Holy Cross College (Autonomous), Nagercoil-629004

Kanyakumari District, TamilNadu.

Nationally Re-Accredited with A+ by NAAC IV Cycle – (CGPA 3.35)

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

DEPARTMENT OF CHEMISTRY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

Issued from the Deans Office

(With effect from the Academic year 2020– 2021)

DEPARTMENT OF CHEMISTRY

HOLY CROSS COLLEGE (AUTONOMOUS), NAGERCOIL

Vision

Impart quality education, scientific skills, academic excellence, research attitude and skills to face global challenges

Mission

To develop intellectual and professional skills of thestudents

To provide a firm foundation in chemical concepts, laws and theories

To sharpen the scientific knowledge

To enhance critical thinking, problem solving ability, scientific temper and innovation

To apply chemistry in medicine, biology, industry and environment

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO	***Upon completion of M.Sc. degree programme, the graduates***
PEO - 1	apply scientific and computational technology to solve social issues and pursue research
PEO - 2	continue to learn and advance their careers in industry both in public and private sectors, government and academia
PEO - 3	imbibe ethical standards, teamwork, leadership, communication skills and professionalism with global competencies addressing chemistry related issues to the society

PROGRAMME OUTCOMES (POs)

PO	***Upon completion of M.Sc. degree programme, the graduates will be able* to:**
PO-1	acquire scientific skills and innovative ideas in their own discipline
PO-2	identify, formulate, perform research and contribute to the developmental needs of the society
PO-3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe
PO-4	emerge as expressive, ethical and responsible citizens with proven expertise

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO	***Upon completion of M.Sc Chemistry programme, the graduates will be able to:***
PSO-1	impart in-depth knowledge about various aspects of chemistry within an environment committed to excellence
PSO-2	develop critical thinking, technical skills and innovative ideas in analysing and solving problems in the field of chemistry
PSO-3	explore and expedite the recent avenues in chemistry research across the globe with professional competency
PSO-4	inculcate positive approach towards environment and ecology from the chemistry perspective
PSO-5	promote entrepreneurial skills and become self-reliant

Eligibility Norms for Admission

A pass in the B.Sc. Chemistry or equivalent examination with Chemistry as Major, with a minimum of 50% in major and major related papers. For SC/ST candidates, a pass in B.Sc. Chemistry is sufficient.

Duration of the Course: 2 years.

Medium of Instruction: English

Passing Minimum

A minimum of 50 % in the external examination and an aggregate of minimum 50% is required. There is no minimum pass mark for the continuous internal assessment

Components of the M. Sc. Chemistry Programme

Paper	**No. of Papers**	**Max. Marks / Paper**	**Total Marks**
Major Core - Theory	11	100	1100
Major Core - Practical	4	100	400
Major Elective	4	100	400
Project Dissertation	1	100	100
Total	**20**	**20 x 100**	**2000**

Course Structure

Distribution of Hours and Credits

Course	Sem. I	Sem. II	Sem. III	Sem. IV	Total	
					Hours	**Credits**
Major Core - Theory	6 (5) + 6 (5) + 6 (5)	6 (6) + 6 (5) + 6 (5)	6 (5) + 6 (5)	6 (6) + 6 (5) + 6 (5)	66	57
Major Elective	4 (3)	4 (3)	4 (3)	4 (3)	16	12
Major Core - Practical	4+4	4+4 (4+4)	4 +4	4+4 (4+4)	32	16
Major Project	-	-	6 (5)	-	6	5
TOTAL	**30 (18)**	**30 (27)**	**30 (18)**	**30 (27)**	**120**	**90**
Nonacademic courses						
Life Skill Training - I	-	(1)	-	-	-	1
Life Skill Training - II	-	-	-	(1)	-	1
ServiceLearning Programme (SLP) – Community Engagement Course	-	(1)	-	(1)	-	2
Summer Training Programme	-	(1)		-	-	1

Non academic courses are mandatory and conducted outside the regular working hours.

Total number of hours = 120

Total number of compulsory credits = 90+5

Courses offered

Semester	Course code	Title of the Course	Hours/Week	Credits
I	PG2011	Core I Structure and Bonding	6	5
	PG2012	Core II Reaction Mechanism and Stereochemistry	6	5
	PG2013	Core III Chemical Kinetics and Electrochemistry	6	5
	PG2014 PG2015	Elective I (a) Analytical Chemistry (b) Electrochemistry	4	3
	PG20P1	Practical I Inorganic Chemistry - I	4	-
	PG20P2	Practical II Organic Chemistry	4	-
	LST 201	Life Skill Training (LST) – I	-	-
II	PG2021	Core IV Coordination Chemistry	6	6
	PG2022	Core V Reaction Mechanism and Molecular Rearrangements	6	5
	PG2023	Core VI Quantum Chemistry and Spectroscopy	6	5
	PG2024 PG2025	Elective II (a) Research Methodology (b) Nuclear Chemistry	4	3
	PG20P1	Practical I Inorganic Chemistry - I	4	4
	PG20P2	Practical II Organic Chemistry	4	4
	LST 201	Life Skill Training (LST) – I	-	1
	SLP 201	Service Learning Programme (SLP): Community Engagement Course	-	-
	STP201	Summer Training Programme	-	1
III	PG2031	Core VII Organic Spectroscopy	6	5
	PG2032	Core VIII Thermodynamics and Group Theory	6	5
	PG2033 PG2034	Elective III (a) Advanced Topics in Chemistry (b) Medicinal Chemistry	4	3
	PG20P3	Practical III Inorganic Chemistry - II	4	-
	PG20P4	Practical IV Physical Chemistry	4	-
	PG20PR	*Project	6	5
	LST 202	Life Skill Training (LST) – II	-	-
	SLP 201	Service Learning Programme (SLP): Community Engagement Course	-	2
IV	PG2041	Core IX Inorganic Spectroscopy, Photochemistry and Organometallics	6	6
	PG2042	Core X Photochemistry and Natural Products	6	5
	PG2043	Core XI Polymer Chemistry	6	5
	PG2044 PG2045	Elective IV (a) Energy for Future (b) Nanochemistry	4	3
	PG20P3	Practical III Inorganic Chemistry - II	4	4

	PG20P4	Practical IV Physical Chemistry	4	4
	LST 202	Life Skill Training (LST) – II	-	1
		TOTAL	**120**	**95**

* Subject based group project (2 students per group) with an individual viva voce during the III semester

Self-Learning Course (Extra credit courses)

Semester	Course code	Title of the Course	Hours/Week	Credits
III	PC20S1	Chemistry for Lecturership exam - I	-	2
IV	PC20S2	Chemistry for Lecturership exam - II	-	2
I/II/III/IV	PC20S3	Online Course (MOOC – Swayam / NPTEL)	-	2

Instruction for Course Transaction

Theory (Major Core/ Major Elective) Paper Hours

Components	Sem. I	Sem. II	Sem. III	Sem. IV
Lecture hours	75/45	75/45	75/45	75/45
Continuous Internal Assessment (CIA)(2)	5	5	5	5
Quiz (2)	1	1	1	1
Class Test (2)	2	2	2	2
Class assignment/Group Discussion / Problem solving/ Field Visit Report / Article Review	2	2	2	2
Seminar	10	10	10	10
Total Hours / Semester	**90/60**	**90/60**	**90/60**	**90/60**

Examination Pattern

a) Theory Papers

Ratio of Internal and External Components (Major Core/ Major Elective)- 40:60

Internal Components and Distribution of Marks

Internal Components	Marks
Internal Assessment (2)	20
Quiz (2)	4
Class test (2)	4
Seminar	4
Group discussion/ Open book test / Problem solving	4
Online Home Assignment	4
Total	**40**

Question Pattern (Major Core/ Major Elective)

Internal Test	Marks	External Exam	Marks
Part A 4x1 (No Choice)	4	Part A 10x1 (No Choice)	10
Part B 3x4 (Internal Choice)	12	Part B 5x3 (Internal Choice)	15
Part C 3x8 (Internal Choice)	24	Part C 5x7 (Internal Choice)	35
Total	**40**	**Total**	**60**

b) Examination Pattern for Practicals

Ratio of Internal and External (Major) 40:60

Internal Components and Distribution of Marks

Internal Components	Marks
Attendance	5
Record	5
Performance	10
Viva-voce	10
Total	**40**

