M.Sc CHEMISTRY
(SEMESTER PATTERN)
CHOICE BASED CREDIT SYSTEM (CBCS)
TWO YEARS FULL TIME PROGRAMME
COURSE OF STUDIES R-20

GIET UNIVERSITY, GUNUPUR
ODISHA

All the precautions have been taken to print the course curriculum accurate. However, mistakes if any will be corrected as and when noticed. The university reserves the right to include/exclude any content at any point of time during the progression of the course.

M.Sc CHEMISTRY

Schedule for Instruction and Examination
(Proposed Scheme for Academic year 2020-2021)

I SEMESTER [FIRST YEAR]

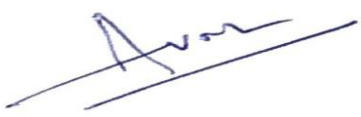
Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	CHPC	101	Organic Chemistry-I	4	0	0	4
2	CHPC	102	Inorganic Chemistry-I	4	0	0	4
3	CHPC	103	Physical Chemistry-I	3	1	0	4
4	CHPC	104	Spectroscopy-I	3	1	0	4
PRACTICAL / SESSIONAL							
5	CHPC	105	Organic Practical	0	0	6	4
6	CHPC	106	Seminar & Project-I	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	CHPC	201	Organic Chemistry-II	4	0	0	4
2	CHPC	202	Inorganic Chemistry-II	4	0	0	4
3	CHPC	203	Physical Chemistry-II	3	1	0	4
4	CHPC	204	Spectroscopy-II	3	1	0	4
PRACTICAL / SESSIONAL							
5	CHPC	205	Inorganic Practical	0	0	6	4
6	CHEC	206	Seminar and Project - II	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

BoS Members: 1. Dr. T.Ch. Behera 2. Dr. Pravin Kar 3. Dr Prativa Kar
4. Dr Jitendra Kumar Sahu 5. Mrs. G. Mohini 6. Ms. Pallavi Priyadarshani

BOS Approved
Date:04/06/2020



III SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	CHPC	301	Analytical Chemistry-I	3	1	0	4
2	CHPE	302	Organic Chemistry-III	3	1	0	4
		303	Advanced Organometallic Chemistry				
3	CHPE	304	Environmental and Analytical Chemistry	4	0	0	4
		305	Nano Chemistry				
4	CHCBOE	306	Chemistry of Materials	4	0	0	4
		307	Chemistry and Environment				
PRACTICAL / SESSIONAL							
5	CHPC	308	Analytical Practical	0	0	6	4
6	CHEC	309	Summer Internship / Seminar and Project - III	0	0	2	2
TOTAL				**14**	**2**	**8**	**22**

IV SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
THEORY							
1	CHPC	401	Physical Chemistry-III	3	1	0	4
2	CHPE	402	Organic Chemistry-IV	4	0	0	4
		403	BioInorganic Chemistry				
		404	Polymer Chemistry				
		405	Industrial Chemistry				
3	CHOE	406	Ethics & IPR	4	0	0	4
PRACTICAL / SESSIONAL							
4	CHPE	407	Physical Practical	0	0	6	4
5	CHEC	408	Major Project / Dissertation	0	0	10	8
6	VAC	409	Value added course/ MOOCS	-	-	-	-
TOTAL				**11**	**1**	**16**	**24**

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SCHEME OF INSTRUCTION SUMMARY

SL. NO.	COURSE WORK - SUBJECTS AREA	CREDITS / SEMESTER				TOTAL CREDITS	%
		I (500 marks)	II (550 marks)	III (550 marks)	IV (500 marks)	Total (2200 marks)	
1	Professional Course (PC)	20	20	8	4	52	58
2	Professional Electives (PE)	-	-	8	8	16	18
3	Choice Based Open Elective (CBOE) / Open Elective (OE)	-	-	4	4	8	9
4	Project Work, Seminar and/or Internship in Industry or elsewhere (EC)	2	2	2	8	14	15
5	Value added Courses	-	-	-	-	-	-
	TOTAL	**22**	**22**	**22**	**24**	**90**	**100**

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MSC Chemistry (Credits-Hours-Marks Distribution)

Semester	Course	Course Title	Hrs per week L-T-P	Credit L-T-P	Exam Hrs L-T-P	Marks		Total
						Mid Sem	End Sem	
I	CHPC101	Organic Chemistry-I	4	4	3	30	70	100
	CHPC102	Inorganic Chemistry-I	4	4	3	30	70	100
	CHPC103	Physical Chemistry-I	4	4	3	30	70	100
	CHPC104	Spectroscopy-I	4	4	3	30	70	100
	CHPC105	Organic Practical	6	4	6	0	100	100
	CHPC106	Seminar and Project - I	2	2	2	0	50	50
			24	**22**				**550**
II	CHPC201	Organic Chemistry-II	4	4	3	30	70	100
	CHPC202	Inorganic Chemistry-II	4	4	3	30	70	100
	CHPC203	Physical Chemistry-II	4	4	3	30	70	100
	CHPC204	Spectroscopy-II	4	4	3	30	70	100
	CHPC205	Inorganic Practical	6	4	6	0	100	100
	CHEC206	Seminar and Project - II	2	2	2	0	50	50
			24	**22**				**550**

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(Credits-Hours-Marks Distribution)

Semester	Course	Course Title	Hrs per week L-T-P	Credit L-T-P	Exam Hrs L-T-P	Marks Mid Sem	Marks End Sem	Total
III	CHPC301	Analytical Chemistry-I				30	70	100
	CHPE302	Organic Chemistry-III	4	4	3	30	70	100
	CHPE303	Organometallic Chemistry						
	CHPE304	Environmental Chemistry	4	4	3	30	70	100
	CHPE305	Nano Chemistry						
	CHCBOE306	Chemistry of Materials	4	4	3	30	70	100
	CHCBOE307	Chemistry and Environment						
	CHPC308	Analytical Practical	6	4	6	0	100	100
	CHEC309	Summer Internship / Seminar and Project - II	2	2	2	-	-	50
			24	**22**				**550**
IV	CHPC401	Physical Chemistry-III	4	4	3	30	70	100
	CHPE402	Organic Chemistry-IV	4	4	3	30	70	100
	CHPE403	Bio Inorganic Chemistry						
	CHPE404	Polymer Chemistry						
	CHPE405	Industrial Chemistry						
	CHOE406	Ethics & IPR	4	4	3	30	70	100
	CHPE407	Physical Practical	6	4	4	0	100	100
	CHPC408	Major Project / Dissertation	10	8	6		200	200
	VAC	Value added course/MOOCS	0	0	0			0
			28	**24**				**600**
		Grand Total	**100**	**90**				**2250**

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SEMESTER-I

Course Code:	CHPC101	No. of Credits:	4
Course Name:	ORGANIC CHEMISTRY-I	Sem End Exam & Cycle Test:	70+30

Course Educational Objectives:

This course enables the students

CEO1: To impart advanced knowledge of reactive intermediates and control of reactions progress.

CEO2: To learn concepts of stereochemistry

CEO3: To study and understand the nucleophilic substitutions in aliphatic molecules.

Course Outcomes:

Upon successful completion of this course, students should be able to:

CO1: To understand the various electronic effects and intermediates in the reaction mechanism.

CO2: To understand the concepts of kinetic and thermodynamic control of different reactions and principle of HSAB.

CO3: To learn the concept stereochemistry and its importance

CO4: To understand the various types of aliphatic nucleophilic substitutions.

Mapping of COs with POs

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-										
CO2	2	2										
CO3	3	3										
CO4	3	1										

COURSE CONTENT

Unit-I: Basic Concepts (10 hours)

A) Application of Inductive effect, Resonance and Hyper conjugation, Aromaticity in benzenoid and nonbenzenoid compounds, Huckel‘s rule, Addition Compounds: Crown ether complexes and cryptands, Inclusion complexes, Cyclodextrins, Catenanes and Rotaxanes.

B) Reaction intermediates: Classification, Structure, Stability, Generation and Fate of intermediates-carboanion, carbocation, ,carbenes and free radicals.

Unit-II: Structure and reactivity (11 hours)

Types of reaction mechanisms, types of reactions, Thermodynamic and Kinetic requirements, Kinetic and Thermodynamic control, Hammond’s postulate, Curtin-Hammett principle, Potential energy diagram, Methods of determining mechanism, Isotope effect, Hard-soft concept of acid base, HSAB principle, Hammett equation, Hammett equation and linear free energy relationships, substituent and reaction constants, Taft equation.

Unit-III: Stereochemistry (12 hours)

Isomerism-Structural isomerism, stereoisomerism, geometrical isomerism, optical isomerism,Conformation of cycloalkanes and decalins. Effect of conformation on reactivity, conformation of sugars , Optical activity in absence of chiral carbon (biphenyls, allenes and spirans), Chirality due to helical shape, Asymmetric synthesis. Racemic modification, Resolution of racemic modification, Absolute and relative configuration, R-S nomenclature, Optical purity, E-Z-notation.

Unit-IV: Aliphatic nucleophilic substitutions (12 hours)

SN_2 and SN_1 mechanisms , Ion pairs in SN_1- mechanisms , Mixed SN_2 and SN_1 -mechanisms, SET mechanism, SN_i- mechanism, Nucleophilic substitution in allylic , vinylic and aliphatic trigonal carbon , Neighbouring group participation mechanism, Non-classical carbocation, Effect of structure of the substrate , attacking nucleophile , solvent and leaving group on reactivity of nucleophilic substitution.

Books recommended:

1. Organic synthesis: Clayden, Greeves, Warren and Wouthers, Oxford Univ. Press, 2nd Ed (2012).
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part A and B Springer, 5th Ed.(2005)
3. A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6th Ed.(1999)
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press,3rd (1957).
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall, 6th Ed.(1992)
6. Modern Organic Reactions, H. O. House, W.A. Benjamin. 2nd Ed.(1972)
7. Principles of Organic Synthesis, R.O.C. Norman and J. M. Cox, CRC Press 3rd (2014).
8. Reaction Mechanism in Organic Chemistry, S. M. Mukherjee and S. P. Singh, Macmillan.3rd Ed. (2009).
9. Stereochemistry of Organic Compounds, E. L. Eliel, S. H. Wilen, L.N. Mander, John Wiley & Sons, Inc., New York, NY. (1994).
10. Organic reaction mechanism (Benjamin) R. Breslow
11. Organic chemistry (McGraw-Hill)Hendrikson, Cram and Hammond.
12. Basic principles of Organic chemistry (Benjamin) J. D.Roberts and M. C. Caserio.
13. Organic reaction mechanism (McGraw-Hill) R. K. Bansal.
14. Organic Chemistry By I.L Finar (Volume 1 & 2) Pearson Publication
15. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley, 6th Ed.(2006

Course Code:	CHPC102	No. of Credits:	4
Course Name:	INORGANIC CHEMISTRY-I	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To impart advanced knowledge of chemical bonding

CEO2: To learn concepts of CFT and MOT

CEO3: To study and understand the nuclear reaction and radioactive element

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand the hybridization of polyatomic molecules, Valence bond and Molecular orbital theories

CO2: Students should learn applications in crystal field theory and molecular spectroscopy. Determine the exact shape of co-ordination complex compound.

CO3: To learn the concept of electronic structure and magnetic properties of coordination complexes to identify the occurrence, active site structure and functions of some transition metal ions.

