, properties and uses of Butadiene, Isoprene and chloroprene. Natural and Synthetic Adhesives - Classification animal glue. Protein and starch adhesives – Resin Adhesives. Difference between plastics, elastomers and adhesives.

Text Books:

1. Introduction to Polymer Chemistry, Raymond B, Seymour.

2. Polymer science, V.R. Gowariker et al ., New Age International (P)Ltd, New Delhi.

3. Organic Chemistry of Synthetic High Polymers, Robert W. Lenz, Interscience Publishers.

4. Textbook of Polymer Science P. W. Billmeyer, John Wiley, 1962

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 4.4 (Elective): Green Chemistry

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 4.4 Elective	Green Chemistry	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of basic principles of green chemistry, green methods and procedures, biocatalysts and aqueous phase reactions, organic synthesis in solid state, applications of green chemistry

CO 2: To understand basic principles of green chemistry, green methods and procedures, biocatalysts and aqueous phase reactions, organic synthesis in solid state, applications of green chemistry

CO 3: To apply basic principles of green chemistry, green methods and procedures, biocatalysts and aqueous phase reactions, organic synthesis in solid state, applications of green chemistry

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain basic principles of green chemistry, green methods and procedures, biocatalysts and aqueous phase reactions, organic synthesis in solid state, applications of green chemistry

LO 2: Apply basic principles of green chemistry, green methods and procedures, biocatalysts and aqueous phase reactions, organic synthesis in solid state, applications of green chemistry

LO 3: Evaluate basic principles of green chemistry, green methods and procedures, biocatalysts and aqueous phase reactions, organic synthesis in solid state, applications of green chemistry

Unit I: Basic Principles of Green Chemistry: (12 hours) Prevention of Waste/ By-Products, Maximum Incorporation of the Reactants into the Final Product, Prevention or Minimization of Hazardous Products, Designing Safer Chemicals, Energy Requirements for Synthesis, Selection of Appropriate Solvent, Selection of Starting Materials, Use of Protecting Groups, Use of Catalyst, Products Designed Should be Biodegradable, Designing of Manufacturing Plants, Strengthening of Analytical Techniques. Green Chemistry in Day-to-Day Life: Dry Cleaning of Clothes, Versatile Bleaching Agent.

Green Reagent: Dimethylcarbonate, Polymer Supported Reagents. Green Catalysts: Acid Catalysts, Oxidation Catalysts, Basic Catalysts, Polymer Supported Catalysts.

Unit II: Green Methods and Procedures: (12 hours) Phase Transfer Catalysis in Green Synthesis: Introduction, Applications of PTC in Organic Synthesis, Oxidation Using Hydrogen Peroxide Under PTC Condition, Crown Ethers. Microwave Induced Green Synthesis: Introduction, Applications – Microwave Assisted Reactions in Water, Microwave Assisted Reactions in Organic Solvents, Microwave Solvent Free Reactions (SolidState Reactions). Ultrasound Assisted Green Synthesis: Introduction, Applications of Ultrasound.

Unit III: Biocatalysts and Aqueous Phase Reactions: (12 hours) Biocatalysts in Organic Synthesis: Introduction, Biochemical (Microbial) Oxidations, Biochemical (Microbial) Reductions, Enzymes Catalysed Hydrolytic Processes.

Aqueous Phase Reactions: Introduction, Diels-Alder Reaction, Claisen Rearrangement, Wittig-Homer Reaction, Michael Reaction, Aldol Condensation, Knoevenagel Reaction, Pinacol Coupling, Benzoin Condensation, Claisen-Schmidt Condensation, Heck Reaction, Strecker Synthesis, Wurtz Reaction, Oxidations, Reductions, Polymerisation Reactions, Photochemical Reactions, Electrochemical Synthesis, Miscellaneous Reactions in Aqueous Phase.

Unit IV: Organic Synthesis in Solid State: (12 hours) Organic Synthesis in Solid State: Introduction, Solid Phase Organic Synthesis Without Using Any Solvent, Solid Supported Organic Synthesis. Versatile Ionic Liquids as Green Solvents: Green Solvents, Reactions in Acidic Ionic, Liquids, Reactions in Neutral Ionic Liquids.

Unit V: Applications of Green Chemistry: (12 hours) Synthesis Involving Basic Principles of Green Chemistry: Some Examples; Introduction, Synthesis of Styrene, Synthesis of Adipic Acid, Catechol and 3- dehydroshikirnic Acid (a potential replacement for BHT), Synthesis of Methyl Methacrylate, Synthesis of Urethane, An Environmentally Benign Synthesis of Aromatic Amines, Selective Alkylation of Active Methylene Group, Free Radical Brornination, Acetaldehyde, Furfural from Biomass, Synthesis of (S)-metolachlor, an Optically Active Herbicide, Synthesis of Ibuprofen, Synthesis of Paracetamol. Designing a Green Synthesis: Choice of Starting Materials, Choice of Reagents, Choice of Catalysts, Choice of Solvents.