(c) Project

Ratio of Internal and External 40 : 60

Internal (Supervisor)	Marks
I Review	10
II Review	10
Report	20
External (External Examiner)	
Report	40
Viva-voce (individual, open viva-voce)	20
Total	**100**

(d) Foundation Course

Life Skill Training- I (I Year)

Internal Component

Component	Marks
Album (20 pages)	40
Group Song, Mime, Skit(Groupof 5 students)	20
Total	**60**

External Component

Course	Summative Examinations	Marks
Life Skill Training- I	Written exam Part A 5x8 = 40 marks (Any 5 out of 7 questions)	**40**
	Total	**40**

Life Skill Training- II (II Year)

Internal Component

Component	Marks
Case Study (30 page)	60
Total	**60**

External Component

Course	Summative Examinations	Marks
Life Skill Training- II	Written exam Part A 5x8 = 40 marks (Any 5 out of 7 questions)	**40**
	Total	**40**

Community Engagement Programme

SLP Extension Activity (II & III Sem)

Courses / Programmes conducted outside the regular working hours on Saturdays and holidays. No. of hours allotted for each of these programmes is 30 and is supervised by the faculty in-charge. [Field work (15hrs); Class hours (15 hrs); Total 30 hrs]

Internal Components

Component	Marks
Assignment	10
Group Discussion	10
Attendance (Field Work)	30
Total	**50**

External Components

Course	Summative Examinations	Marks
Community Engagement Programme	Project Report / Case study (10 – 15 pages in print)	**50**
	Total	**50**

(f) Self Learning Course

Ratio of Internal and External 40 : 60

Chemistry for Lecturership exam

Internal Test	Marks	External Exam	Marks
Part A - 10 x 1 (Objective type question)	10	Part A - 20 x 1 (Objective type question)	20
Part B - 5 x 2 (Objective type question)	10	Part B - 10 x 2 (Objective type question)	20
Part C - 5 x 4 (Objective type question of higher order thinking)	20	Part C - 5 x 4 (Objective type question of higher order thinking)	20
Total	**40**	**Total**	**60**

Semester I
Structure and Bonding (Core I)
Course Code: PG2011

No. of hours per week	Credit	Total no. of hours	Marks
6	5	90	100

Objectives:

- To provide knowledge about the concepts in structure and bonding of simple molecules
- To understand the structure and diffraction methods of solids
- To attain knowledge about the structure of boron, inorganic chains and cluster compounds

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the structure and bonding in inorganic compounds	PSO-1	U
CO-2	apply the concepts of chemical bonding to predict the structure of compounds	PSO-2	A
CO-3	analyze the types of bonding, crystal lattices and crystal defects	PSO-2	Y
CO-4	evaluate bond energy, lattice energy and properties of inorganic compounds	PSO-2	E

Unit I Chemical Bonding **(18 Hours)**

VB approach to bonding - Heitler-London - Pauling and Slater refinements.Concept of hybridization and structure of molecules. VSEPR theory - shapes of molecules. MO approach to covalent bonding - symmetry and overlap of atomic orbitals - symmetry of molecular orbitals - sigma and pi bonding - energy levels in homo and hetero nuclear diatomic systems - bond length - bond order and bond energy - application to small molecules such as $BeCl_2$ - BCl_3 - CCl_4 and SF_4. Ionic character in a covalent bond and concept of multicentre bonding.Pseudo halogens - structure and bonding in ClF_3 - BrF_3 - BrF_5 - IF_5 - IF_7 etc.Oxides and oxyacids of halogens. Bonding in noble gas compounds - $XeCl_2$ - XeF_4 - $XeOF_4$ and XeF_6.

Unit II Chemistry of Solid State I **(18 Hours)**

Weak chemical forces - van der Waals forces and hydrogen bonding. Close packing of atoms and ions - HCP and BCC - types of packing voids - radius ratio - derivation - its influence on structures. Lattice energy - Born-Lande equation - Kapustinski equation and Madelung constant. Representative structures of AB and AB_2 types of compounds - rock salt - cesium chloride - wurtzite - zinc blende - rutile - fluorite - antifluorite - cadmium iodide and nickel arsenide. Structure of graphite and diamond.Spinels - normal and inverse types and perovskite structures.

Unit III Chemistry of Solid State II (18 Hours)

Defects in crystal - line - plane defects - stoichiometry and non-stoichiometry defects.Band theory of solids.Electrical properties of solids - conductor - insulator - semiconductor - intrinsic and extrinsic semiconductors.Optical properties - lasers and phosphors.Elementary study of liquid crystals. Difference between point group and space group - screw axis - glide plane - symmetry elements - relationship between molecular symmetry and crystallographic symmetry. Concept of reciprocal lattice.X-ray diffraction by single crystal - rotating crystal and powder diffraction.Neutron diffraction - elementary treatment and comparison with X-ray diffraction.Electron diffraction- basic principle.Crystal growth methods from melt and solution. Hydrothermal and gel methods.

Unit IV Boron Compounds and Clusters (18 Hours)

Chemistry of boron - preparation - properties and structure of boranes - higher boranes - borazines - boron nitrides - hydroborate ions - STYX numbers - Wade's rules.

Carboranes - types - preparation - properties and structure of nido - closo – arachno. Metallocarboranes - general study. Metal clusters - chemistry of low molecularity metal clusters. Structure of Re_2Cl_8 and multiple metal-metal bonds.

Unit V Inorganic Chain and Cluster Compounds (18 Hours)

Types of inorganic polymers - comparison with organic polymers - silanes - higher silanes - multiple bonded systems - silicon nitrides and siloxanes. P-N compounds - cyclophosphazenes and cyclophosphazanes. S-N compounds - S_4N_4 and $(SN)_x$.

Isopoly and heteropoly acids - structure and bonding of 6- and 12- isopoly and heteropoly anions. Structure of silicates - applications of Paulings rule of electrovalence - isomorphous replacements in silicates - ortho - meta and pyro silicates - one dimensional - two dimensional and three dimensional silicates.

Text Books:

1. Cotton, F.A. & Wilkinson, G. (1999). Advance Inorganic Chemistry. (6thed.). New York: Wiley Interscience.
2. Puri B.R., Sharma, L.R. &Kalia, K.C. (2012). Principles of Inorganic Chemistry. (4thed.). India: Milestone publishers.
3. Kittle, C. (2012). Introduction to Solid State Physics. (8thed.). New York: Wiley Eastern Ltd.
4. Puri, R.K. &Babber, V.K. (2001). Solid State Physics. (1sted.). India: S. Chand and Company Ltd.
5. Lee, J.D. (2008). Concise Inorganic Chemistry. (5thed.). New York: Wiley Interscience.
6. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. (2011). Inorganic Chemistry: Principles of Structure and Reactivity. (4thed.). India: Pearson Education.

Reference Books:

1. Purcell, K.F. &Kotz, J.C. (2012). Inorganic Chemistry. (2nded.). India: Cengage Learning India Pvt. Ltd.
2. Azaroff, L.V. (1989). Introduction to Solids.India: Tata McGraw Hill Publishing Ltd.
3. Dougles, D.E., McDaniel, D.H.& Alexander, J.J. (1994). Concepts and Models of Inorganic Chemistry. (3rded.). New York: John Wiley and Sons Ltd.
4. Malik, W.U., Tuli, G.D. &Madan, R.D. (2012). Selected topics Inorganic Chemistry. (5thed.). New Delhi: S. Chand Company Ltd.
5. Miessler, G.L. (2004). Inorganic Chemistry, (3rded.). India: Pearson Education.

Semester I
Reaction Mechanism and Stereochemistry (Core II)
Course Code: PG2012

No. of hours per week	Credit	Total no. of hours	Marks
6	5	90	100

Objectives:

- To understand the fundamental mechanisms involved in electrophilic and nucleophilic reactions
- To familiarize the basic aspects of stereochemistry and conformation

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the basic concepts of reaction mechanisms, stereochemistry and conformation in organic compounds	PSO-1	U
CO-2	apply the reaction mechanism, stereochemistry and conformation for the synthesis of organic compounds	PSO-2	A
CO-3	analyse the types of reaction mechanisms involved in synthetic organic transformation.	PSO-2	Y
CO-4	create novel organic compounds	PSO-3,4	C

Unit I Reaction Mechanism and Reactive Intermediates (18 Hours)

Reaction mechanism - energy diagram of simple organic reactions - transition state and intermediate. Kinetic and non-kinetic methods of determining organic reaction mechanisms. Isolation - trapping of intermediates and isotopic labeling studies. Primary kinetic isotopic effect.Correlation analysis - linear free energy relationships - Hammett equation - significances of σ and ρ - applications of Hammett equation.Taft equation and applications.Reactive intermediates - generation - stability and reactivity - carbocations - carbanions - free radicals - carbenes - benzynes and nitrenes.