CO4: To understand the the composition of the nuclear structure, its stability and induce the students to take up nuclear research in their higher studies

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-										-
CO2	1	2										-
CO3	2	3										-
CO4	2	3										2

COURSE CONTENT

Unit-I: Covalent Bond (10 hours)

Qualitative discussion on valence bond theory-formation of hydrogen molecule, Qualitative discussion on molecular orbital theory, bonding and antibonding orbitals, energy distribution and stability, MO energy level diagrams of simple diatomic molecules like N_2, O_2, F_2, CO, NO and HF, Hybridisation and wave mechanical description for sp, sp^2 and sp^3 orbitals, qualitative idea about dsp^2,$dsp^3$and d^2sp^3 orbitals, VSEPR theory, shapes of simple molecules and ions.

Unit-II: Bonding in Co-ordination Compounds (12 hours)

Valence bond theory-strength and short coming, Crystal field theory-effect spin types, CFSE, factors affecting the magnitude of 10 Dq, Evidence for crystal stabilization energy in octahedral, tetrahedral, tetragonal, square pyramidal and square planner fields, Jahn-Teller distortion, Applications of Crystal Field Splitting, Molecular orbital theory(qualitative), MO energy level diagrams, Sigma –pi bonding and their importance in co- ordination compounds

Unit-III: Spectral and Magnetic Properties of Transition Metal Complexes (14 hours)

Spectroscopic ground states, Correlation, Orgel and Tanabe-Sugano diagrams for transition metal complexes (d^1-d^9 states), Charge transfer spectra, Elementary idea about magneto chemistry of metal complexes, Diamagnetism, Para magnetism, Temperature independent paramagnetism, Magnetic susceptibility and its measurement, Paramagnetism applied to metal complexes, Ferromagnetism Ferrimagnetism and Anti-ferromagnetism.

Unit-IV: Nuclear Chemistry (10 hours)

Radioactive decay and equilibrium, nature of α- and β-particles, Artificial radioactivity, Disintegration by α-particle and neutron, Types of nuclear reaction: fission and fusion, Applications radio isotopes to physic chemical problems, Uses of radio isotopes for dating, medicine agriculture and industry.

Books recommended

1. Advanced Inorganic Chemistry: F. A. Cotton and G. Wilkinson, John Wiley.
2. Inorganic Chemistry: J. E. Huheey, E. A. Keiter, R. L. Keiter, Pearson Education.
3. Inorganic Chemistry: Missler and Tarr, Prentice Hall.
4. Chemistry of the Elements: N. N. B. Greenwood and A. Earnshow, Pergamon.
5. Essential of Nuclear Chemistry: H. J. Arnikar, ACS.
6. Concise Inorganic Chemistry: J. D. Lee, WILEY
7. Selected topics in In-organic Chemistry: Dr. Wahid U. Malik, Dr. G. D. Tuli, Dr. R. D. Madan, S. CHAND
8. Principles of In-organic Chemistry: Puri, Sharma, Kalia, VPC

Course Code:	CHPC103	No. of Credits:	4
Course Name:	PHYSICAL CHEMISTRY-I	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: The aim of this course is to provide a systematic treatment of symmetry in chemical systems within the mathematical framework known as group theory.

CEO2: The course emphasizes on practical applications of point group theory chemistry by considering the symmetry of molecules.

CEO3: To understand the concept of quantum chemistry

CEO4: To understand C-programming language and it's use in chemistry

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: Apply the knowledge of symmetry and point group of molecules

CO2: Generate a representation and to reduce it to its irreducible components

CO3: Use symmetry arguments to understand bonding and geometry of molecules

CO4: Explain the postulates and general principles of quantum mechanics.

CO5: Apply the Computer programming skills in C programming language and develop small computer codes involving simple formula in chemistry.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										
CO2	1	3										
CO3	1	2										
CO4	2	2										
CO5	1	3										

COURSE CONTENT

Unit-I: Symmetry and group theory **(13 hours)**

Symmetry operation, symmetry element, classification of symmetry elements, Definition of group, subgroup, Classes, Relationship between orders of a finite group and its subgroup, Mathematical requirement of point group, symmetry Point group, group multiplication table(C_3, C_{2v}, C_4,C_{2h}, D_2, S_4) conjugacy relation and classes, matrix representation of symmetry elements, reducible and irreducible representation, the great orthogonality theorem (without proof) and its explanation, Standard reduction, Character table (C_{2v}, C_{3v}, C_{4v},C_{2h}, D_2, D_{2d} Point group), Direct product.

Unit-II: Application of group Theory **(12 hours)**

Transformation properties of atomic orbitals, Hybridization scheme for σ-bonding (C_{3v}, C_{4V}, D_{3h}, T_d) projection operator, Symmetry adopted LCO, Hybrid orbital as linear combination of atomic orbitals, MO treatment of coordination compounds, σ-bonding in octahedral complexes, Formation of LCO, Formation of MO, Construction of MO diagram.

Unit-III: Quantum chemistry **(14 hours)**

Angular momentum, Particle in one and three dimensional boxes, Hydrogen atom, Transformation of co-ordinate, Separation of variables, φ-equation, θ-equation, The radial equation, Shapes of s,p and d orbitals.
Postulates of quantum mechanics, Simple harmonic oscillator, Rigid rotator, The variation theorem, Linear variation theorem, Linear variation principle, Perturbation theory (first order and nondegenerate), Application of various methods and perturbation theory to Helium atom, Huckel theory of conjugated systems, Bond order and charge density calculation, Application to ethylene, butadine, cyclobutadiene.

Unit-IV: Computer for chemists **(10 hours)**

Computer programming in C: Elements of computer language, Constant and Variables, Operation and symbols, Expressions, Arithmetic assignment, Input and output, Conditional statement, Loops, Logical variables. C Programming in chemistry: Development of small computer codes involving simple formulae in chemistry such as vander Waal‘s equation, Radioactive decay constant, Rate constant, Evaluation of energy level and radius of an orbit.

Books recommended

1. K. Veera Reddy, Symmetry and Spectroscopy of Molecules, New Age International, Delhi
2. I.N. Levine, Quantum Chemistry, 5th edition (2000), Pearson Educ. Inc., New Delhi.
3. A.K. Chandra, Introductory Quantum Chemistry, 4th edition, Tata McGraw Hill, New Delhi.
4. L. Pauling and E. B. Wilson, Introduction to Quantum Mechanics with Applications to Chemistry (1935), McGraw Hill, New York.
5. R.K.Prasad,‖ Quantum Chemistry‖, Wiley.
6. F.A. Cotton, Chemical Applications of Group Theory, Wiley 7. Ramesh Kumari, Computers and their Applications to Chemistry, Narosa, New Delhi
7. Physical Chemistry by P.W Atkins’ ,Oxford Publication
8. Group Theory In Chemistry By Alok K Mukherjee, B.C Ghosh ,University Press
9. R. Ameta, Symmetry and Group Theory in Chemistry, New Age International Ltd., 1st edn, 2013, New Delhi.

Course Code:	CHPC104	No. of Credits:	4
Course Name:	SPECTROSCOPY-I	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:
This course enables the students

CEO : To provide knowledge of advanced spectroscopic techniques for identification and elucidation of structures of molecules.

Course Outcome:
Upon successful completion of this course, students should be able to:
CO1: To understand electronic and molecular spectroscopy of different elements and simple molecules.
CO2: To introduce vibrational-rotational energy levels, selection rules and their applications in IR and Raman spectroscopy.
CO3: To learn the fundamental and advanced concepts of Microwave and photo electron spectroscopy and their applications for chemical analysis.
CO4: To study the concepts and principles of Mössbauer Spectroscopy and electron spin resonance spectroscopy and their applications.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										
CO2	2	2										
CO3	2	3										
CO4	3	3										

COURSE CONTENT

Unit-I: Electronic & Molecular Spectroscopy (10 hours)

A. Atomic spectroscopy- Energies of atomic orbital, Spectra of hydrogen atom and alkali metal atom.
B. Molecular spectroscopy-Energy levels, Molecular orbitals,Vibrational progression and geometry of excited state, Frank-Condon principle. Electronic spectra of poly atomic molecules.

Unit-II: Vibrational Spectroscopy (14 hours)

A. Infra red spectroscopy: Introduction, Vibrational energy of diatomic molecules, zero point energy, force constant and bond strength, Morse potential energy diagram, vibrational-rotational spectroscopy, P,Q,R branches, break – down of Oppenheimer approximation, vibration of polyatomic molecules, Selection rules, Normal mode of vibration, Group frequencies, Overtones,

Hot bands, Factors affecting the band positions and intensities, far IR- region.

B. Raman Spectroscopy: Introduction, Classical and quantum theories of Raman effect, Pure rotational, vibrational and rotational Raman spectra, Selection rule, Mutual exclusion principle , Coherent anti Stoke‘s-Raman spectroscopy.

Unit-III **(13 hours)**

A.Microwave spectroscopy: Classification of molecules, Rigid rotator model, Intensities of spectral lines , Effect of isotopic substitution on transition frequencies, Non- rigid rotator. , Stark effect, applications.

B.Photo electron spectroscopy: Introduction, Basic principles, Photoelectric effect, Ionisation process, Koopmans‘s theorem ,photoelectron spectra of simple molecules, ESCA, Chemical information from ESCA, Auger electron spectroscopy-basic idea.

Unit-IV **(13 hours)**

A. Electron spin resonance spectroscopy: Basic principles, Zero- field splitting and Kramer‘s degeneracy, Factors affecting the “g” value, hyperfine splitting in isotropic systems involving more than one nucleus, Isotopic and anisotropic hyperfine coupling constant, Measurement techniques, Application.

B. Mossbauer spectroscopy: Basic principles, Spectral parameters and spectral display, Application of the techniques to study the bonding and structure of Fe^{2+} and Fe $^{3+}$ compounds including those of intermediate spins.

Books recommended

1. Modern Spectroscopy, J.M. Hollas, John Wiley, 2004, 4th edition, Sussex.
2. Physical Methods in Chemistry, R.S. Drago, Sauders College.
3. Chemical Applications of Group Theory, F.A. Cotton.
4. Introduction to Molecular Spectroscopy, G.M. Barrow, McGraw Hill
5. Basic Principles of Spectroscopy, R. Chang, McGraw Hill.
6. Theory and Applications of UV Spectroscopy, H.H.Jaffe and M.Orchin, IBH-Oxford.
7. Introduction to Photoelectron Spectroscopy, P.K.Ghosh, John Wiley.
8. Introduction to Magnetic Resonance, A. Carrington and A.D. Maclachalan, Harper & Row.
9. Spectroscopy, S. Walker and H. Straw, Chapman and Hall ltd.
10. Energy levels in atom and molecules, W.G. Richards and P.R. Scott, Oxford University Press, Oxford Chemistry Primer vol. 26, 1994, New York.
11. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont.
12. Electronic Absorption Spectroscopy and Related Techniques, D. Sathyanarayana, University Press (India) Ltd., 2001, Hyderabad.
13. Molecular Spectroscopy, P.S. Sindhu, Tata McGraw Hill , 1985, New Delhi.
14. Fundamental of Molecular Spectroscopy, C. N. Banwell and E. McCash, Tata McGraw Hill, 4th edition, 1994, New Delhi.
15. Physical chemistry by P.W.Atkins,ELBS. 1986
16. Molecular Spectrocopy by I.N.Levins,Wiley Interscience.

Course Code:	CHPC105	No. of Credits:	4
Course Name:	ORGANIC PRACTICAL	Sem End Exam :	100

(6hrs per week)

Course Educational Objective:

This course enables the students

CEO1: To apply the skill in two stage preparation, purification and recrystallisation.

CEO2: To focus on Synthesis of organic compounds

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To familiarize the solubility nature of organic substances of different functional group.

CO2 To expertise the various techniques of preparation and analysis of organic substances

CO3: To learn two stage preparation involving molecular rearrangement.