TEXT BOOKS:

1. P. Anastas and H. Williamson, Green chemistry frontiers in benign chemical synthesis and processes, Oxford University Press.

2. Lerma and W. Straat, Chemical management: Reducing wast and cost through innovative supply strategies, Willey Sons.

3. M.C. Cann and M. E. Connelly Real world cases in green chemistry, ACS Publications.

4. T. Clayton, Policies for cleaner Technologies, Earthscan

5. V. K. Ahluwalia and M. Kidwai, New Trends in Green Chemistry, Anamaya Publishers, New Delhi.

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 4.4 (Elective): Quantum Chemistry

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 4.4 Elective	Quantum Chemistry	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of quantum mechanics, approximate methods, angular momentum, electronic structure of atoms, Born-Oppenheimer Approximation

CO 2: To understand knowledge of quantum mechanics, approximate methods, angular momentum, electronic structure of atoms, Born-Oppenheimer Approximation

CO 3: To apply knowledge of quantum mechanics, approximate methods, angular momentum, electronic structure of atoms, Born-Oppenheimer Approximation

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain knowledge of quantum mechanics, approximate methods, angular momentum, electronic structure of atoms, Born-Oppenheimer Approximation

LO 2: Apply knowledge of quantum mechanics, approximate methods, angular momentum, electronic structure of atoms, Born-Oppenheimer Approximation

LO 3: Evaluate knowledge of quantum mechanics, approximate methods, angular momentum, electronic structure of atoms, Born-Oppenheimer Approximation

Unit I: Quantum Mechanics: (12 hours) Introduction, Schrodinger equation and the postulates of quantum mechanics. Discussion of solutions of the Schrodinger equation to some model systems viz., particle in a box, the harmonic oscillator, the rigid rotor, the hydrogen atom.

Unit II: Approximate Methods: (12 hours) The variation theorem, linear variation principle. Perturbation theory (first order and non degenerate). Applications of variation method and perturbation theory to the Helium atom.

Unit III: Angular Momentum: (12 hours) Ordinary angular momentum, generalized angular momentum, eigenfunctions for angular momentum, eigenvalues of angular momentum, operator using ladder operators, addition of angular momenta, spin, antisymmetry and Pauli exclusion principle.

Unit IV: Electronic Structure of Atoms: (12 hours) Electronic configuration, Russell-Saunders terms and coupling schemes, Slater-Condon parameters, term separation energies of the pn configuration, term separation energies for the dn configurations, magnetic effects: spin-orbit coupling and Zeeman splitting, introduction to the methods of self –consistent field, the virial theorem.

Unit V: Born-Oppenheimer approximation: (12 hours) Hydrogen molecule ion. LCAO-MO and VB treatments of the hydrogen molecule; electron density, forces and their role in chemical binding. Hybridization and valence MOs of H2O, NH3 and CH4. Huckel theory of conjugated systems, bond order and charge density calculations. Applications to ethylene, butadiene, cyclopropenyl radical and cyclobutadiene.

TEXT BOOKS:

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Introduction to Quantum Chemistry, AK Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentce Hall.
4. Coulson's Valence, A. McWeeny, ELBS

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 4.4 (Elective): Nuclear Chemistry

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT 4.4 Elective	Nuclear Chemistry	Theory	4-0-0(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic knowledge of reactions, nuclear reactions, nuclear reactors, detection and measurement of activity and isotopes for nuclear reactors

CO 2: Tounderstand reactions, nuclear reactions, nuclear reactors, detection and measurement of activity and isotopes for nuclear reactors

CO 3: To apply reactions, nuclear reactions, nuclear reactors, detection and measurement of activity and isotopes for nuclear reactors

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain reactions, nuclear reactions, nuclear reactors, detection and measurement of activity and isotopes for nuclear reactors

LO 2: Apply reactions, nuclear reactions, nuclear reactors, detection and measurement of activity and isotopes for nuclear reactors

LO 3: Evaluate reactions, nuclear reactions, nuclear reactors, detection and measurement of activity and isotopes for nuclear reactors

Unit I: Nuclear Models: (12 hours) Introduction to Nuclear chemistry-The shell model –The Liquid Drop Model –The Fermi Gas Model – The Collective Model

Unit II: Nuclear Reactions: (12 hours) Radioactivity- Radioactive Elements-Bethe's Notation – Types of Nuclear Reactions – Conservation in Nuclear