Unit II Aliphatic Nucleophilic Substitution (18 Hours)

Mechanism of aliphatic nucleophlic substitution reaction - S_N1 - S_N2 and S_Ni mechanisms.Solvent and leaving group effects on aliphatic nucleophlic substitution reactions.Neighbouring group participation (NGP).Substitution at carbonyl - vinylic and bridgehead system.Substitution with ambident nucleophiles- "O" Vs "C"alkylation. Role of LDA - crown ethers and phase transfer catalysts (PTC) in nucleophilic substitution reactions.Mechanism of ester hydrolysis (only BAc^2 - AAc^2 and AAl^1). Alkylation of active

methylene compounds. Asymmetric alkylation - Evans - Enders and Meyers procedures. Preparation and synthetic utility of enamines - Finkelstein reaction and Wurtz coupling.

Unit III Aromatic Electrophilic and Nucleophilic Substitutions (18 Hours)

Aromatic electrophilic substitution - mechanism of nitration - sulfonation - Friedel-Crafts alkylation and acylation reactions.Synthesis of di- and tri-substituted benzenes from benzene or mono-substituted benzenes.Haworth reaction for naphthalene - Scholl reaction - Vilsmeier-Haackformylation - Gattermann reaction - Reimer-Tiemann and Bischler-Napieralski reactions.

Aromatic nucleophilic substitution in aryl halides by Meisenheimer complex mechanism and benzyne mechanism.Reactions of aryldiazonium salts.Zeigler alkylation - Vicarious Nucleophlic Substitution (VNS) - Chichibabin and Schiemann reactions.

Unit IV Stereochemistry (18 Hours)

Chirality - symmetry elements - asymmetric and dissymmetric chiral molecules.Relative and absolute nomenclature.Newman - Sawhorse - Fischer projections - their conversions.Axial chirality - planar chirality - helicity - allenes - spiranes - biphenyls - ansa compounds and trans-cycloalkenes.Stereochemistry of compounds containing nitrogen - sulphur and phosphorus.Topicity - homotopic - enantiotopic and diastereotopic ligands - groups and faces. Stereospecific and stereoselective synthesis.Asymmetric synthesis.Cram's rule - open chain - cyclic and dipolar model.Prelog's rule.

Unit V Conformational Analysis (18 Hours)

Conformation - definition - differences between configuration and conformation.Conformation of simple acyclic systems.Effect of conformation on reactivity of acyclic system - cis- and trans- eliminations. Conformation of cyclic systems uptosix membered rings. Conformation of mono and di-substituted - three - four - five and six membered ring systems.Effect of conformation on reactivity of cyclic systems - S_N1 and S_N2 reactions.Quantitative correlation between conformation and reactivity - Winstein-Eliel equation and Curtin-Hammet principle.Conformations of decalin - perhydrophenanthrene and perhydroanthracene.

Text books:

1. March, J. (2006). Advanced Organic Chemistry. (4thed.). New York: John Wiley and Sons.
2. Sykes, P. (2003). A Guidebook to Mechanism in Organic Chemistry. (6th ed.). India: Pearson.

3. Norman, R.O.C. &Coxon, J.M. (1993). Principles of Organic Synthesis, (3rd ed.). New York: CRC press, Taylor and Francis Group.
4. Ahluwalia, V.K. &Parshar, R.K. (2010). Organic Reaction Mechanism. (4th ed.). India: Narosa publishing House, 2010.
5. Nasipuri, D. (2011). Stereochemistry of Organic Compounds - Principles and Applications. (3rd ed.). India: New Age International, Ltd.
6. Kalsi, P.S. (2015). Stereo chemistry Conformation and Mechanism. (8th ed.). India: New Age International, Ltd.

Reference books:

1. Morrison, R.T. & Boyd, R.N. (1997). Organic Chemistry. (6thed.). New Jersey: Prentice Hall.
2. Carey, F. &Sundberg, R.J. (2007). Advanced Organic Chemistry-Part A and B. (5thed.). USA: Springer.
3. Smith, M.B. & March, J. (2001). Advanced Organic Chemistry. (5thed.). New York: John Wiley and Sons.
4. Bansal, R.K. (2005). Reaction Mechanism in Organic Chemistry. (3rded.). Tata McGraw Hill.
5. Clayden, J. Greeves, N& Warren, S. (2012). Organic Chemistry. (2nded.). Oxford University Press.
6. Eliel, E.L. &Wilen, S.H. (2003). Stereochemistry of organic compounds. (1sted.). New York: Wiley.

Semester I
Chemical Kinetics and Electrochemistry (Core III)
Course Code: PG2013

No. of hours per week	Credit	Total no. of hours	Marks
6	5	90	100

Objectives:

- To understand the mechanism of kinetics and catalysis of chemical reactions
- To attain knowledge about the concepts of photochemistry and electrochemistry

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the concepts of chemical kinetics, catalysis, photochemistry and electrochemistry	PSO-1	U
CO-2	apply the mechanism of kinetics and catalysis to chemical reactions	PSO-2,3	A
CO-3	analyze the principles and applications of kinetics, catalysis, photochemistry and electrochemistry	PSO-2,3	Y
CO-4	evaluate the kinetics and mechanism of chemical reactions	PSO-4	E

Unit I Chemical kinetics **(18 Hours)**

Arrhenius equation - Simple collision theory - ARRT theory - statistical and thermodynamic treatments.Ionic reactions - primary and secondary salt effects.Derivation and significance of volume of activation.

Kinetic isotopic effect - Kinetics of unimolecular reaction - Lindemann-Hinshelwood and Rice-Ramsperger-Kassel Marcus.Fast reactions - general features - flow techniques - relaxation theory and relaxation techniques (T-jump and p jump) - crossed molecular beam technique.

Unit II Catalysis **(18 Hours)**

Homogenous Catalysis - General catalytic mechanism - equilibrium treatment and steady state treatment - general acid-base catalysis and determination of catalytic co-efficient. Discussion of protolytic and prototropic mechanisms of acid catalysis.Bronsted relationships as linear free energy relationships.Acidity functions and correlation of mechanisms.

Heterogeneous Catalysis - physisorption and chemisorption - Langmuir adsorption isotherm - mechanism of surface reactions. Langmuir - Hinshelwood and Eley-Rideal mechanism. Absolute rate of surface reactions.

Unit III Photochemistry (18 Hours)

Introduction to photochemistry - laws of photochemistry - quantum yield calculation. Physical properties of electronically excited molecules - excited state dipole moment - acidity constant and redoxpotential. Photophysical processes in electronically excited molecules - Jablonski diagram - intersystem crossing - internal conversion - fluorescence - phosphorescence - delayed fluorescence and other deactivation processes.

Stern-Volmer equation and its application.Photosensitation and chemiluminescence. Chemical lasers - photoexplosion and dissociation laser - experimental techniques. Chemical actinometry and flash photolysis.

Unit IV Electrochemistry - I (18 Hours)

Deviation from ideal behavior - ion-solvent and ion-ion interactions.Debye-Hückel-Bjerrum model - ion association and triple ion formations.Expression for the mean activity coefficient.Debye-Hückel limiting law and its applications - diverse ion effect.Van't Hoff factor and its relation to colligative properties.Debye-Hückel theory of strong electrolytes.Debye-Huckel length and potential around a central ion - interpretation.Transport of ions in solution - electrolytic conduction - Debye - Huckel-Onsager treatment of strong electrolytes - ionic atmosphere and anomalous conductance of non-aqueous electrolytes.

Unit V Electrochemistry – II (18 Hours)

Electrical double layer - electrocapillary phenomena - surfactants and Lipmann's equation.Electrokinetic phenomena - zeta potential and its applications.Structure of electrical double layer - Helmholtz-Perrin - Guoy-Chapmann and Stern models. Butler-Volmer equation for one electron transfer reaction - equilibrium and exchange current densities - symmetry factor and transfer coefficient. Cyclic voltammetry and stripping voltammetry - principle and instrumentation.Corrosion and passivation of metals - Pourbaix diagram - Evans diagram.Batteries and fuel cells.Ion selective electrodes.