CO4: To learn the preparations of derivative of all functional groups

CO5: To understand the techniques involving drying and recrystalliation by various method.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				1							
CO2	2				1				1			
CO3	2				1							
CO4	2				1				1			
CO5	2											

1. **Qualitative Analysis**
    i. Identification of organic compounds having at least two functional group. Submission of derivatives.
    ii. Identification of organic compounds of binary mixture by (Thin Layer Chromatography) and determination of Rf value
    iii. Purification of organic compounds of binary mixture by Column Chromatography
    iv. Characterization of functional group by IR spectra/NMR/Mass

2. **Synthesis of organic compounds:**
    i. p- Nitroacetanilide.
    ii. p- Nitroaniline.
    iii. Ethylbenzoate.
    iv. m-Dinitrobenzene.
    v. Dibenzyl acetone and its derivatives
    vi. Anthranilic acid
    vii. Methyl Orange
    viii. Adipic acid by chromic acid oxidation of cyclohexanol
    ix. Triphenyl methanol from benzoic acid (Grignard reaction)
    x. Benzaldehyde to cinnamic acid

3. **Quantitative Analysis**
    i. Estimation of Acetyl group
    ii. Estimation Phenolic group
    iii. Estimation of Keto group

Book recommended

1. Quantitative and Qualitative analysis By A.I. Vogel, John Wiley.
2. Experiments and Techniques in Organic Chemistry, D.Pasto, C.Johnson, & M.Miller, Prentice Hall.
3. Systematic Qualitative Organic Analysis, H. Middleton, Edward Arnold (Publisher).
4. Hand Book of Organic Analysis, Qualitative & Quantitative, M.T. Clarke, Edward Arnold (Publisher).
5. Macroscale and Microscale Organic Experiments, K. L. Williamson, D. C. Heath.

Course Code:	CHPC106	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT-I	Sem End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Literature Survey/Reference	10
Abstract/Synopsis on Project work	15
Presentation/seminar	25
Total Marks	50

SEMESTER –II

Course Code:	CHPC201	No. of Credits:	4
Course Name:	ORGANIC CHEMISTRY-II	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To learn the mechanism of nucleophilic substitutions in aromatic molecules and electrophilic substitutions in aliphatic and aromatic molecules.

CEO2: To learn the mechanism of addition and elimination reaction.

CEO3: To learn the concepts of free radical mechanism.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand the mechanism of substitution of electrophile in aliphatic and aromatic molecules.

CO2: To understand the various nucleophilic substitutions in aromatic systems and free radical mechanism in molecules.

CO3: To learn the mechanism of addition reactions.

CO4: To understand the various types of elimination reactions.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										
CO2	2	2										
CO3	3	3										
CO4	3	-										

COURSE CONTENT

Unit-I: **(13 hours)**

A. Aliphatic electrophilic substitutions: SE_1, SE_2 and SE_i – mechanisms, Distinction in between SE_2 and SE_i „ Electrophilic substitutions at allylic substrate. Effect of substrate structure, leaving group and solvent polarity on the reactivity.

B. Aromatic electrophilic substitutions: Arenium ion mechanism, Pi – complex mechanism, Orientation and reactivity, Energy profile diagram, Ortho/para ratio , Ipso attack , Orientation of benzene with more than one substituent , Vilsmeier- Hack reaction. Gattermann – Koch reaction , Reimer- Tiemann reaction ,Friedel Craft reaction, Diazonium coupling

Unit-II: **(14 hours)**

A. Aromatic nucleophilic substitutions :

$ArSN_2$– mechanism, $ArSN_1$– mechanism, Benzyne mechanism , SRN_1– mechanism, Reactivity effect of substrate structure ,leaving group ,attacking nucleophile ; Von-Richter rearrangement , Sommelet –Hauser rearrangement , Smiles rearrangement .

B. Free radical substitutions: Free radical reactions , Mechanism of free radical substitutions, Neighbouring group assistance in free radical reactions, Free radical substitutions at bridge head Allylic halogenations, Coupling of alkynes, Arylation of aromatic compounds by diazonium salt, Hunsdiecker reaction, Kochi reaction,sandmeyer reaction

Unit –III: **(13 hours)**

Addition reaction : Mechanistic and stereochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselecticvity, orientation and reactivity, Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration, Oxymercuration, Epoxidation, Sulfonium Ylides, Halohydrin addition, Michael reaction, Sharpless asymmetric epoxidation and dihydroxylation.

Unit –IV: **(13 hours)**

Elimination reaction : The E^2, E^1 and E^1cB -mechanisms, salient feature, evidences ,Comparison in between E_2, E_1 and E_1cb,Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium. Mechanism and orientation in pyrolytic elimination. Saytzeff and Hofmann Elimination, Bredt's rule.

Books recommended

1. Organic synthesis: Clayden, Greeves, Warren and Wouthers, Oxford Univ. Press, 2nd Ed (2012).
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part A and B Springer, 5th Ed.(2005)
3. A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6th Ed.(1999)
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press,3rd (1957).
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall, 6th Ed.(1992)
6. Organic reaction mechanism (Benjamin) R. Breslow
7. Mechanism and structure in Organic chemistry (Holt Reinh.) B. S. Gould.
8. Organic chemistry (McGraw-Hill)Hendrikson, Cram and Hammond.
9. Organic reaction mechanism (McGraw-Hill) R. K. Bansal.
10. Principle of organic synthesis- R.O.C. Norman and J. M. Coxon.(ELBS)
11. Reaction mechanism in organic chemistry- S. M. Mukharji and S. P. Singh.
12. Advanced organic chemistry (McGraw-Hill) J. March.
13. Some Modern Methods of Organic synthesis. W. Carruthers, Cambridge Univ. Press.
14. Modern Synthetic Reactions, H. O. House, W.A. Benjamin

Course Code:	CHPC202	No. of Credits:	4
Course Name:	INORGANIC CHEMISTRY-II	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: The objective of the course is to appraise the students about the Metal cluster.

CEO2: To learn about the 18 electron rule and its violation

CEO3: To learn methods, including spectroscopy techniques used to determine the structure of metal carbonyl complexes and to probe reaction mechanism.

CEO4: The students should be able to give appropriate definitions of the terms inert and labile and state which d-electron configurations are associated with inertness.

CEO5: The students should be able to explain the use of terms Hard and Soft in relation to metal ions and ligands and discuss the stability of complexes in terms of hard and soft interactions.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: Understand the chemistry of cluster compounds. structure of carboranes, metallo boranes, hetero boranes, metal carboranes, etc. Apply the concept for future research in this field.

CO2: Student can predict the structure of carboranes, metallo boranes, hetero boranes, metal carboranes.

CO3: Student should learn the role of the metal ion as catalyst and its important various catalytic pathway of the synthetic procedure. Industrial application of this catalytic cycle will also be informed.

CO4: This course is very important for the learners. This course gives them idea about the way a reaction precedes and kinetics in details, specially for inorganic substitution reactions.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										-
CO2	2	2										-
CO3	2	3										-
CO4	1	3										2

COURSE CONTENT

Unit-I: Metal Π-Complexes (14 hours)

Chemistry of metal carbonyls, Constitution of metal carbonyls: mononuclear, poly nuclear clusters with terminal and bridge carbon monoxide ligand units, 18 electron rule, Effective atomic number rule, Carbonylate anions, Carbonyl hydrides and Carbonyl halides. Metal nitrosyl and other types of metal nitric oxide complexes, Cyanonitrosyl complexes of metals, Brown ring compounds, dinitrogen complexes. Metallocenes: preparation, properties, structure and bonding of ferrocene like compounds.

Unit-II: Rings, Cages and Metal Clusters (12 hours)

Classification of Metal carbonyl clusters (Low and High nuclearitry carbonyl cluster), Inorganic catenation and hetero catenation, Inorganic ring: borazine, phosphazine and their derivatives, Inorganic cages: borides and carbides, higher boranes, carboranes, metallaboranes and metallacarboranes, compounds with metal-metal multiple bonds.

Unit-III: Metal-Ligand Equilibria in Solution (12 hours)

Stepwise and overall formation constants and their interaction, Trends in stepwise constants, Inert and labile complexes, Kinetic application of valence bond and crystal field theories, Kinetics of octahedral substitution, Factors affecting stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, Determination of binary formation constants by potentiometric and spectrophotometric methods.

Unit-IV: Reaction Mechanism of Transition Metal Complexes (10 hours)

Acid hydrolysis, Factors affecting acid hydrolysis, Base hydrolysis, Conjugate base mechanism, Direct and indirect evidences in favour of conjugate mechanism, Anation reactions, Reactions without metal ligand bond cleavage, Substitution reactions in square planar complexes, Trans effect, Mechanism of one electron reactions, Outer-sphere type reactions, Cross reactions and Marcus-Hush theory, Inner sphere type reactions.

Books recommended

1. Mechanism of Inorganic Reactions: F. Basalo and R. G. Pearson, Wiley Eastern publication 1967.
2. Advanced Inorganic Chemistry: F. A. Cotton and G. Wilkinson, Wiley Estern 1988
3. Inorganic Chemistry: J. E. Huheey, E. A. Keiter, R. L. Keiter, Pearson Education.
4. Inorganic Electronic Spectroscopy: A. B. P. Lever, Elsevier.
5. Magnetochemistry: R. L. Carlin, Springer Verlag.
6. Chemistry of the Elements: N. N. B. Greenwood and A. Earnshow, Pergamon.
7. Mechanism of Inorganic Reactions: F. Basalo and R. G. Pearson, Wiley Eastern publication 1967.
8. Basic Inorganic chemistry By F.A cotton

Course Code:	CHPC203	No. of Credits:	4
Course Name:	PHYSICAL CHEMISTRY-II	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To understand the concept of different laws of thermodynamics.

CEO2: To evaluate most probable distribution state for all type of statics i.e. for Maxwell-Boltzmann, Fermi dirac and Bose –Einstein statistics

CEO3: To understand the concept of partition function, its physical significance and calculation of molar and atomic partition function.

CEO4: To understand Entropy production

CEO5: To understand the different theories of chemical kinetics.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: State and apply the Zeroth law, first law , second law and third law of thermodynamics to the real system..

CO2: Define and determine Partial molar properties, Chemical potential and fugacity.

CO3: Explain statistical thermodynamics as logical consequences of the postulates of statistical mechanics, learn the Maxwell –Boltzmann, Fermi –Dirac and Bohr's Einstein statistics Comparison and applications, know about the Partition functions and apply the principles of statistical mechanics to selected problems.

CO4: Explain the entropy production, entropy flow and entropy balance equation for the different reversible processes

CO5: Explain the steady state approximation, Lindemann-hinshelwood mechanism, RRKM theories, chain reaction, General features of fast reaction, Belousov-Zhabotinsky reaction, Photochemical reactions.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										1
CO2	1	3										
CO3	2	3										
CO4	2	2										
CO5	1	3										

COURSE CONTENT

Unit-I: Classical thermodynamics (12 hours)

Brief resume of the concept of enthalpy, entropy, free energy and laws of thermodynamics, Partial molar properties: (partial free energy, molar volume and molar heat content), Chemical potential, Effect of temperature and pressure, Determination of partial molar properties by: (1) Direct Method, (ii) Apparent method, (iii) Method of intercept.
Concept of fugacity and its determination by (i) Graphical method, (ii) From equation of state (iii) Approximation method, Nernst heat theorem and its application to solid, Third law of thermodynamics, Experimental determination of entropy by third law. Entropy and probability, Boltzmann-Planck equation.

Unit-II: Statistical thermodynamics (14 hours)

Thermodynamic probability and entropy, Maxwell-Boltzmann statistics, Partition function (translational, vibrational, rotational and electronic) for diatomic molecules, relationship between partition and thermodynamic function (internal energy, enthalpy, entropy and free energy), Calculation of equilibrium constant, Fermi-Dirac statistics, Bose-Einstein statistics, Distribution law and its application to metal.