Reactions – Reaction Cross section –The Compound Nucleus Theory – Experimental Evidence of Bohr's Theory : Experiments of Ghoshal and of Alexander and simonoff – Specific Nuclear Reactions –Transuraniens-Photonuclear Reactions –Thermonuclear Reactions –Fusion Reactions –The Origin and Evolution of Elements

Unit III: Nuclear Reactors: (12 hours) The Fission Energy –The Natural Uranium Reactor-The Four Factor Formula : The Reproduction Factor k –The Classification –of Reactors –Reactor Power - Critical Size of a Thermal Reactor – India's Nuclear Energy Programme – Reprocessing of spent Fuels: Recovery of uranium and Plutonium – Nuclear Waste Management –Nature's Nuclear Reactor

Unit IV: Detection and Measurement of Activity: (12 hours) The Electrometer – the Ionization Chamber – Electron Pulse counters- Scintillation Detectors – Semiconductor Detector –Thermo luminescence Detectors –Neutron Detectors

Unit V: Isotopes for Nuclear Reactors: (12 hours) The Nature –The Atomic Age –Isotope Separation – Separation of Selected Isotopes - Applications of Radioactivity - Probing by Isotopes –Typical Reactions Involved in the preparation of Radioisotopes-The Szilard –Chalmers' Reaction Cow and milk Systems –Use of Charged Plates in Collection of Radioisotopes – Radiochemical Principles in the Use of tracers –uses of Nuclear Reactions – Radio Isotopes as a Source of Electricity

TEXT BOOKS:

1. Essentials of Nuclear Chemistry, H.J. Arnikar, Eastern Wiley (1990).

2. Nuclear & Radiochemistry, G. Friedlandes&J.W. Kennedy, John Wiley & Sons (1987).

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACT 4.5: INTELLECTUAL PROPERTY RIGHTS

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT4.5	Intellectual Property Rights	Theory	4-0-0(60)	70	30	100	3 Hours	2

Course Objectives:

CO 1: To acquire the basic knowledge of Intellectual Property Rights, its nature, trademarks, copyrights, patent rights, trade secrets ant their new developments

CO 2: To understand Intellectual Property Rights, its nature, trademarks, copyrights, patent rights, trade secrets ant their new developments

CO 3: To apply Intellectual Property Rights, its nature, trademarks, copyrights, patent rights, trade secrets ant their new developments

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain Intellectual Property Rights, its nature, trademarks, copyrights, patent rights, trade secrets ant their new developments

LO 2: Apply Intellectual Property Rights, its nature, trademarks, copyrights, patent rights, trade secrets ant their new developments

LO 3: EvaluateIntellectual Property Rights, its nature, trademarks, copyrights, patent rights, trade secrets ant their new developments

Unit I: Introduction to Intellectual Property Rights(12 hours) Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.International overview on intellectual property, international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

Unit II: Nature of Intellectual Property Rights (12 hours) Patents, Designs, Trade and Copyright - Process ofPatenting and Development: technological research, innovation, patenting, development - International Scenario: International cooperation on Intellectual Property. Procedure forgrants of patents, Patenting under PCT.

Unit III: Trademarks and Copyrights (12 hours) Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes. Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law.

Unit IV: Patent Rights and Trade Secrets and Unfair Competition (12 hours) Foundation of patent law, patent searching process - Scope of Patent Rights. Licensing and transfer of technology. Patentinformation and databases. Geographical Indications - Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation - Misappropriation right of publicity, false advertising.

Unit IV: New development of Intellectual Property Rights (12 hours) Administration of Patent System. New developments in IPR; IPR of Biological

Systems, Computer Software etc.Traditional knowledge Case Studies - New developments in trade mark law; copy right law, patent law, intellectual property audits.

TEXT BOOKS:

1. Intellectual property right, Deborah. E. Bouchoux, C engage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company Ltd.
3. Resisting Intellectual Property, Halbert, Taylor & Francis Ltd,2007.
4. Robert P. Merges, Peter S. Menell, Mark A. Lemley, ¯ Intellectual Property in New Technological Age, 2016.
5. T. Ramappa, ¯Intellectual Property Rights Under WTO, S. Chand, 2008

Mapping of PO/CO

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M
L – LOW	M- MEDIUM		H-HIGH				

ACT 4.6: MOOC COURSE

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACT4.5	MOOC Course	ONLINE	0-4-0(60)	100	-	100	As per thecourse	2

Course Objectives:

CO 1: To acquire the basic knowledge of an advanced area in chemistry through MOOC programmes offered by NPTEL-SWAYAM

CO 2: To appreciate the advantages of learning by online mode

CO 3: To advance the knowledge in the areas of interest

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Successfully complete the course as per his/ her choice

LO 2: Produce his/ her continuous performance report

LO 3: Produce his mastery of the course by providing the pass certificate with the grade awarded by NPTELSWAYAM