Text books

1. Laidler, K.J. (1987). Chemical Kinetics. (3rded.). New York: Harper and Row.
2. Atkins, P. & Atkins, J.P. (2002). Physical Chemistry. (7thed.). USA: Oxford university press
3. Puri, B.R., Sharma, L.R. &Pathania, M.S.(2016). Principles of Physical Chemistry. (47thed.). India: Vishal Publications.
4. G. W. Castellan, (2004).Physical Chemistry. (4thed.). India: Narosa publishing House.

5. Turro, N.J. (1978). Modern Molecular Photochemistry. (1st ed.). California: Benjamin/Cummings, Menlo Park.
6. Glastone, S.A. (1969). Text Book of Physical Chemistry. (2nd ed.). London: Macmillan and Co Ltd.
7. Hamann, C.H., Hamnett, A. &Vielstich, W. (2001). Electrochemistry. (4th ed.). New York: John Wiley and Sons.
8. Perez, N. (2016). Electrochemistry and Corrosion Science. New York: Springer.

Reference Books

1. Agarwal, G.L. (1990). Basic Chemical Kinetics. (1st ed.). India: Tata McGraw Hill.
2. Silbey, R.J., Alberty, R.A. &Bawendi, M.G. (2015). Physical Chemistry.(4th ed.).India: Wiley.
3. Barrow, G.M. (2018). Physical Chemistry. (6th ed.). Ney York: Tata McGraw Hill.
4. Rohatgi-Mukhergee, K.K. (1997). Fundamentals of Photochemistry. (3rd ed.). India: New Age International Ltd.
5. Holze, R. (2009). Experimental Electrochemistry. New York: John Wiley and Sons.
6. Rieger, P.H. (2010). Electrochemistry. (2nd ed.). New York: Chapmann and Hall.

Semester I

Analytical Chemistry (Elective I (a))

Course Code: PG2014

No. of hours per week	Credit	Total no. of hours	Marks
4	3	60	100

Objectives

- To attain the ability to identify the errors.
- To understand various analytical techniques.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the principle and instrumentation of various analytical techniques	PSO-1	U
CO-2	apply the principle of analytical techniques to predict the purity, stability and concentrations of compounds	PSO-2,4	A
CO-3	analyse chemical compound using various analytical techniques	PSO-2,3	Y
CO-4	evaluate the quality and quantity of chemical compounds	PSO-3	E

Unit I Error Analysis (12 Hours)

Significant figures - rounding off the values - accuracy and precision. Errors - classification of errors. Expression and calculation of errors in different forms.Precision and accuracy with respect to random errors.Minimization of errors - calibration of apparatus - analysis of standard samples - running a blank determination and independent analysis.Confidence limits. Tests of significance - F-test - t-test - chi square test and annova. Correlation and regression analysis.

Unit II Chromatography (12 Hours)

General principle - classification of chromatographic methods - nature of partition forces and chromatographic behaviour of solutes.Plate and rate theories.Normal and reversed phase liquid chromatography.Column chromatography - principle - experimental technique and applications.Gas chromatography - gas-solid and gas-liquid chromatography. Thin layer chromatography - ion exchange chromatography and high performance liquid chromatography.

Unit III Colorimetric and Spectrophotometric Analytical Techniques (12 Hours)

Colorimetry - fundamental laws - instrumentation and applications. Spectrophotometry - instrumentation and applications. Principle - instrumentation -

applications of fluorimetry - phsophorimetry - flame photometry - nephelometry and turbidimetry. Turbidimetric titrations and applications.

Unit IV Thermoanalytical Techniques (12 Hours)

Thermogravimetric analysis (TGA) - principle - instrumentation - factors affecting thermogram - decomposition of calcium oxalate monohydrate and copper sulphatepentahydrate. Differential thermal analysis (DTA) - principle - instrumentation and thermal behaviour of copper sulphatepentahydrate by DTA.Differential scanning calorimetry (DSC) - principle - instrumentation - phase transition studies by DSC. Thermometric titrations - principle - working and applications.

Unit V Electroanalytical Techniques (12 Hours)

Electrogravimetric analysis - theory - instrumentation and applications.Coulometric analysis - coulometric titrations and applications.Potentiostaticcoulometry. Polarography - principle - current-voltage relationship - dropping mercury electrode (DME) - experimental assembly - polarogram - half-wave potential - Ilkovic equation - applications to qualitative and quantitative analysis. Concept of pulse polarography.Voltametry - principle - cyclic voltametry.Amperometric titrations - principle and applications.

Text Books:

1. Kaur, H. (2016). Instrumental Methods of Chemical Analysis. India: PragatiPrakashan Publishing Ltd.
2. Day, R.A. & Underwood, A.L. (1998). Quantitative Analysis. (6th ed.). India: Prentice Hall.
3. Chatwal, G.R. &Anand, S.K. (2002). Instrumental Methods of Chemical Analysis. (5th ed.). India: Himalaya Publishing House.

Reference Books:

1. Higson, S. (2003). Analytical Chemistry. (1sted.). USA: Oxford University Press.
2. Christian, G.D. (2007). Analytical Chemistry. (6th ed.). New York: John Wiley & Sons.
3. Skoog, D.A, Holler, F.J & Crouch, S.R (2007). Principles of Instrumental Analysis. (6thed.). Australia: Thompson Brooks/Cole.
4. Gopalan, R., Subramanian, P.S. &Rengarajan, K. (2003). Elements of Analytical Chemistry. (3rded.). New Delhi: Sultan Chand & Sons.

Semester I
Electrochemistry (Elective I (b))

Course Code: PG2015

No. of hours per week	Credit	Total no. of hours	Marks
4	3	60	100

Objectives:

- To acquire knowledge about industrial electrochemistry and its applications.
- To know the types of batteries and cells.
- To understand the types of corrosion and methods of prevention of corrosion.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the principle of electrochemistry	PSO-1	U
CO-2	apply the concepts of electrochemistry in industries	PSO-2	A
CO-3	analyze the different electrochemical processes	PSO-3	Y
CO-4	create fuel cells	PSO-3,5	C

Unit I Industrial Electrochemistry (12 Hours)

Electrochemical processes in industry - components of electrochemical reactors - types of electrolytes. Cathodes and anodes in electrochemical reactor and separators.Electro inorganic chemicals - chlorates - perchlorates - hydrogen peroxide - caustic soda and chlorine production. Mercury cells - diaphragm cells - membrane cells - advantages of membrane cells. Organic electrochemicals - special features of electroorganic synthesis - electrochemical oxidation - Kolbe synthesis - electroreduction of carbonyl compounds and adiponitrile synthesis.

Unit II Electrometallurgy (12 Hours)

Electrodeposition of metals - principle - nucleation and growth of crystals - nature of electrodeposits.Hydrometallurgy - recovery of metals from aqueous electrolytes - recovery of silver from photographic emulsion - electrorefining - production of high purity copper and process description.Pyrometallurgy - necessity for using molten electrolytes - reactors for molten salt electrolysis - production of aluminium - electrodes and electrode reactions in cryolite melt - electrochemical purification of aluminium. Production of Mg and Na through molten salt electrolysis.

Unit III Electroplating **(12 Hours)**

Fundamental principle - nature of deposits for electroplating - Hull cell experiments - operating conditions and nature of deposits - throwing power - preparation of samples for electroplating - chemical and electrochemical cleaning - electroplating of copper - nickel and cadmium.Electroless plating - importance - plating on non-metals - bath composition - electroless plating of copper and nickel.

Unit IV Electrochemical Power Sources **(12 Hours)**

Basic principle - chemical and electrical energy - interconversion - charging and discharging - requirements for a good power source - types of power sources. Primary batteries - description of primary cells -alkaline - manganese cells - button cells - silver oxide - zinc cells - lithium primary cells - applications. Secondary batteries - important applications - charge discharge efficiency - cycle life - energy density - lead acid batteries - nickel - metal hydride batteries - lithium - secondary batteries - batteries for electrical vehicles. Fuel cells - basic principle - H_2-O_2 fuel cells - gas diffusion electrodes for alkaline fuel cells.