Unit-III: Non-equilibrium thermodynamics (10 hours)

Thermodynamic criteria for non-equilibrium states, Entropy production and entropy flow, Entropy balance equation for the different reversible processes: (Entopy Production in chemical reaction, Entropy production/Entropy flow in Open system), Different types of forces and fluxes, Transformation Properties of fluxes and forces, Non-equilibrium stationary state, Microscopic reversibility, Onsager‘s reciprocity relation, Verification of Onsager‘s reciprocity relation : Kinetically and Thermodyanamically, Electrokinetic phenomena, Diffusion, Electric conduction.

Unit-IV: Chemical Dynamics (14 hours)

Collision theory of reaction rate, Activated complex theory, Arrhenius equation, Ionic reaction, Kinetic salt effect, Steady state kinetics, Photochemical reaction (Hydrogen-Bromine and Hydrogen-Chlorine reactions), Oscillatory reactions (Belousov-Zhabotinsky reaction), Homogeneous catalysis, General features of fast reaction, Study of fast reaction by flow method and relaxation method. Treatment of Unimolecular reactions (Lindemann-Hinshelwood and Rice-Ramsperger-Kassel-Marcus theories(RRKM))

Books recommended:

1. K.L. Kapoor, Text book on Physical Chemistry, Volume 2, Macmillan India Ltd. Delhi

2. P. W. Atkins, Physical Chemistry, 7th Edition, (2002) Oxford University Press, New York.

3. Andrew Maczek, Statistical Thermodynamics, (1998) Oxford University Press Inc., New York.

4. F.W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Wiley-Interscience, New York.

5. K. J. Laidler, Chemical Kinetics, Third Edition (1987), Harper & Row, New York.

6. P. W. Atkins, Physical Chemistry, Seventh Edition (2002), Oxford University Press, New York

7. I.N. Levine, Physical Chemistry, 5th Edition (2002), Tata McGraw Hill Pub. Co. Ltd., New Delhi.

8. J. Raja Ram and J.C. Kuriacose, Kinetics and Mechanism of Chemical Transformations (1993), MacMillan Indian Ltd., New Delhi.

9. S. K. Dogra ,S. Dogra, Physical Chemistry Through Problems, New Age International (P)Limited.

10.R.P. Rastogi & R.R Mishra An introduction to Chemical Thermodynamics, Vikas Publishing House Pvt Ltd; Sixth edition (2018)

Course Code:	CHPC204	No. of Credits:	4
Course Name:	SPECTROSCOPY-II	Sem End Exam & Cycle Test:	70+30

Course Educational Objective: This course enables the students
To learn various techniques of spectrometric identification of organic compounds and characterizes organic compounds by applying various techniques together.

Course Outcome:
Upon successful completion of this course, students should be able to:
CO1: To understand about electronic transitions, UV of carbonyl compounds,dienes and heterocyclic compounds.
CO2: To study the instrumentation ,components of IR and identify different functional groups in compounds.
CO3: To understand processes responsible for NMR chemical shifts and splitting patterns by interaction of ^{1}H and ^{13}C nuclei.
CO4: To study the concepts, principles, splitting patterns of Mass Spectroscopy and their applications to structural determination of organic molecules.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3										
CO2	2	2										
CO3	3	3										
CO4	3	3										

COURSE CONTENT

Unit-1: Ultraviolet and Visible spectroscopy (11 hours)

Various electronic transitions (185-800 nm), Beer-Lambert Law , molar extinction coefficient, Effect of solvent on electronic transitions, relationship of potential energycurves to electronic spectra, Chromophores, auxochromes, blue shift, red shift, hypo and hyperchromic effect, Ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes and conjugated dienes, Woodward rulesfor conjugated dienes,Ultraviolet spectra of aromatic and heterocyclic compounds, Steric effect in biphenyls.

Unit –II: Infra-red spectroscopy (12hours)

Infra-red spectroscopy :,Instrumentation , Characteristics vibrational frequencies of simple organic molecules like alkanes, alkene, alkyne , aromatic compounds , alcohols, phenol, amines, aldehydes, ketones, acids and acid derivatives, Effect of hydrogen bonding and Solvent effect on IR –spectra, Overtones and combination bands, Fermi resonance, FT-IR.

Unit-III **(15hours)**

A. Nuclear Magnetic Resonance Spectroscopy

Basic principle, Chemical shift, Spin-spin interaction, Shielding mechanism, Chemical shift values and correlation to protons bonded to carbon and other nuclei, coupling constant and factors affecting the coupling constant, Chemical exchange, Effect of deuteration, Complex spin-spin interaction between two, three, four and five nuclei , Hindered rotation, Shift reagent , Nuclear-overhauser effect(NOE)

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B. Carbon-13 NMR spectroscopy:

General consideration, Chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic, and carbonyl carbon), Coupling constant , 1H-decoupling, noise decoupling, broad band decoupling; Introduction to two dimension NMR spectroscopy: COSY, DEPT , INDEQUATE techniques.

Unit-IV: Mass Spectroscopy **(10hours)**

Introduction , methods of ionization - EI, CI, Brief description of FD and FAB, Factors affecting fragmentation, Ion analysis, Ion abundance fragmentation of organic compounds with common functional groups, Molecular ion peak , Metastable ions , Mc-Lafferty rearrangement , Nitrogen rule, High resolution mass spectrometry, Examples of mass spectra fragmentation for the determination of structure of simple organic molecules.

Books recommended

1. Instrumental Methods of analysis by Willard, Merrit, Dean and Settle
2. Spectroscopic identification of organic compounds- R.M. Silverstein and G.C. Bassler
3. Applications of spectroscopic techniques in Organic chemistry- P.S. Kalsi
4. Absorption spectroscopy of organic molecules- V.M. Parikh
5. Introduction to Spectroscopy, Pavia, Brooks/Cole Cenage, 4th edition, 2009, Belmont
6. Organic Spectroscopy, W. Kemp, Palgrave
7. Symmetry ans Spectroscopy of Molecules, , K.V. Reddy, New Age International (P) Ltd., Ist edition, 1998, New Delhi.
8. Modern NMR Spectroscopy: A Guide for Chemists. J. K. M. Sanders, B. K. Hunter. Oxford UniversityPress, 1993
9. Principles of nuclear magnetic resonance in one and two dimensions. R. R. Ernst, Geoffrey Bodenhausen, and Alexander Wokaun. Oxford University Press, 1987
10. Spectrometric Identification of Organic Compounds, R. M. Silverstein, F. X. Webster, D. J. Kiemle, D. L. Bryce, Willey, 8th Edition (2015).
11. Mössbauer Spectroscopy, N.N. Greenwood and T.C. Gibb, , Chapman and Hall 1971, London.
12. Mössbauer Spectroscopy and Transition Metal Chemistry, P. Gütlich, R. Link, A. Trautwein, , Springer, 1978, Verlag, Berlin-Heidelberg-New York.
13. Analytical Method By R Gopal & K S Viswanatthan ,University Press

Course Code:	CHPC205	No. of Credits:	4
Course Name:	INORGANIC PRACTICAL	Sem End Exam:	100

(6hrs per week)

Course Educational Objective:

This course enables the students

CEO: To explore the basic chemistry in aqueous medium, solubility product, color, texture, solubility, group chemistry etc. of some common inorganic salts (both cations and anions).

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: Detect the cations and anions present in unknown inorganic sample.

CO2: Analyze unknown inorganic samples containing 3 acid and 3 basic radicals including rare elements.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3			1				1			
CO2	2	3			1				1			

1. Qualitative analysis of mixtures containing not less than six radicals (organic radicals should be excluded).Anyone of the following rare metal ions may be included.

a) V b) Mo c) W d) Ti

2. A) Volumetric analysis involving EDTA as reagent.

I. Determination of Ca^{2+} and Mg^{2+} in Dolomite.

II. Determination of Nickel in Stainless steel. OR

B) Complete analysis of:

i) Brass ii) Cement iii) chromo iron ore. OR

C) Preparation of Hexamine Cobalt (III) chloride.

Book recommended

1. Quantitative and Qualitative analysis By A.I. Vogel Semester-III

Course Code:	CHEC206	No. of Credits:	2
Course Name:	SEMINAR AND PROJECT _II	Sem End Exam:	50

Every student will be assigned one individual project under the guidance of the professors of the department. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc. Each student will submit a technical report with details regarding the Literature survey, References, Objective and Plan of the project work assigned.

CRITERIA	Max. Marks
Presentation	10
Communication	15
Seminar contents	25
Total Marks	**50**

SEMESTER-III

Course Code:	CHPC301	No. of Credits:	4
Course Name:	ANALYTICAL CHEMISTRY-I	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To learn the different techniques for characterization of organic and inorganic materials.

CEO2: To understand crystal structure, morphology, microstructure, different types of phases present in a material, purity of the material.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand the instrumentation, applications of TGA, DTGA and DTA.

CO2: To explain the electrodes, processes, suitable method for the analysis of a particular sample and analytical applications of Voltametry.

CO3: To educate in structure identification, topology, morphology, composition and crystallographic information by using XRD , SEM, TEM and even the data analysis.

CO4: To understand the classification and various analyses of fuel and drugs.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2										
CO2	3	2										
CO3	3	2										
CO4	2	2										

COURSE CONTENT

Unit- I Thermal methods of analysis (14 hours)

Thermo analytical methods: Thermogravimetric analysis (TGA): Principle, instrumentation, factors affecting TGA curve, derivative thermogravimetric analysis (DTGA) and application of thermogravimetric analysis to physical studies (reaction kinetics and information for the constitution of phase diagram), Differential thermal Analysis (DTA), instrumentation of DTA and application of DTA, Simultaneous study of TGA, DTA with examples. Differential scanning calorimetry (DSC) and thermometric titration.

Unit-II Electrical methods of analysis (12 hours)

Electroanalyctical Method Polarography: Basic principle, instrumentation, theory of current-voltage curve, Theory of diffusion current, Dropping mercury electrode, Ilkovic equation, polarography wave and half wave potential. Application of polarography.

Voltametry : Reversible reactions, The residual current, Current maxima, Principle, Application, advantage and disadvantage of Cyclic voltammetry anodic stripping voltammetry, amperometry, conductrometry and ion selective electrodes.

Unit-III X-Ray Diffraction Method (12 hours)

X-Ray method: X-Ray absorption and X-Ray Diffraction methods, Electron Spectroscopy: Photoelectron Spectroscopy (PES), Electron Microscop: Scanning Electron Microscope(SEM), Transmission Electron Microscopy(TEM)

Analysis of data: Types of errors, determinate error, indeterminate error, minimisation of error, Accuracy and precession. Mean (Average Deviation), Standard deviation, Median, Methods of repeating analytical data, statistical evaluation of data, statistical analysis. Problems.

Unit-IV Analysis of Fuel and Drugs (11 hours)

(a) Fuel analysis: Solid, liquid and gas. Ultimate and proximate analysis—heating values grading of coal. Liquid fuels-flash point, Aniline point, octane number and carbon residue. Gaseous fuels-producer gas and water gas-calorific value.
(b) Drug analysis: Narcotics and dangerous drugs. Classification of drugs. Screening by gas and thin layer chromatography and separation of Amino acids by gas chromatography method.