NOTE: The Student has to submit the E-verifiable certificate given by NPTEL to the Department to award marks

Reference: https://nptel.ac.in/about_nptel.html#E regarding certification process

Mapping of PO/CO

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CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M
L – LOW	M- MEDIUM		H-HIGH				

ACP 4.6: QUANTITATIVE ANALYSIS PRACTICAL - II

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP 4.6	Quantitative Analysis Practical - II	Lab	0-0-6(60)	70	30	100	3 Hours	4

Course Objectives:

CO1: To acquire the basic skills in quantitative analysis using potentiometers, pH meters, conductometers, colorimeters

CO 2: To understand the methods of quantitative analysis using potentiometers, pH meters, conductometers, colorimeters

CO 3: To apply quantitative analysis using potentiometers, pH meters, conductometers, colorimeters

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain the procedures of quantitative analysis using potentiometers, pH meters, conductometers, colorimeters

LO 2: Determine the quantitative analysis using potentiometers, pH meters, conductometers, colorimeters

LO 3: Evaluatequantitative analysis using potentiometers, pH meters, conductometers, colorimeters

POTENTIOMETRIC TITRATIONS

1. Determination of Iron (II) with chromium (VI) .
2. Determination of Iron (II) with cerium (IV) .
3. Determination of Vanadium (V) with Iron (II) .

pH METRIC TITRATIONS

4. Titration of a strong acid against a strong base. 5.Titration of a weak acid against a strong base.

6. Titration of a mixture of weak acid and a strong acid against a strong base.

CONDUCTOMETRIC TITRATIONS

7. Titration of a weak acid against a strong base.
8. Determination of percentage purity of $AgNO_3$Solution using KCl .

COLOURIMETRIC TITRATIONS

9. Determination of Manganese.
10. Determination of Fe (II) .

TEXT BOOKS:

1.A text book of Practical Inorganic Chemistry by AI Vogel, ELBS
2.Laboratory manual of Engineering Chemistry by Dr Sudha rani

Mapping of PO/CO

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CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACP 4.7: APPLIED CHEMISTRY PRACTICAL

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP 4.7	Applied Chemistry Practical	Lab	0-0-6(60)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To acquire the basic skills in methods of determination, analysis, preparation of various chemical substance

CO 2: To understand the methods of determination, analysis, preparation of various chemical substance

CO 3: To apply quantitative analysis methods of determination, analysis, preparation of various chemical substance

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Explain the procedures of methods of determination, analysis, preparation of various chemical substance

LO 2: Determine the quantitative methods of determination, analysis, preparation of various chemical substance

LO 3: Evaluate quantitative methods of determination, analysis, preparation of various chemical substance

1. Determination of saponification value and Acid value of a vegetable oil
2. Determination of Iodine value of a non-edible oil
3. Determination of Glucose
4. Analysis of Honey
5. Determination of Molecular Weight of a Polymer
6. Determination of Aspirin
7. Preparation of Soap
8. Preparation of cold Cream
9. Preparation of Shampoo
10. Preparation of Phenol- Formaldehyde Resin
11. Preparation of Copper pigment
12. Preparation of Paracetamol
13. Preparation of Fluorescein dye
14. Isolation of Caffeine
15. Isolation of Lycopene

Mapping of PO/CO

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CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH

ACP 4.8: PROJECT WORK

Course Code	Course Title	Course Type	Instruction Periods per weekL-T-P	External Marks	Internal Marks	Total Marks	Duration of External Examination	Credits
ACP4.8	Project Work	Internship	0-0-24(144)	70	30	100	3 Hours	4

Course Objectives:

CO 1: To develop scientific aptitude, critical thinking, experiment planning through the conduct of project

CO 2: To understand experiment planning, reporting and auditing the experimental data

CO 3: To acquire interpretation to result discussion, research writing and research presentation.

Learning Outcomes:

At the end of the course, the learners should be able to:

LO 1: Investigate various aspects related to the chemical process/ QC/ instrumental analysis/ chemistry problem

LO 2: Appreciate the literature and its relevance to his/her topic of interest

LO 3: Write research proposal independently

LO 4: Would generate interest in current topics of research

Project Work:

Project supervisor at the chemical industry/ R&D unit/ laboratory would be allocated at the start of the project work and research project would be undertaken in discussion with the project supervisor. At the end of the project tenure the student has to prepare a project report as per the university guidelines. Upon submission of the project report, the projects would be evaluated based on a project presentation and viva-voce examination.

Mapping of PO/CO

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CO 1	H	M	M	M	L	M	M
CO 2	M	L	H	M	M	M	L
CO 3	H	M	M	H	M	H	M

L – LOW M- MEDIUM H-HIGH