Unit V Corrosion **(12 Hours)**

Principles - stability of metals - EMF series - active and noble metals - pH effect on stability - Pourbaix diagram - kinetics of corrosion - mixed potential process - cathodic reaction - anodic reaction - corrosion current - active dissolution - passivation - breakdown of passivity - Evans diagram. Methods of corrosion protection - principles - inhibition of anodic, cathodic processes - inhibitive additives for corrosion protection - protective coatings - types of coatings - protection of structures and pipelines - cathodic protection - examples - sacrificial anodes - protection of ships in sea water.

Text Books:

1. Hamann, C.H., Hamnett, A. &Vielstich, W. (2001). Electrochemistry. (4th ed.). New York: John Wiley and Sons.
2. Holze, R. (2009). Experimental Electrochemistry. New York: John Wiley and Sons.
3. Pletcher, D. & Walsh. F.C. (1993). Industrial Chemistry. (3rd ed.). London: Blackie Academic and Professional.
4. Perez, N. (2016). Electrochemistry and Corrosion Science. New York: Springer.

Reference Books:

1. Bard, A.J. (2006). Electrochemical Methods: Fundamentals and Applications. (3rded.). New York: John Wiley and Sons.
2. Oldham, K., Myland, J. & Bond, A. (2012). Electrochemical Science and Technology: Fundamentals and Applications. New York: John Wiley and Sons.
3. Rieger, P.H. (2010). Electrochemistry. (2nded.). New York: Chapmann and Hall.

Life Skill Training - I
Course Code: LST201

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:

- To understand the fundamental rules of success
- To practice integrity in day to day life

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	Understand the human values to lead a successful life	PSO-	U
CO-2	Applythe ethics in real life situation	PSO-	A
CO-3	Analyseand improve one's attitude	PSO-	Y

Unit I

Success - Success formulae.

Goals - The law of Karma, The law of clarity, and The law of flexibility.

Positive Mental Attitude - The law of optimism and self-confidence.

Unit II

Purposeful-Burning desire - The law of desire and The law of energy.

Planning and Preparation - The law of planning.

Unit III

Resources - The law of maximization - Time and its management: health, courage, strengths and weaknesses, attitude, will and skill, enthusiasm, initiative, creativity/resourcefulness/ingenuity, experience, appearance, orderliness and neatness, courtesy, politeness and manners, charisma, live life, have luck and skills.

Unit IV

Self-discipline -The law of time preference and The law of direction.

Action - The law of applied effort and The law of compensation.

Persistence.

Unit V

Prayers - The partnership with God - work with commitment towards the goal - work and prayer.

Values - to attain stability in life -Benjamin Franklin's thirteen virtues.

Text Book

Rao, C.N. (2014). 10 Fundamental Rules of Success. India: V &S Publisher.

ReferenceBooks:

1. Bellamy, D.R. (1999). 12 Secrets for Manifesting your Vision, Inspiration and Purpose. India: Master Mind Books.
2. Iyer, S.S. (2009). Managing for Value. New Delhi: New Age International Publishers.
3. Sharma, S.P. (1999). Success Through Positive Thinking. Delhi: Pustak Mahal
4. Raj, A.S. (2015). Personality Development. Delhi: Firewall Media.

Semester II
Coordination Chemistry (Core IV)
Course Code: PG2021

No. of hours per week	Credit	Total no. of hours	Marks
6	6	90	100

Objectives:

- To understand the thermodynamic and stereochemical aspects of complexes
- To learn about the various mechanisms of substitution and electron transfer reactions.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the various theories and reaction mechanisms related to coordination compounds	PSO-1	U
CO-2	apply the theories and reaction mechanisms to determine the properties of complexes	PSO-2	A
CO-3	analyze the reaction mechanism of coordination compounds	PSO-2,3	Y
CO-4	evaluate the magnetic and spectral properties of complexes	PSO-2,3	E
CO-5	create novel complexes and catalyst	PSO-4,5	C

Unit I Stability of Complexes **(18 Hours)**

Stability of complexes - factors affecting stability of complexes - thermodynamic aspects of complex formation - stepwise and overall formation constants - stability correlations - statistical factors and chelate effect. Determination of stability constant and composition of the complexes - spectrophotometric method - ion exchange method - polarographic method and continuous variation method (Job's method).

Stereochemical aspects - stereoisomerism in inorganic complexes - isomerism arising out of ligand distribution and ligand conformation.Chirality - nomenclature of chiral complexes - application of ORD and CD in the identification of complexes.

Unit II Metal Ligand Bonding **(18 Hours)**

Crystal field theory - Splitting of d orbitals under various geometries - factors affecting splitting - CFSE - evidences for CFSE (structural and thermodynamic effects) - spectrochemical series - Jorgensen relation - site preferences - Jahn-Teller distortion - dynamic and static Jahn-Teller - Jahn-Teller effect and chelation. Application of CFT - magnetic properties - spectral properties and kinetic properties - limitations of CFT- evidences for M-L overlap.

Molecular Orbital Theory - energy level diagrams concept of weak and strong fields - sigma and pi bonding - octahedral - square planar and tetrahedral complexes. Nephelauxetic effect.Magnetic properties of complexes.Comparison of CFT and MOT of bonding in octahedral complexes.

Unit III Electronic Spectra of Complexes **(18 Hours)**

Spectroscopic term symbols for d^n ions - derivation of term symbols and ground state term symbol - Hund's rule - selection rules - breakdown of selection rules - spin orbit coupling - band intensities - weak and strong field limits - correlation diagram - energy level diagrams. Orgel diagram for weak field Oh and Td complexes - splitting of energy level due to Jahn-Tellerdistortion.Modified orgel diagram - limitations of orgel diagram. Tanabe-Sugano (T-S) diagrams - evaluation of Dq and B values for d^2- d^8 complexes charge transfer spectra. Complications in band classification between LF (d-d) and CT bands.Comparison between d-d bands and CT bands - numerical problems.Lanthanides and Actinides- spectral properties.

Unit IV Inorganic Reaction Mechanism **(18 Hours)**

Electron transfer reactions - Inner sphere (ISET) and outer sphere (OSET) electron transfer processes. Reaction mechanism of coordination compounds - Types of ligand substitution reactions- mechanism- Dissociative mechanism (D) - Associative mechanism (A) interchange mechanism (I) - labile and inert complexes. Substitution reaction in octahedral complexes - general mechanism - general rate law for A - D and I - distinction between D – ID - IA pathways - replacement of coordinated water - mechanism of acid hydrolysis - base hydrolysis – DCB mechanism - direct and indirect evidences in favour of the mechanism. Ligand substitution reactions without cleavage of M-L Bond.Anation Reactions - substituion in square planar complexes - general mechanism - trans effect- influences of entering and leaving groups - application of trans effect – synthesis of isomers of Pt(II) complexes –

theories of trans effect and cis-trans isomerisation reaction. Application of substitution reactions in the synthesis of platinum and cobalt complexes.

Unit V Catalysis **(18 Hours)**

General principles of catalysis - basic reactions involved in the catalysis by organometallic compounds. Hydrogenation of olefins (Wilkinson's catalyst) - Hydro formylation of olefins using cobalt or rhodium catalysts (OXO process) - oxidation of olefins to aldehydes and ketones (wacker process) - Monsanto acetic acid synthesis from methanol. Cyclooligomerisation of acetylene using Ni catalyst (Reppe's catalyst) - synthetic gasoline by using ZSM-5 catalyst (Fisher-Tropsch and mobil process) - polymerization of olefins (Zeigler-Natta Catalyst) - polymer bound catalyst.

Text Books:

1. Lee, J.D. (2008). Concise Inorganic Chemistry. (5th ed.). India: Wiley India.
2. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. (2011). Inorganic Chemistry: Principles of Structure and Reactivity. (4th ed.).India: Pearson Education.
3. Puri B.R., Sharma, L.R. &Kalia, K.C. (2012). Principles of Inorganic Chemistry. (4th ed.). India: Milestone publishers.
4. Malik, W.U., Tuli, G.D. &Madan, R.D. (2012). Selected topics Inorganic Chemistry. (5th ed.). New Delhi: S. Chand Company Ltd.

Reference Books:

1. Cotton, F.A. & Wilkinson, G. (1988). Advance Inorganic Chemistry. (2nd ed.). India: Wiley Eastern Private Ltd.
2. Miessler, G.L. (2004). Inorganic Chemistry. (3rd ed.), India: Pearson Education.
3. Purcell, K.F. &Kotz, J.C. (2012). Inorganic Chemistry. (2nded.). India: Cengage Learning India Pvt. Ltd.
4. Kettle, S.F.A, (1996).Coordination Chemistry-Ari Approach. USA: Spectrum Academic publishers Oxford.
5. Mehrotra, R. C. & Singh, A. (2014). Organometallic Chemistry. (2nded.) New Delhi: New Age International Ltd.
6. Parkins, A. W. &Poller, R. C. (1987). An Introduction to Organometallic Chemistry. Chennai: Oxford University Press.