Book recommended

1. Analytical chemistry by Gurdeep Chatwal

2. Instrumental methods of Chemical Analysis ny H.Kaur

3. Instrumental Method of Analysis by H. Willard, L. Merritt, J. Dean & F. Settle

4. Analytical Chemistry (Theory and Practical) by U.N. Dash

5. Basic Principle of Analytical Chemistry by S.M. Khopkar

6. Standard Methods of chemical Analysis Vol.3, Part A & B, By F. J. Welcher,

7. Instrumental Methods of Analysis 4th and 5th editions By G.W. Ewing,

8. Vogel's Textbook of Quantititative Inorganic Analysis By Bassett, Denney-Jeffer and Mendham,.

9. Electro-analytical chemistry, edited by H.W.Nurnberg.

10. A Textbook of Electrochemistry By Kortum and Bockris

11. Principles of Electrochemistry by D.A. Maclines,.

Course Code:	CHPE302	No. of Credits:	4
Course Name:	ORGANIC CHEMISTRY-III	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To learn electro cyclic reactions, sigma topic rearrangement, Introduction to photochemistry, cyclisation reaction and ring opening of 1, 3 Butadiene, 1, 3, 5 hexatriene systems.

CEO2: To provide knowledge of photochemistry and applications to organometallics.

CEO3: To learn the mechanism of condensation, oxidation and reduction.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand the orbital symmetry and different approaches of pericyclic reactions.

CO2: To understand the concept of photochemistry and various photochemical reactions of in organic molecules.

CO3: To learn the mechanism of condensation, oxidation and reduction in different functional groups.

CO4: To understand the importance of organometallic compounds in synthesis.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3										
CO2	2	3										
CO3	2	3										
CO4	2	3										

COURSE CONTENT

Unit-I: Pericyclic Reaction (17 hours)

Molecular orbital symmetry, Frontier orbital of ethene, 1,3- Butadiene,1,3,5-Hexatriene,Allyl system, Classification of pericyclic reaction,Methods of explaining pericyclic reactions- Woodward-Hoffmann method, Frontier molecular orbital theory approach, Huckel-Mobius approach.

Electrocyclic reactions : Dis and Con rotation, 4n ,4n+2 and allylic system, Explanation through correlation diagram and Huckel-Mobius approach,

Cycloaddition reaction : 2+2 and 4+2 cycloaddition, 1,3-Dipolar cycloaddition, Cheletropic reactions, Sigmatropic rearrangements ,Claisen Rearrangement,Cope rearrangement ,Ene reaction

Unit-II: Organic Photochemistry (10 hours)

Electronic excitations, Fate of excited molecules (Jablonski diagram), Fluorescence, Phosphorescence, Photodissociation reactions: Norrish Type-I &II cleavage, Photo isomerisation,Photo-Fries rearrrangment, Paterno-Buchi reaction, Barton reaction, Di-Pi methane rearrrangment, Photochemistry of aromatic compounds, Photo-Oxidation of alkenes, Photochemistry of vision.

Unit-III: Name reaction and molecular rearrangement (12 hours)

A: Name reaction :Chichibabin reaction, Clasien-Schmidth reaction, Bayer villager reaction, Hoffman reaction, Shapiro reaction, Stobbe condensation, Wittig reaction. Aldol condensation, knoevenagel condensation, Claisen condensation, Mannich Reaction, Benzoin condensation, Perkin Reaction, Michael reaction, Reformatsky reaction

B: Molecular rearrangement :Beckmann rearrangement, Benzilic acid rearrangement, Pinacol-Pinacolone rearrangement, Wagner-Meerwein rearrangement, Dienone-Phenol rearrangement , Favorskii rearrangement,Fries rearrangement, Lossen rearrangement , Neber rearrangement, Steven rearrangement ,Benzidine rearrangement .

Unit-IV: Applications of Organometallic compounds (10 hours)

Metal atom functionality in Organometallic reactions: Carbocationic behaviour, Carbanionic behaviour, Free radical behaviour. Synthetic applications of organozinc, organocadmium, organolithium, organomercury and organocopper compounds, Grignard reagent

Book recommended

1) Photo chemistry and Pericyclic reaction by Jagadamba Singh & Jaya Singh , New Age International Publication
2) Organic synthesis: Clayden, Greeves, Warren and Wouthers, Oxford Univ. Press, 2nd Ed (2012).
3) Fundamentals of Photochemistry, K. K. Rohtagi-Mukherji, Wilcy-Eastern.
4) Molecular Photochemistry, N. J. Turro, W. A. Benjamin.
5) Introductory Photochemistry, A. Cox and T. Camp. McGraw-Hill.
6) Photochemistry, R. P. Kundall and A. Gibert, Thomson Nelson.
7) Organic reaction mechanism (Benjamin) R. Breslow
8) Organic reaction mechanism (McGraw-Hill) R. K. Bansal.
9) Organic chemistry By Dy Sunakar Panda
10) Organometallic chemistry By Indrajit Sharma
11) Reaction ,Rearrangement and Reagents By S N Sanyal, Bharati bhawan (P&D)

Course Code:	CHPE303	No. of Credits:	4
Course Name:	ORGANOMETALLIC CHEMISTRY	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: The objective of the course is to appraise the students about the organometallic Chemistry.

CEO2: To identify the basic concept, terms, and important events in the development of organometallic chemistry.

CEO3: To learn methods, including spectroscopy techniques, used to determine the structure of organometallic complexes and to probe reaction mechanism.

CEO4: To develop an appreciation for the scope, diversity, and application of organometallic chemistry.

CEO5: To learn about the common organometallic reactions and to be able to draw reasonable reaction mechanisms

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand the preparation, properties and structure of main group organometallic chemistry.

CO2: Be able to use knowledge about structure and bonding issues to understand the stability and reactivity of simple organometallic complexes.

CO3: It is use full for industrial processes include olefin metathesis, alkene polymerization, alkene

CO4: Know important applications of organometallic homogeneous catalysis in the production of large-scale (bulk) and smaller-scale (fine chemicals) production.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										-
CO2	1	2										-
CO3	2	3										-
CO4	2	3										2

COURSE CONTENT

Unit I: Main Group Organometallics (12 hours)

Synthesis and reactions of organolithium compounds; Synthesis and reactions of organ magnesium compounds; Organometallics of zinc and mercury: preparation, structure, bonding and reactions of aluminum organyls; Silicon organyl of coordination number 4.

Unit II: Transition Metal–Carbon Bond (12 hours)

(a) Transition Metal–Carbon σ-Bond: Brief review of metal alkyl compounds; transition metalcarbene and transition metal-carbyne compounds; transition metal vinylidene and transition metal allenylidene compounds.

(b) Transition Metal-Carbon π-Bond: Cyclopropenyl cation ($C_3R_3^+$) as a ligand; C_4R_4 as a ligand (R = H, Me, Ph), cyclopentadienyls as ligand

Unit III: Syntheses of Cyclopentadienyl and Arene Metal Analogues (12 hours)

Synthesis and reactions of cyclopentadienyl metal carbonyls, arene metal carbonyls, η^6-arene-chromium tricarbonyl in organic synthesis. η6 -cycloheptatriene and η6 -cyclooctatriene ligands: synthesis and reactions.

Unit IV: Organometallic Compounds in Catalysis (12 hours)

Stiochiometric reactions for Organometallic catalysts: Dissociation & Substitution, Oxidative addition & carbonylation, Oxygen transfer from Peroxo and Oxo Species, Reductive & Hydride elimination, Insertion, Displacement and Isomerization reaction, Hydrogenation , Hydrosilation and Hydrocynation of unsaturated compounds, Hydroformylation of alkenes (Using cobalt and rhodium catalyst), Wacker (Smidt) Process, Olefin Metathesis, Fischer-Tropsch synthesis, Zeigler-Natta polymerization of olefins, Water gas reaction.

Book recommended

1. Molecular Chemistry of the Transition Elements: F. Mathey & A. Sevin, John Wiley.
2. Organometallic Chemistry: A Unified Approach (2nd edn.), R. C. Mehrotra & A. Singh, New Age International.
3. The Organometallic Chemistry of the Transition Metals (4th edn.): R. H. Crabtree John Wiley.
4. Basic Organometallic Chemistry: Concepts, Synthesis and Applications (2nd edn.), B. D. Gupta & A. J. Elias, Springer Science.
5. Basic organometallic Chemistry by B. D. Gupta, A. J. Elias, University Press (India) Pvt. Ltd., 2nd edn, Hyderabad, 2013
6. Organometallic Chemistry by R. C. Mehrotra, A. Singh, New Age International Ltd., 1st edn, 2011, New Delhi
7. Organometallic Compounds by Indrajeet Kumar, 4th edn, 2013, Pragati Prakashan, Meerut.

Course Code:	CHPE304	No. of Credits:	4
Course Name:	ENVIRONMENTAL AND ANALYTICAL CHEMISTRY	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To explain the types of air pollutants, casuses and consequences of air pollution.

CEO2: To explain the concepts behind wastewater characterization, treatment.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: Students will be able to define air pollution, explain the sources of air pollution, discuss and describe types of air pollution.

CO2: To describe the main sources of water pollution, the main types of pollutant .

CO3: To understand the principle, instrumentation, differences between absorption and emission of spectroscopy.

CO4: To get acquainted with the sources, properties and ill-effects of important radioactive pollutants and apply analytical tools to determine and measure pollutants.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2					1					1
CO2	2	2					1					1
CO3	1	3										
CO4	1	2										1

COURSE CONTENT

Unit-I Air pollution **(12 hours)**

Primary pollutants like Carbon monoxide, nitrogen oxides, hydro carbons, sulphur dioxide, particulate matter, Consequences of air pollution : Acid rain, Green house effect, Ozone layer depletion, Smog formation, Sampling, monitoring and analysis of Carbon monoxide, Nitrogen oxide, Sulphur dioxide, Hydrocarbons, Aromatic hydrocarbons. Aromatic hydrocarbons in exhaust petrol and acid.

Unit-II Water pollution and water analysis: (12 hours)

Water pollutants, type of water pollutants: Ground water, surface water, lake water, river water and sea water. Sources of water pollution: Domestic source, industrial effluents, agricultural discharge, radioactive material. General effect of water pollution, analysis of water pollutants: important parameters like colour turbidity, electrical conductivity, total suspended solids, hardness, alkalinity,fluoride, dissolved oxygen, chemical oxygen demand, biochemical oxygen demand. Detrimental effect of some toxic elements like Cd, Cr, Pb, Zn and Hg. Waste water treatment.

Unit-III Absorption and Emission Spectroscopy: (12 hours)

Principle, difference between atomic absorption spectroscopy and flame emission spectroscopy, advantages and disadvantages of atomic absorption spectroscopy. Instrumentation, detection limit and sensitivity. Fluorimetry and Phosphorimetry, Comparision of Fluorimetry and Phosphormetry, Some Flurometric applications and some phosphorimetric applications.

Unit-IV Radio isotopes in Analysis: (10 hours)

Applications of radio isotopes to physico-chemical problems: solubility of sparingly soluble salt, surface area of powder or precipitate, rate of diffusion and study of reaction mechanism. Analytical applications of radioactivity: Radio chromatography, isotopic dilution analysis, Neutron activation analysis and radiometric titration. Use of radio isotopes for dating, in medicine, agriculture and industry.

Book recommended

1. Environment and Ecology by Sunakar Panda
2. Text book of Environmental chemistry by A.K. De
3. Analytical chemistry by Gurdeep Chatwal
4. Environmental Chemistry by B.K.Sharma

Course Code:	CHPE305	No. of Credits:	4
Course Name:	NANOCHEMISTRY	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To provide introduction to nanoscience and technology.

CEO2: To learn the various approaches for the synthesis of nanoscale materials/nanoparticles.

CEO3: To understand crystal structure, morphology, microstructure, different types of phases present in a material.

CEO4: To study applications of nanoparticles.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand about nanostructure.