Semester II
Reaction Mechanism and Molecular Rearrangements (Core V)
Course Code: PG2022

No. of hours per week	Credit	Total no. of hours	Marks
6	5	90	100

Objectives:

- To understand the mechanism of organic reactions.
- To get an in-depth knowledge on the various types of oxidation and reduction reactions along with their synthetic utility.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the mechanisms of organic reactions	PSO-1	U
CO-2	apply the reaction mechanisms to synthesize organic compounds	PSO-2,3	A
CO-3	analyze the type of reactions in organic compounds	PSO-2,3	Y
CO-4	evaluate nucleophilic, electrophilic substitution and elimination reactions in aromatic and aliphatic compounds	PSO-2	E
CO-5	create novel organic compounds	PSO-3,4	C

Unit I Addition to Carbon-Carbon Multiple Bond (18 Hours)

Electrophilic addition to carbon-carbon double and triple bonds.Nucleophilic addition to carbon-carbon multiple bonds.Mechanism and stereochemical factors in reactions - addition of hydrogen halides, hypohalous acids and hydroboration.Hydroxylation of olefinic double bonds - OsO_4 - $KMnO_4$ - Woodward and Prevost hydroxylation. Epoxidation using peracids - Sharplessepoxidation and ozonolysis.

Mechanism and applications of Michael addition - Robinson annulation sequence - Diels' Alder - Knoevenagal - Mannich - Stork-enamine - Grignard - Darzen's and Reformatsky reactions.

Unit II Addition to Carbon-Oxygen Multiple Bond (18 Hours)

Nucleophilic addition to carbon-oxygen double bond - Mannich, benzoin - Darzen'sglycidic ester - Stobbe and Knovenagel condensation reactions. Wittig - Wittig-

Horner olefination reactions. Reactions of sulphur and sulphoniumylides.Julia olefination and Peterson alkene synthesis.Asymmetric reduction of carbonyl functions (Corey's procedure).

Unit III Elimination Reactions (18 Hours)

Elimination reactions - E_1 - E_2 - E_{1cb} and $E_i$elimination.Effect of solvent - substrate and leaving group in elimination reactions. Hofmann - Saytzeff and Bredt's rule. Saytzeff'sVs Hoffman elimination.Stereochemistry of E_2 elimination.Mechanism of pyrolytic elimination - Chugaev and Cope elimination reactions.Hoffmann exhaustive methylation and pyrolysis of esters.

Unit IV Molecular Rearrangments and Name Reactions (18 Hours)

Molecular rearrangements - classification - electrophilic - nucleophilic and free radical rearrangements. Mechanisms of Wagner Meerwin - Tiffenev-Demyanov - Dienone-Phenol - Favorskii - Fries - Baeyer-Villager - Stevens - Neber - Sommelet-Hauser - Baker-Venkatraman - von-Richter - Ullmann - Pummerer and di- π methane rearrangements. Name reactions - Dieckmann cyclization - Hofmann-Loffler Freytag reaction - Mitsunobu reaction - Shapiro reaction - Eschenmoser-Tanabe and Ramburg-Backlund reactions.

Unit V Oxidation and Reduction Reactions (18 Hours)

Oxidation with Cr - PCC - PDC and Jones.Oxidation with Mn - MnO_2 and $BaMnO_4$ reagents.Oxidation with LTA - DDQ and SeO_2.Oxidation using DMSO - DCC - acetic anhydride and oxaloyl chloride.Oxidation using IBX and Dess-Martin Periodinane (DMP) reagent.

Reduction with $NaBH_4$ - $NaCNBH_3$ - $Zn(BH_4)_2$ - $LiAlH_4$ - $Li(BuO)_3AlH$ - DIBAL-H - Red-Al - Et_3SiH and Bu_3SnH. Reduction using selectrides- Birch reduction.

Text Books:

1. March, J. (2006). Advanced organic chemistry. (4th ed.).New York: John Wiley and Sons.
2. Ahluwalia, V.K. &Parshar, R.K. (2005). Organic Reaction Mechanism. (2nd ed.). India: Narosa, publishing House.
3. Norman, R.O.C. &Coxon, J.M. (1993). Principles of Organic Synthesis, (3rded.). New York: CRC press, Taylor and Francis Group.
4. Morrison, R.T. & Boyd, R.N. (1997). Organic Chemistry. (6thed.). New Jersey: Prentice Hall.
5. Jain, M.K. & Sharma, S.C. (2014). Modern Principles of Organic Chemistry. India: Vishal publication.
6. Chatwal, G.R. (2016). Reaction Mechanism and Reagents in Organic Chemistry. (5th ed.). India: Himalaya Publishing House.

Reference books:

1. Carey, F. &Sundberg, R.J. (2007). Advanced Organic Chemistry-Part A and B. (5th ed.). USA: Springer.
2. Smith, M.B. & March, J. (2001). Advanced Organic Chemistry. (5th ed.). New York: John Wiley and Sons.
3. Bansal, R.K. (2005). Reaction Mechanism in Organic Chemistry. (3rd ed.). Tata McGraw Hill.
4. Clayden, J. Greeves, N & Warren, S. (2012). Organic Chemistry. (2nd Ed.). Oxford University Press.
5. Tewari, K.S., Vishnol, N.K. &Mehrotra, S.N. (2002). A text book of organic chemistry. India: Vikas publishing House Ltd.
6. Kalsi, P.S. (1996). Organic Reactions and Mechanism. (1st ed.). India: New Age International Ltd.

Semester II
Quantum Chemistry and Spectroscopy (Core VI)
Course Code: PG2023

No. of hours per week	Credit	Total no. of hours	Marks
6	5	90	100

Objectives:

- To learn the principle of quantum mechanics of simple systems.
- To understand the principle, instrumentation, interpretation and applications of various spectroscopic and analytical techniques.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the concepts of quantum chemistry, spectroscopy and surface chemistry	PSO-1	U
CO-2	apply the principles of quantum mechanics to simple systems, spectroscopy to characterize compounds and surface chemistry to determine the surface area of surface films and liquids	PSO-2	A
CO-3	analyse molecules using quantum mechanics and spectroscopic techniques	PSO-2,3	Y
CO-4	evaluate eigen values, bond angles, electron density and surface area of simple molecules	PSO-2,3	E

Unit I Quantum Chemistry-I **(18 Hours)**

Black body radiation - Planck's quantum theory - wave particle duality - uncertainty principle. Operators - linear - commutation - Hermitian and Hamiltonian operators. Eigen functions and eigen values. Postulates of quantum mechanics.Derivation of Schrodinger's time-independent wave equation - application - one dimensional box - particle in a three dimensional box - harmonic oscillator and hydrogen atom.

Unit II Quantum Chemistry - II **(18 Hours)**

Born-Oppenheimer approximation - Hydrogen molecule ion.LCAO-MO and VB treatments of the hydrogen molecule.Anti-symmetry and Pauli's exclusion principle.Slater detrimental wave function - term symbols and spectroscopic states - Russell Saunders coupling.The variation theorem and perturbation theory - applications of variation method and perturbation theory to the helium atom. Hybridization-determination of bond angles ofsp- $sp^2$and sp^3 hybridizations. Huckel pi electron (HMO) theory and its applications to ethylene - butadiene and benzene.

Unit III Molecular Spectroscopy - I **(18 Hours)**

Electronic Spectroscopy - principle - laws of light absorption - Born-Oppenheimer approximation. Franck-Condon principle - wave-mechanical formulation - dissociation energy - dissociation products and predissociation. Microwave spectroscopy - rotation of molecules - rotational spectra of diatomic molecules - intensity of spectral lines - effects of isotopic substitution - non-rigid rotator.Rotational spectra of polyatomic molecules - chemical analysis by microwave spectroscopy.

Unit IV Molecular Spectroscopy - II **(18 Hours)**

ESR - theory - hyperfine interactions in ESR - double resonance (ENDOR, ELDOR) - Mc Connell's relation - verification of the relation for cyclic polyene radical - calculation of electron density and experimental techniques.