CO2: To obtain knowledge about synthesis of nanoparticles.

CO3: To understand the instrumentation, transmission and diffraction techniques.

CO4: To understand various applications of nanomaterials.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2	2	3										
CO3	3	2										
CO4	1	3										

COURSE CONTENT

Unit I Introduction to nano scale Science and Technology (10 hours)

Introduction and classification -What is nanotechnology? - Classification of nanostructures - Nanoscale architecture; Summary of the electronic properties of atoms and solids - The isolated atom - Bonding between atoms - Giant molecular solids - The free electron model and energy bands - Crystalline solids - Periodicity of crystal lattices - Electronic conduction; Effects of the nanometer length scale - Changes to the system total energy - Changes to the system structure - How nanoscale dimensions affect properties- Fabrication methods: Top-down processes, Bottom-up processes, Methods for templating the growth of nanomaterials, Ordering of nanosystems

Unit II: Synthesis and Stabilization of Nano particles: (10 hours)

Chemical Reduction; Reactions in Micelles, Emulsions; Photochemical and Radiation Cryochemical Synthesis: Physical Methods; Particles of Various Shapes and Films.

Unit III: Experimental Techniques: Electron Microscopy: (12 hours)

Transmission electron microscopy (TEM), Scanning electron microscopy (SEM): Diffraction Techniques: X-ray diffraction,
Neutron diffraction and some miscellaneous Techniques: X-ray fluorescence spectroscopy, UV-visible spectroscopy

Unit IV: Applications of Nanoparticle: (10 hours)

Catalysis on Nano particles, Semiconductors, Sensor, Electronic Devices, Photochemistry and nanophotonics, Application of Carbon Nano tubes, Nanochemistry in Biology and Medicine

Book recommended

1. Nanomaterials and Nanochemistry, Br'echignac C., Houdy., and Lahmani M. (Eds.) Springer Berlin Heidelberg New York. 2007.
2. Nanoscale Science and Technology, Robert W. Kelsall, Ian W. Hamley and Mark Geoghegan, John Wiley & Sons, Ltd., UK, 2005.
3. Introduction to Nanotechnology, Charles P. Poole Jr and Frank J. Owens, Wiley Interscience, 2003.
4. Bio-Inspired Nanomaterials and Nanotechnology, Edited by Yong Zhou, Nova Publishers.
5. Nano:The Essentials: Understanding Nanoscience and Nanotecnology, T.Pradeep, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.
6. Nanoparticle Technology Handbook. M. Hosokawa, K. Nogi, M. Naito and T. Yokoyama (Eds.) First edition 2007. Elsevier
7. Nanotechnology Basic Calculations for Engineers and Scientists. Louis Theodore, John wiley & sons, inc., publication, 2006.

Course Code:	CHCBOE306	No. of Credits:	4
Course Name:	CHEMISTRY OF MATERIALS	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: Develop understanding of the structure of ceramic materials, knowledge of mechanical properties including examples of ceramics and glass applications.

CEO2: To learn preparation, properties and applications of composites.

CEO3: To study the properties and applications of ionic conductors and films.

CEO4: To study about the conducting and magnetic properties of Fullerenes and optical materials**.**

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To obtain knowledge of the structure of clays, ceramics, and glasses.

CO2: To understand the preparation, properties and applications of composites

CO3: To understand the types,properties,defects and applications of ionic conductors and films.

CO4: To recognize conducting and magnetic properties of Fullerenes and optical materials

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-										
CO2	2	2										
CO3	3	3										
CO4	2	3										

COURSE CONTENT

Unit-I Glasses, Ceramics, Clay and Refractories: (12 hours)

Glassy State, Glass Formers and Glass Modifiers, Applications. Ceramic Structures, Mechanical Properties, Clay Products. Refractories, Characterizations, Properties and Applications

Unit-II Composites, and Nanomaterials: (11 hours)

Macroscopic Composites, Dispersion-Strengthened and Particle-Reinforced, Fibre-Reinforced

Composites, Macroscopic Composites. Nanocrystalline Phase, Preparation, Procedures, Special Properties, Applications.

Unit-III (13 hours)

A:Ionic Conductors: Types of Ionic Conductors, Mechanism of Ionic Conduction, Interstitial Jumps (Frenkel), Vacancy Mechanism, Diffusion Superionic Conductors, Phase Transition and Mechanism of Conduction in Superionic Conductors, Examples and Applications of Ionic Conductors.

B: Thin Films and Langmuir-Blodgett Films: Preparation Techniques, Evaporation/Sputtering, Chemical Processes, Sol-Gel, etc. Langmuir-Blodgett (LB) Film, Growth Techniques, Photolithography, Properties and Application of Thin and LB Films.

Unit-IV Organic Solids, Fullerenes, and Molecular Devices: (15 hours)

Conducting Organics, Organic Superconductors, Magnetism in Organic Materials. Fullerenes-Doped, Fullerenes as Superconductors. Molecular Rectifiers and Transistors, Artificial Photosynthetic Devices, Optical Storage Memory and Switches-Sensors. Nonlinear Optical Materials: Nonlinear Optical Effects, Second and Third Order, Molecular Hyperpolarisability and Second Order Electric Susceptibility, Materials for Second and Third Harmonic Generation.

Books Recommended:

1. N.W. Ashcroft and N.D. Mermin, Solid State Physics, 33rd Edition, Holt, Rinehart and Winston, 1976.
2. W.D. Callister and D.G. Rethwisch, Materials Science and Engineering: An Introduction, 9th Edition, John Wiley & Sons, 2014.
3. H.V. Keer, Principles of Solid State, 1st Edition, New Age International, 1993.
4. J.C. Anderson, K.D. Leaver, R.D. Rawlings, and J.M. Alexander, Materials Science, 4th Edition, Springer, 2013.
5. G.W. Gray, Thermotropic Liquid Crystals, 1st Edition, John Wiley & Sons, 1987.
6. H. Kelker and R. Hatz, Handbook of Liquid Crystals, 1st Edition, VerlagChemie, 1980.
7. D. Singh, D. Zhu, W.M. Kriven, S. Mathur, H.-T. Lin, Design, Development, and Applications of Structural Ceramics, Composites, and Nanomaterials, 1st Edition, John Wiley & Sons, 2014.
8. C. S. Sunandana, Introduction to Solid State Ionics: Phenomenology and Applications, 1st Edition, CRC Press, 2016.

Course Code:	CHCBOE307	No. of Credits:	4
Course Name:	CHEMISTRY AND ENVIRONMENT	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: Environmental chemistry is the study of chemical alterations in the environment. Principal areas of study include soil, air contamination and water pollution.

CEO2: The topics of analysis include chemical degradation in the environment, multi-phase transport of chemicals and chemical effects upon biota. Thus it will provide you with a detailed knowledge and comprehensive understanding of environment.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand the different classification and components of Environment and Degradation

CO2: To understand consequences of deforestation, Renewable and nonrenewable resources, Conventional and nonconventional energy resources

CO3: To understand classification and effect of various pollution

CO4: To understand the structure and composition of atmosphere, Ozone layer depletion, Greenhouse effect, Smog, Acid rai), control of air pollution, air quality and standards.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2					1					-
CO2	1	2					1					-
CO3	1	2					2					-
CO4	1	2					2					2

COURSE CONTENT

Unit-I Environmental Processes (10 hours)

Environment and its classification, Factors influencing environment, Components of Environment; Environmental degradation, biogeochemical cycles; Hydrological cycle, Gaseous cycles (Oxygen cycle, CO_2 cycle, Nitrogen cycle), Sedimentary cycles (Sulfur cycle, Phosphorous cycle)

Unit-II Natural Resources (10 hours)

Introduction of , classification of resources; land resources , formation of soil, soil erosion, Water resources, Sources of fresh water, Uses of water, causes for the depletion of water resources ;mineral resources, Forest resources, Deforestation, consequences of deforestation; affords to control

deforestation, Renewable and nonrenewable resources, Conventional and nonconventional energy resources

Unit-III Environmental pollution (10 hours)

Introduction, Pollutants, Types of pollutants, Classification of pollution, effects of pollution, Radiation pollution: sources, effect and control of radiation pollution, Thermal pollution: sources, effects and its control, Industrial pollution, Sewage and sewage treatment.

Unit-IV Air Pollution and its control (10 hours)

Atmosphere; structure and composition of atmosphere, Classification of air pollutants, Primary Pollutants (Carbon Monoxide, Nitrogen Oxides, and Sulphur Dioxide), Consequences of air pollution (Ozone layer depletion, Greenhouse effect, Smog, Acid rain), control of air pollution, air quality and standards.

Book recommended

1. Environment and Ecology By Dr. Sunakar Panda
2. Environmental Chemistry By A.K. De
3. Air Pollution By Wark & Werner
4. Environmental Pollution Control in Process Industries By S.P. Mahajan
5. Environmental Chemistry By B.K. Sharma & H.Kaur
6. Introduction to Air Pollution By P.K. Trivedi
7. Environmental Pollution Analysis By S.M. Khopkar
8. A Text Book of Environmental Pollution By D. D. Tyagi, M. Mehre
9. Environmental Pollution Engineering and Control By C.S. Rao

Course Code:	CHPC308	No. of Credits:	4
Course Name:	ANALYTICAL CHEMISTRY PRACTICAL	End Exam:	100

Course Educational Objective:
This course enables the students
CEO1: To determine relative strength of acids, rate constant & order of reactions PKa value of a weak acid potentiometric titration and conductometric titration.

Course Outcome:
Upon successful completion of this course, students should be able to:
CO1: An appreciation for modern problems and scientific controversies in physical chemistry.
CO2: How to design and perform experiments to determine the rate, order, and activation energy of chemical reactions by varying concentrations and/or temperature
CO3: Methods to measure equilibrium concentrations and equilibrium constants for acid-base, solubility, and complexation reactions given initial concentrations of reactant
CO4: To the preparation of buffer solutions at a required pH, given a choice of solutions of acid/conjugate base pairs
CO5: To know the principle and mechanism of Conductormetric and potentiometric titrations.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											
CO2	2	1										
CO3	2											
CO4	2											
CO5	2											

6Hrs duration **F.M.-100**

1. To find out the dissociation constant of the given tribasic acid, i.e. phosphoric acid by treating it against NaOH using a pH Meter
2. Determination of hydrolytic constant (Kh) of ammonium chloride solution pH-metrically.
3. To estimate the iron content in the given ferrous ammonium sulphate solution by Colorimetry
4. To determine the composition and stability constant of Fe(III) –salicylic acid complex colorimetrically by Job‘s method of continuous variation.
5. To determine the Λo and Ka of weak electrolyte at a definite temperature by Debye Huckel Onsagar equation.

6. To determine the stoichoimetric ratio in the complex metric titration of HgCl2 against potassium iodide conductometrically.
7. To determine the total cation concentration in natural water.
8. To estimate the amount of Na^+ ion in a given sample using ionisation resin column.
9. Potentiometric estimation of Mohr salt solution with standard potassium dichromate solution and also determination of formal potential (reduction) of ferric-ferrous system.
10. Determination of activity solubility product of silver chloride by emf measurement
11. Adsorption of CH_3COOH on activated charcoal and verification of Freundlich's & Langumir's adsorption isotherm.
12. Simultaneous estimation of Mn and Cr in a solution of $KMnO_4$ and $K_2Cr_2O_7$

Book recommended

1. Physical Chemistry Practical by Saroj Kr Maity and Naba Kr Ghosh

2. Experimental Physical Chemistry by R.C. Das and B. Behera

3. Text book of Quantitative Inorganic Analysis by A.I. Vogel,ELBS(1978)

4. Experimental Physical chemistry by J B Yadav, Goel Pub. House,(1981)

5. Senior Practical Physical Chemistry by B. C. Kosla, Simla Printers New Delhi (1987).

6. Experimental Physical Chemistry by Daniel et al., McGraw Hill, New York (1962).

Course Code:	CHEC309	No. of Credits:	2
Course Name:	SUMMER INTERNSHIP/ Seminar & Project - III	Sem End Exam & Cycle Test:	50

Course Educational Objective:

This course enables the students

CEO1: To gain practical experience by working in a professional chemistry –related environment.

CEO2: To demonstrate an ability to work independently and utilize principles of chemistry to solve real-world problems

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To know the various types of industries, nature of job involved, entire work area of the industry/institution and to adapt with the working people.

CO2: To learn the procedure of identifying, approaching, applying and getting approval of internship from a leading industry/institutions.

CO3: To identify the manufacturing procedures and technical skills involved and correlate the manufacturing procedures with simple laboratory synthesis

CO4: To learn the environment aspects, pollution their control involved in the manufacturing unit.

CO5: To prepare a final evalution report and presentation for the internship carried out for minimum 30 days.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2								1			
CO2	2	1										
CO3	2											
CO4	2						1					
CO5	2								1			

A student has to work in a reputed industry for the period of minimum 30days during summer vacation after the completion of 2nd semester and he/she has to submit a thesis report and give a power point presentation about the work done in the industry.

SEMESTER IV

Course Code:	CHPC401	No. of Credits:	4
Course Name:	PHYSICAL CHEMISTRY-III	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To understand the Debye Huckel Theory of ion-ion interactions.

CEO2: To understand Semiconductor interfaces, Fuel cell, Corrosion

CEO3: This course is intended as an introduction to surface chemistry and cover fundamental and applied aspects of surface chemical processes; theories of molecular adsorption/desorption, surface active agent

CEO4: To provide an introduction to the concepts underlying solid state chemistry.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: Discuss electrical properties of ionic solutions, describe Debye –Huckel equation: limiting and extended forms, calculate effect of ionic strength on ion reaction rates and determine the activity coefficient by different methods,

CO2: State and explain Semiconductor interfaces, Fuel cell and its applications, Corrosion monitoring and prevention, solve the cell reactions and calculate EMF.

CO3: Understand the adsorption of gases by solid type of isotherms, estimate the surface area, study the various types of surfactants and factors affecting CMC.

CO4: Classify Crystal systems and lattices, describe specific crystal structures by applying basic crystallographic concepts

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										
CO2	2	3										
CO3	2	2										
CO4	1	3										

COURSE CONTENT

Unit-I Electrochemistry-I **(13 hours)**

A. Electrochemistry of solution: Ion-solvent interactions, Born Model, Ion-ion interactions: Debye-Huckel (ion-cloud), Bjerrum Model, Thermodynamics of electrified interface equations; Ion transport in solution: Debye Huckel-Onsager equation, Derivation of electrocapillarity, Lippmann equations, Structure of electrified interfaces, Over potential, Derivation of ButlerVolmer equation, Tafel plot.

B. Activity and activity coefficient, Ionic strength, Debye-Huckel limiting law and its verification, Degree of dissociation and its determination, Determination of activity coefficient by freezing point, Vapour pressure and solubility measurement, Ion association, Association constant, Determination of dissociation constant of electrolyte

Unit-II Electrochemistry-II (12 hours)

A. Semiconductor interfaces, Theory of double layer at semiconductor, Electrolytic solution interfaces, Structure of double layer interfaces, Effect of light at semiconductor solution interface, Fuel cell, Corrosion: Homogeneous theory forms of corrosion, corrosion monitoring and prevention, Passivity of metals.

B. Electromotive force, Measurement of EMF, Relationship between EMF and thermodynamics parameters (free energy change, enthalpy change and entropy change), Thermodynamics of reversible cells, Electrode potential in terms of osmotic pressure and solution pressure. Nernst equation relating electrode potential and concentration.

Unit-III Surface Chemistry (12 hours)

A. Adsorption, Surface tension, Capillary action, Pressure difference across curved surface (Laplace equation), Vapour pressure of droplets (Kelvin equation), Gibb‘s adsorption isotherm, Estimation of surface area (BET equation), Surface films on liquids (electrokinetic phenomenon), Catalytic activity at surfaces.

B. Micelles

Surface active agents, Classification, Micellization, Hydrophobic interaction, Critical micellar concentration (CMC), Factors affecting CMC of surfactants, Counter ion Binding to micelles. Thermodynamics of micellization, Phase separation and mass action models, Solubulisation, Microemulsion, Reverse micelles.

Unit-IV Solid state (10 hours)

Crystal systems and lattices, Miller Indices, wises indices, Miller planes, Crystal packing, Crystal defects; Point Defects(Schottky and Frenkel Defects), Line defects, Surface defect, Volume defects, X-Ray Crystallography, Bragg‘s Law, Ionic crystals, Band theory, Metals and semiconductors, Types of solid state reactions.

Books recommended

1. J.O‘M. Bockris and A.K.N. Reddy, Modern Electrochemistry, Vol. 1 & 2A and 2 B, (1998) Plenum Press, New York.

2. Y. Moroi, Micelles : Theoretical and Applied Aspects, (1992) Plenum Press, New York.

3. F.W. Billmayer, Jr., Text Book of Polymer Science, 3rd Edition (1984), Wiley-Interscience, New York.

4. A.R. West, Solid State Chemistry and its Applications, (1984) John Wiley & Sons, Singapore.

5. C.N R. Rao and J. Gopalkrishnan, New Directions in Solid State Chemistry, (1997) Cambridge Univ. Press.

6. S. Glasstone, ― Introduction to Electrochemistry‖ Affiliated East West

Course Code:	CHPE402	No. of Credits:	4
Course Name:	ORGANIC CHEMISTRY-IV	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To acquire the knowledge of heterocyclic Chemistry.

CEO2: To understand the synthetic application of various reagents and polymers.

CEO3: To study about various natural products and their synthesis

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand about oxidation and phenomenon of oxidation in alkanes, alkenes, alcohols, carbonyl compounds, carboxylic acids by various reagents.

CO2: To understand about reduction and phenomenon of reduction in alkenes, carbonyl compounds, carboxylic acids by various reagents.

CO3: To learn the mechanism of synthesis of various heterocycles, natural products and drugs.

CO4: To understand the basic knowledge, classification and synthesis of polymers

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1										-
CO2	2	2										-
CO3	3	-										-
CO4	3	-										3

COURSE CONTENT

Unit-I: Oxidation Reaction (13 hours)

Different oxidative processes , Oxidation of hydrocarbon , alkanes, alkenes, aromatic ring, alcohol , α, β- diol, allylic and benzylic alcohols, aldehydes ketones, carboxylic acids , amines, Dioxirane, Sharpeless Epoxidation and Dihydroxylation, Fentens oxidation, Ozone, Hydroboration Oxidation, Oxymercuration. Oxidation with RuO_4, PCC, PDC, $KMnO_4$, $K_2Cr_2O_7$, SeO_2, CrO_3,m-CPBA

Unit-II: Reduction Reaction (13 hours)

Different reductive processes, Reduction of alkenes, alkynes, aromatic rings, cycloalkanes, carbonyl compounds, aldehydes , ketones , acids and their derivatives, reduction of nitro compounds,Catalytic Hydogenation: (Hydrogenolysis, H_2/Pd/C, H_2/Pt, Lindlar reduction) $NaBH_4$, Luche reduction, B_2H_6, $LiAlH_4$, $LiEt_3BH$, Birch Reduction, Baker-Yeast Reduction, Wolf-Kishner Reduction, Noyori Reduction.

Unit-III Synthesis of Heterocycles, Natural Product and Drugs (13 hours)

Saturated heterocycles, synthesis of 5- membered rings-pyrrol,furan,thiophene, synthesis of 6-membered rings-pyridine,aromatic heterocycles-benzothiophene,benzopyrrol,benzofuran in organic synthesis. Synthesis of Porphyrin, Paal-knorr pyrole synthesis, Fisher-Indole Synthesis, Hantzsch Pyridine Synthesis, Saccharin Synthesis. Synthesis of Salbutamol, L-DOPA, prostaglandin F2α, Aspirin, α -pinene, Longifolene, Artimisnin.

Unit-IV: Organic Polymers (8 hours)

Basic concepts of Polymer, Classification, Number, weight and viscosity average molecular weights. Polydispersity and molecular weight distribution. Mechanism of polymerization (Cationic/anionic/Free radical). Synthesis and application of Polyamide, Polyester, Poly carbonate, Living Polymer, Bio- degradable polymer, Zeigler-Natta polymerization, Atactic, Syndiotactic and isotactic Polymer, Solid state peptide synthesis.

Books recommended

1. Organic synthesis: Clayden, Greeves, Warren and Wouthers, Oxford Univ. Press, 2nd Ed (2012).
2. Advanced Organic Chemistry, F. A. Carey and R. J. Sundberg, Part A and B Springer, 5th Ed.(2005)
3. A Guide Book of Mechanism in Organic Chemistry, Peter Sykes, Longman.6th Ed.(1999)
4. Structure and Mechanism in Organic Chemistry, C. K. Ingold, Cornell University Press,3rd (1957).
5. Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall, 6th Ed.(1992)
6. Advanced organic chemistry by F.A.carey and R.M.Saundberg
7. A guide book to mechanism in Organic chemistry (Orient-Longmens)- Peter Sykes
8. Organic reaction mechanism (Benjamin) R. Breslow
9. Mechanism and structure in Organic chemistry (Holt Reinh.)B. S. Gould.
10. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley, 6th Ed.(2006).
11. Chemistry Of Natural Product N R Krishnaswamy ,University Press

Course Code:	CHPE403	No. of Credits:	4
Course Name:	BIO-INORGANIC CHEMISTRY	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To understand the role of metal ions in biological system

CEO2: To understand the structure of Hb

CEO3: To understand the essential and trace metals

CEO4: To understand the different classes of drugs

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: Able to understand the mechanism of oxygen transport in body and able to understand various pumps in the body and their significance, and Able to know about the phenomenon of muscle contraction.

CO2: Able to understand the different proteins and their structures

CO3: Abe to understand the enzymes with different metal atoms their individual structures, functions in human body with aspects of biological mechanism.

CO4: Able to understand positive and negative impacts of drugs

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										-
CO2	2	3										-
CO3	2	3										-
CO4	1	2										-

COURSE CONTENT

Unit-I: Bioinorganic Chemistry of Alkali and Alkaline Earth Metals (12 hours)

Essential and trace elements in biological systems, structure and functions of biological membranes; mechanism of ion transport across membranes; sodium pump; ionophores: valinomycin and crown ether complexes of Na^+ and K^+; photosynthesis: chlorophyll a, PS I and PS II; role of calcium in muscle contraction, blood clotting mechanism.

Unit- II: Metalloproteins (12 hours)

Heme proteins and oxygen uptake, Structure and functions of haemoglobin, myoglobin, hemocyanin and hemerythrin, Iron-sulphur proteins: rubredoxin and ferredoxins, Nitrogenase, Bio-inorganic aspects of nitrogen fixation.

Unit- III: Metalloenzymes (12 hours)

Zinc enzymes – carboxypeptidase and carbonic anhydrase, Iron Enzymes – catalase peroxidise and cytochrome p-450, Copper enzymes – superoxide dismutase, Mg enzymes – vitamin B_{12}.

Unit IV: Metal complexes in Medicine (10 hours)

Cisplatin: Anticancer drug, Wilson's disease, Anti-Arthritis, Hypercalcemia, Magnetic Resonance Imaging, Siderosis Disease, Use of chelating agents in metal poisoning: the chelate therapy (Lead, Cadmium, and Mercury), Deficiency symptoms of some trace metals.