Laser Raman Spectroscopy - Einstein treatment of absorption and emission phenomena- Einstein's coefficients - probability of induced emission - applications to lasers- conditions for laser action - properties - types of lasers - advantages of lasers in Raman spectroscopy and experimental techniques.

Unit V Surface chemistry **(18 Hours)**

Electrical aspects of surface chemistry - electrical double layer - zeta potential. BET and Gibbs adsorption isotherms - derivation – applications - determination of surface area (BET equation) - surface films and liquids. Membrane equilibria and dialysis.

Surface active reagents - classification of surface agents - micellization- hydrophilic interactions - critical micellar concentration - factors affecting the CMC of surfaces. Transition state theory of surface reactions - rates of chemisorptions - Hertz-Knudson equation.

Text Books:

1. Chandra. A.K. (2001). Introductory Quantum Chemistry. (4thed.). India: Tata McGraw-Hill.
2. Prasad, R.K. (2014). Quantum Chemistry. (4th ed.). New Delhi: New Age International Publishers.
3. Atkins, P. & Atkins, J.P. (2002). Physical Chemistry. (7thed.).USA: Oxford university press.
4. BanWell, C.N. &Mccash, E.M. (1997). Fundamentals of Molecular Spectroscopy. New Delhi: Tata Mc Grow Hill.

Reference Books:

1. Mcquarrie, D.A. (2008). Quantum Chemistry. Sausalito: University Science Books.
2. Puri, B.R., Sharma, L.R. &Pathania, M.S. (2016). Principles of Physical Chemistry (47thed.). India: Vishal Publications.
3. Aruldhas, G. (2011). Molecular Structure and Spectroscopy. (2nd ed.), India: PHI Learning Pvt. Ltd.

Semester II
Research Methodology (Elective II (a))
Course Code: PG2024

No. of hours per week	Credit	Total no. of hours	Marks
4	3	60	100

Objectives

- To understand the importance of research for future development.
- To get information about computation techniques in research

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the sources of literature survey and analytical techniques for documentation of research and cheminformatics for molecular representation	PSO-1	U
CO-2	apply the features of literature survey in research and analytical techniques to characterize compounds	PSO-2,3	A
CO-3	analyse the sources of research information and chemical compounds	PSO-2,3	Y
CO-4	evaluate the results using analytical techniques	PSO-2,3	E
CO-5	create a journal article	PSO-3	C

Unit I Literature Survey **(12 Hours)**

Source of chemical information - primary - secondary and tertiary sources.Literature survey - indexes and abstracts in science and technology. Applied science and technology index - chemical abstracts - chemical titles - current chemical reactions - current contents and science citation index. Classical and comprehensive reference works in chemistry- synthetic methods and techniques - treatises - reviews - patents and monographs.

Unit II Chemical Abstracts **(12 Hours)**

Current awareness searching - CA weekly issues and CA issue indexes. Retrospective searching - CA volume indexes- general subject index - chemical substance index- formula index - index of ring systems - author index and patent index. CA collective indexes - collective index (CI) and decennial index (DI). Access points for searching CA indexes- index guide - general subject - terms - chemical substance names - molecular formulas - ring systems - author names - patent numbers. Locating the reference - finding the abstract - finding the original document chemical abstract and service source index.

Unit III Research Problem and Scientific Writing **(12 Hours)**

Identification of research problem - assessing the status of the problem - guidance

from the supervisor - actual investigation and analysis of experimental results - conclusions. Scientific writing - research reports - thesis - journal articles and books.Steps to publishing a scientific article in a journal.Types of publications - communications - articles and reviews. Documenting - Abstracts indicative - descriptive abstracts - informative abstract - footnotes - end notes - referencing styles - bibliography - journal abbreviations - abbreviation used in scientific writing.

Unit IV Instrumental Analysis **(12 Hours)**

Principle - instrumentation and applications - AFM - SEM - STM - TEM and XRD. Determination of surface morphology and particle size.Sample preparations and applications of UV - IR - NMR and mass spectroscopy.

Unit V Cheminformatics **(12 Hours)**

Cheminformatics - history and applications. Representing molecules - connection tables and line notation - Inchi - SMILES and WLN canonicalization. Line notation versus connection tables. Query languages - SMARTS. Molecular similarity.2D topology and 3D configuration.Chemistry softwares - Chemdraw - writing chemical equations and schemes - editing - transporting picture to word and image document. Origin -importing and exporting data - scientific graphing and data analysis - curve fitting and peak analysis - transporting graph to tag image file format.

Text Books:

1. Berg, B.L. (2009). Qualitative Research Methods for the Social Sciences. (7th ed.). India: Pearson Education.
2. Patton, M.Q. (2002). Qualitative research and evaluation methods. (3rd ed.). India: Sage Publications.
3. Alexis, L. & Mathews, L. (1999). Fundamentals of Information Technology. Chennai: Leon Vikas.
4. Mohan, J. (2001). Organic Spectroscopy Principles and Applications. India: Narosa publishing house.
5. Kemp, W. (1994). Organic Spectroscopy. (3rd ed.). New York: acmillan.
6. Polanski, J. (2009). Cheminformatics. Poland: Elsevier Publications.

Reference Books:

1. Silverman, D. (2011). Qualitative Research: Issues of Theory, Method and Practice. (3rded.). India: Sage Publications.
2. Marczyk, G. Dematteo, D. &Festinger, D. (2005). Essential of Research Design and Methodology. New York: John Wiley and Sons.
3. Silverstein, S.M., Bassler, G.V. &Morril, T.C. (2004). Spectrometric identification of organic compounds. (6th ed.). New York: Wiley.
4. Dyer, J.R. (1987). Applications of Absorption spectroscopy of Organic Compounds. New York: Prientice Hall.
5. Dani, V.R. (1995). Organic spectroscopy. India: Tata McGraw Hill.
6. Gasteiger, J. & Engel, T. (2003). Chemoinformatics. New York: John Wiley and Sons.

Semester II
Nuclear Chemistry (Elective II (b))
Course Code: PG2025

No. of hours per week	Credit	Total no. of hours	Marks
4	3	60	100

Objectives:

- To provide knowledge about the radioactivity and nuclear reactions.
- To understand the interaction between radiation and matter.
- To gain knowledge on applications of radio isotopes in industries and daily life.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the principles of radioactivity and nuclear reactions	PSO-1	U
CO-2	apply radioactivity in industries and daily life	PSO-3,4	A
CO-3	analyze the types of nuclear reactions and nuclear reactors	PSO-2	Y
CO-4	evaluate radioactivity of chemical compounds	PSO-2,3	E

Unit I Radioactivity and its Measurement **(12 Hours)**

Discovery - types of decay - decay kinetics - half-life period - mean life - parent-daughter decay - growth relationship - secular and transient equilibrium. Units of radioactivity. Alpha - beta and gamma decay. Theory of decay - energies and properties.Artificial radioactivity. Detectors - ionization chamber - electron pulse counter - scintillation detectors - semiconductor detectors - thermoluminescence detectors and neutron detectors.

Unit II Nuclear Reactions **(12 Hours)**

Bathe's notation - types of nuclear reactions - transmutation reactions - elastic and inelastic scattering - spallation - fragmentation, stripping and pick-up - fission - fusion - photonuclear and thermonuclear reactions. The compound nucleus theory and reaction cross section

Unit III Nuclear Reactors **(12 Hours)**

Fission energy - reproduction factor. Classification of reactors based on moderators - coolants - phase of fuel and generation. Principle of thermal nuclear reactors - four factor formula - reactor power - critical size of a thermal reactor - excess reactivity and control.Breeder reactor. India's nuclear energy programmes. Reprocessing of spent fuels - nuclear waste management - safety culture - active and passive safety.Containment building - nuclear criticality safety - ionizing radiation protection - enforcement agencies.

Unit IV Radiation and Matter **(12 Hours)**

Radiation chemistry - passage of radiation through matter - units for measuring radiation absorption.Radiation dosimetry - radiolysis of water - free radicals in water radiolysis - chemical dosimetry.Radiolysis of Fricke Dosimeter solution. Radiation induced colourcentres in crystals. Effects of radiation with matter. Radiolysis of inorganic gases - organic gases - organic compounds - solids and polymers. Annealing of radiation damage.