Books Recommended:

A) Priciple of Biochemistry (Lehninger): D. L. Nelson and M. M. Cox, W. H. Freeman and company, New York.
B) Fundamentals of Biochemistry: D. Voet, J. G. Voet and C. W. Pratt; John wiley and sons.
C) Bioinorganic Chemistry: Bertini, Gray, Lippard, Valentine, Viva Books Private Limited.
D) Organometallic & Bio-inorganic Chemistry: Ajai Kumar, Aaryush Education.
E) Bio-inorganic Chemistry: Asim K. Das, New Central Publisher

Course Code:	CHPE404	No. of Credits:	4
Course Name:	POLYMER CHEMISTRY	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:
This course enables the students
CEO1: To introduce the chemistry of high molecular weight polymers, both natural and synthetic.
CEO2: The methods used for their characterization and the structure of polymers.
CEO3: Properties of commercial polymers and biomedical polymers.

Course Outcome:
Upon successful completion of this course, students should be able to:
CO1: To understand the basic knowledge, classification and synthesis of polymers.
CO2: To understand about various methods used to characterize polymers.
CO3: To learn about structure and properties of polymers.
CO4: To study the properties and importance of commercial and biomedical polymers.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										1
CO2	2											-
CO3	3											-
CO4	3											3

COURSE CONTENT

Unit-I: Basics of Polymer (9 hours)

Importance of polymers, Basic concepts: Monomer, repeat units, degree of polymerization, Linear, branched and network polymers, Classification of polymers, Polymerization: Condensation, addition, radical and coordination polymerization, Polymerization conditions and polymer reactions, Polymerization in homogenous and heterogeneous systems.

Unit-II: Polymer Characterization (13 hours)

Polydispersion-average molecular concept, Number, weight and viscocity average molecular weights, Polydispersity and molecular weight distribution, Practical significance of molecular weight, Measurement of molecular weights, End group, viscosity, Light scattering, osmotic and ultracentrifugation methods, Analysis and testing of polymers, chemical analysis of polymers, Spectroscopic methods- X-ray diffraction study, Microscopy, Thermal analysis and physical testing-tensile strength, Fatigue impact, Tear resistance, Hardness and abrasion resistance.

Unit-III: Structure and Properties (13 hours)

Morphology and order in crystalline polymers-centrifugation of polymer chains, Crystal structure of polymers, Morphology of crystalline polymers, strain induced morphology, crystallization and melting, Polymer structure and physical properties-crystalline melting point, melting points of homogenous series, effect of chain flexibility and other steric factors, entropy and heat of fusion, Glass transition temperature, Tg, Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking, Property requirements and polymer utilization-elastomers,fibres and plastics.

Unit-IV: Properties of Commercial Polymers (11 hours)

Commercial polymers-importance, properties of Polyethylene, poly vinyl chloride, polyamides, phenolic resins, epoxy resins and silicone polymers, Functional polymers- Fire retarding polymers and electrically conducting polymers, Biomedical polymers–classification, properties of contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

Books Recommended

1. Textbook of Polymer Science: F. W. Billmeyer Jr, Wiley
2. Polymer Science: V. R. Gowariker, N. V. Biswanathan and J. Sreedhar, Wiley, Eastern.
3. Physics and Chemistry of Polymers: J. M. G. Cowie, Blackie Academic and Professional.

Course Code:	CHPE405	No. of Credits:	4
Course Name:	INDUSTRIAL CHEMISTRY	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1: To introduce the technologies of petroleum refining and processing to obtain the more valuable lighter fractions and intermediates for petrochemicals

CEO2: To understand the theory of surfactant behavior and commercial production technology of important surfactants.

CEO3: To highlight various important regulations like GMP and GLP practiced in pharmaceutical industry.

CEO4: To introduce concept of stoichiometry, mass and energy balances and other fundamental aspects of chemistry.

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: To understand the commercial production technology of various important petrochemicals and polymerization mechanisms.

CO2: To understand the importance of fats and oils and analyse the role of surfactant in various value added applications and the fermentation process.

CO3: To understand the manufacture of pesticides and importance of pharmacological industries.

CO4: To analyse the mass transfer systems and identify and understand the unit operations involved in a process.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1											1
CO2	2											2
CO3	3											-
CO4	3											-

COURSE CONTENT

Unit-I. Petroleum and coal based chemicals: (11 hours)

Composition of petroleum, cracking processes, commercial production of Ethylene, Acetylene, Polymerisation mechanism, addition, condensation, step growth, chain growth, method of polymerisation, distillation of coal.

Unit-II Oil based industries: (13 hours)

A. Oils and fats, solvent extraction of oils, hydrogenation of oils, use of oil in the manufacturing of soap, paints and varnishes.

B) Surface active agents:

Classification and manufacturing of detergents used for cleaning purpose.

C) Fermentation industries:

A general discussion of Fermentation conditions, manufacturing of Penicillin.

Unit-III Pesticides and Pharmacological industries: (10 hours)

Manufacture of DDT, BHC.2,4-D manufacture, Parathion manufacture. Pharmaceutical industries.

Unit-IV Stoichiometry and unit operation: (10 hours)

Distillation, Absorption and Stripping, Extraction and leaching, crystallisation, Psychometric, Drying, Evaporation, less conventional operation.

Books Recommended

1. Analytical Chemistry by G. D. Christain
2. Introduction to chromatography : Bobbit
3. Instrumental Methods of analysis (CBS) - H.H. Willard, L.L. Mirrit, J.A. Dean
4. Instrumental Methods of Analysis : Chatwal and Anand
5. Instrumental Methods of Inorganic Analysis(ELBS) : A.I. Vogel
6. Chemical Instrumentation: A Systematic approch- H.A. Strobel
7. The principals of ion-selective electrodes and membrane transport: W.E.Morf
8. Physical Chemistry – P.W. Atkins 9. Principal of Instrumental Analysis- D. Skoog and D.We st

Course Code:	CHOE406	No. of Credits:	4
Course Name:	ETHICS & INTELLECTUAL PROPERTY RIGHTS	Sem End Exam & Cycle Test:	70+30

Course Educational Objective:

This course enables the students

CEO1 : To focus on introduction to Ethics.

CEO2 : To make them understand about Concept of property, rights, duties and their correlation; Intellectual property rights

Course Outcome:

Upon successful completion of this course, students should be able to:

CO1: Understand the basic principles of Ethics, Ethical dilemma, Emotional intelligence

CO2: Describe the related theories of Profession and Craftsmanship, Conflict of interest.

CO3: Acquire knowledge on . Concept of property, rights, duties and their correlation; Intellectual property

CO4: Provide adequate working knowledge and explain about basic requirement of a patentable invention.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	1	2										
CO3	1	3										
CO4	1	3										2

COURSE CONTENT

Unit-1

Introduction to Ethics: 1.1 Basic terms- Moral, Ethics, Ethical dilemma, Emotional intelligence 1.2 Moral development theories of Kohlberg and Piaget 1.3 View on ethics by Aristotle 1.4 Governing factors of an individual's value system 1.5 Personal and professional ethics

Unit-2

Profession and Professionalism: 2.1 Clarification of the concepts: Profession, Professional, Professionalism, Professional accountability, Professional risks, Profession and Craftsmanship, Conflict of interest 2.2 Distinguishing features of a professional 2.3 Role and responsibilities of professionals 2.4 Professionals' duties towards the organization and vice-a-versa 3 Ethical Theories: 3.1 Various ethical theories and their application- Consequentialism, Deontology, Virtue theory, Rights Theory, Casuist theory 3.2 Ethical terms: Moral absolutism, Moral Relativism, Moral Pluralism etc. 3.3 Resolving Ethical Dilemma

Unit-3

Concept of property, rights, duties and their correlation; Intellectual property rights and its types- Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of new GMOs; Process patent vs product patent; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies.

Unit-4

Basic requirement of a patentable invention- novelty, inventive step, Prior art and Stae of art;Patent databases; Searching International Databases; Analysis and report formation; Filing of a patent application; Role of a Country Patent Office; Precautions before patenting-disclosure/non-disclosure; International patenting-requirement; Introduction to History of GATT, WTO, WIPO, TRIPS, PCT and Implications; Patent infringement- meaning, scope, litigation, remedies; Case studies and examples-Rice, Neemetc.

Text Books:

1. R. Subramanian, "Professional Ethics" , Oxford University Press, New Delhi, 2013
2. Edmund G. Seebauer and Robert L. Barry, "Fundamentals of Ethics", Oxford University Press, New Delhi, 2012.
3. Stanley SA, Bioethics, Wisdom educational services
4. Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

Course Code:	CHPE407	No. of Credits:	4
Course Name:	PHYSICAL CHEMISTRY PRACTICAL	Sem End Exam:	100

(6hrs per week)

Course Educational Objective: This course enables the students

CEO: To provide practical knowledge and skills about various topics taught in theory class of physical chemistry.

Course Outcome:

CO1. Understand the basic procedures for carrying out a physical chemistry practical like preparation and standardization of solutions, handling the equipments and measuring with precision.

CO2. Correlate the theoretical and practical aspects and know about the limits of the experimental error.

CO3. Determine the various physical parameters for the various problems under study which in turn will enhance their problem solving and analytical skills.

CO4. Verify various laws studied in the theory part.

Mapping of COs with Pos

COs/Pos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3								1			
CO2	2											
CO3	2	3										
CO4	3											

1) To determine the critical Micelle Concentration (CMC) of surfactant from the measurement of surface tension.
2) To determine the Molecular weight of a polymer from viscosity measurements.
3) Determination of critical solution temperature (CST) of phenol-water system
4) A study of phase diagram of three-component liquid (ternary) system at room temperature: (Benzene-accetic acid-water system)
5) To determine the strength of HCL and acetic acid (AcOH) from the miture of acids by strong alkali (NaOH) conduct metrically.
6) Potentiometric titration of a weak acid (acetic acid) with caustic soda solution and determination of the dissociation constant of the acid using quinhydrone electrode at room temperature
7) To determine the rate constant of base hydrolysis of ester titrometrically.
8) To study the simultaneous equilibria in benzoic acid - benzene water system.
9) To determine the energy of activation from the Kinetic measurement of hydrolysis of ester
10) Study of inversion of cane sugar in acid medium by polarimetry
11) Determination of solubility product of $BaSO_4$.
12) To study of an equilibrium $KI + I_2 = KI_3$.

Text Book:

1. Experimental Physical Chemistry by Das and Behera
2. Practical Physical Chemistry by B. Vishwanathan & P.S. Raghavan
3. Experimental Physical Chemistry by V.D. Athawale

Course Code:	CHPC408	No. of Credits:	8
Course Name:	MAJOR PROJECT AND SEMINAR	End Exam:	200

Objective:

Each student has to work for at least 300 hours in a reputed research laboratory or industry on a specific project under the guidance of a Professor/Associate Professor/Assistant Professor/Reader/lecturer or a Scientist. The project can be a theoretical or experimental related to advanced topic, industrial project, training in a research institute, training of handling of sophisticated equipments etc The research work will be submitted in the form of a dissertation within 15 days of last theory examination. The student has to present his work in power point before an External examiner and an internal examiner for evaluation. The project report should be hard bound and the students will have to submit ***four copies*** of the project report for final evaluation of 200 marks based on the following criteria.

CRITERIA	Max. Marks
Literature Survey/Reference	20
Objectives/Plan of the project	20
Experimental/Theoretical Methodology	40
Significance and originality of the study	20
Depth of knowledge in the subject	20
Results and Discussions	20
Presentation/seminar	60
Total Marks	**200**

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