Unit V Applications of Radioactivity **(12 Hours)**

Application of radioisotopes - probing by isotopes - reactions involved in the preparation of radioisotopes. Szilard-Chalmers' reaction.Radiochemical principles in the use of tracers - applications of radioisotopes as tracers.Chemical investigations - analytical applications - agricultural and industrial applications.Neutron activation analysis.Carbon and rock dating.Use of nuclear reactions.Radioisotopes as source of electricity.Nuclear medicines.

Text Books:

1. Arniker, H.J. (2009). Essentials of Nuclear Chemistry. India: New age International.
2. Puri B.R., Sharma, L.R. &Kalia, K.C. (2012). Principles of Inorganic Chemistry. (4th ed.). India: Milestone publishers.
3. Arora M.G. & Singh, M. (1994). Nuclear Chemistry. India: Anmol Publications.

Reference Books:

1. Glasstone, S. (1967). Source Book on Atomic Energy. (3rd ed.). London: East West press.
2. Friedlander, M.G., Kennedy, J.M., Macian, E.S. & J.M. Miller. (1981). Nuclear and Radiochemistry. (3rd ed.). New York: John Wiley and Sons.
3. Gilreath, E.S. (1982). Fundamental Concepts of Inorganic Chemistry. New York: McGraw Hill

Semester I and II
Inorganic Chemistry - I (Practical I)
Course Code: PG20P1

No. of hours per week	Credit	Total no. of hours	Marks
4	4	60	100

Objectives:

- To gain knowledge in semi-micro qualitative analysis of inorganic mixture.
- To impart skill in estimating the presence of various elements.
- To estimate the elements by photocolorimetric method.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the methods for the separation and estimation of inorganic compounds	PSO-1	U
CO-2	apply the theoretical concepts to identify inorganic compounds	PSO-2	A
CO-3	analyze inorganic compounds using semi-micro qualitative analysis and paper chromatography	PSO-2,3	Y
CO-4	evaluate the quantity of inorganic compounds	PSO-2,3	E

1. Semi-micro qualitative analysis of inorganic mixture containing two familiar and two less Familiar cations.
   Pb, Cu, Bi, Cd, Sb, Zn, Co, Ni, Mn, Ca, Ba, Sr, W, Ti, Se, Te, Mo, Ce, Th, Zr, V, U, Ti and Li.
1. Complexometric titration - Estimation of Cu, Zn and Mg by EDTA titration in presence of either Pb or Ba.
2. Photocolorimetric estimation of Fe, Ni, Cr, Mn, Cu and NH_4^+
3. Separation and identification of a binary mixture of inorganic cations by paper chromatography.

Reference Books:

1. D.G. Davies, and T.V.G. Kelly, Inorganic Reactions at Advanced Level, Mills and Boom publications, 1969.
2. V. Ramanujan, Inorganic Semi-micro Qualitative Analysis, 3rd Ed., National Publishing Company, Chennai, 1990.
3. G. Svehla, Vogel's qualitative inorganic analysis, 7thEd..Pearson Education., India, 2008. 2008).

Semester I and II
Organic Chemistry (Practical II)
Course Code: PG20P2

No. of hours per week	Credit	Total no. of hours	Marks
4	4	60	100

Objectives:

- To provide knowledge about the separation and analysis of binary mixtures.
- To estimate various organic substances.
- To synthesize organic compounds.

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the methods for the separation and estimation of organic compounds	PSO-1	U
CO-2	apply the theoretical concepts to identify and synthesise organic compounds	PSO-2	A
CO-3	analyse the elements and functional groups using microscale analysis	PSO-2	Y
CO-4	evaluate the quality and quantity of organic compounds	PSO-2,3	E
CO-5	create organic compounds using various rearrangement reactions	PSO-4,5	C

1. Separation of a Binary mixture (Minimum six binary mixtures)

Quantitative chemical separation of a binary mixture following a systematic procedure. The two components should not interact at room temperature. They should be sufficiently soluble in ether. Two neutral components should be avoided. A few possible combinations are:

a. Any acidic component and a neutral substance
b. Any basic component and a neutral substance
c. A carboxylic acid and a phenol
d. A phenol and a basic component

The two components must be exhibited along with weight, in the normal physical state of the substance.

2. Estimation of organic compounds.

a. Glucose- Lane and Eynon method
b. Glucose- Bertrand's method
c. Ethyl methyl ketone
d. Iodine value of an oil
e. Saponification value of an oil

3. Double stage preparation of organic compounds

a. P-Bromoaniline from acetanilide
b. P-Nitroaniline from acetanilide
c. Benzpinacolone to benzophenone
d. Benzaniilide from benzophenone
e. Phthalimide from phthalic acid.

Students are expected to submit the recrystallised samples of the final products at the time of practical examination for evaluation by the examiners.
Note: Record of experiments may be evaluated by internal assessment only.

Reference Books:

1. B.B. Dey, M.V. Sitaraman and T.R. Govindachari. Laboratory Manual of Organic Chemistry, 2nd Ed., Allied Publishers, New Delhi, **1992**.
2. A.I. Vogel, Quantitative Organic Analysis Part III. (2nd Ed.). CBS Publishers, New Delhi, **1987**.
3. R.K. Bansal, Laboratory Manual of Organic Chemistry, 2nd Ed., Wiley Eastern Ltd., New York, **1990**.

Semester II
Life Skill Training - I
Course Code: LST201

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:

- To understand the fundamental rules of success
- To practice integrity in day to day life

Course Outcomes (COs)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	understand the importance of soft skills	PSO-	U
CO-2	apply the tools and techniques for effective communication	PSO-	A
CO-3	analyseandimprove mental health	PSO-	Y

Unit I

Soft and Hard Skills - significance of soft skills.

Communication Skills - Types of communication - elements of communication - constituents of communication - characteristics of effective communication.

Unit II

Body Language - Body language interpretation -tips for better body language.

Interpersonal Skills - Tools for effective conversation and building interpersonal skills.

Unit III

Listening Skills - Listening types - tips for listening - listening and leadership.

Soft Skills and Johari Window -Johari windows - advantages of Johari window.

Unit IV

Change Management -Change Vs Zones - tips for managing change.

Stress Management - Types, causes of stress, symptoms of stress and tackling stress.

Unit V

Motivation - Types of motivation - Hierarchy of needs - tips for motivation.

Time Management - Pareto's principle - tools and techniques for time management.

(Compilation will be provided to the students)

Reference Books:

1. Melgosa, J. (2013). Positive Mind. (3rd ed.). Spain: Safeliz.
2. Shukla, A. (2010). The 4-Lane Expressway to Stress Management. New Delhi: Unicorn Books.
3. Pease, A. (1990). Body Language. India: Sudha Publications Pvt. Ltd.

Semester II & III
Service Learning Programme (SLP): Community Engagement Course
Course Code: SLP201

Credits	Total no. of hours	Total marks
2	30 (15 classroom + 15 field)	100 (50 + 50)

Objectives

- To develop an appreciation of rural culture, life-style and wisdom among students
- To learn about the status of various agricultural and rural development programme
- To understand causes for rural distress and poverty and explore solutions for the same
- To apply classroom knowledge of courses to field realities and there by improve quality of learning

Learning Outcomes

After completing this course, student will be able to

- Gain an understanding of rural life, culture and social realities
- Develop a sense of empathy and bond so mutuality with local community
- Appreciate significant contributions of local communities to Indian society and economy
- Learn to value the local knowledge and wisdom of the community
- Identify opportunities for contributing to community's socio-economic improvements

Credit: 2credits, 30hours, atleast 50% in field, compulsory for all students.

Contents:

Course Structure:

2 Credits Course (1Credit for Classroom and Tutorials and 1 Credit for Field Engagement)

S. No.	Module Title	Module Content	Assignment	Teaching/ Learning Methodology	No.of Classes
1	**Appreciation of Rural Society**	Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature and resources, elaboration of "soul of India lies in villages'(Gandhi), rural infrastructure	Prepare a map (physical, visual or digital) of the village you visited and write an essay about inter-family relations in that village.	- Class room discussions - Field visit** - Assignment Map	2 4 2

2	**Understanding rural economy & livelihood**	Agriculture, farming, land ownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets	Rural household economy, its challenges and possible pathways to address them	- Field visit** - Group discussions in class -Assignment	3 4 1
3	**Rural Institutions**	Traditional rural organisations, Self-help Groups, Panchayatiraj institutions (GramSabha, GramPanchayat, Standing Committees), local civil society, local administration	How effectively are Panchayatiraj institutions functioning in the village? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual)	Classroom - Field visit** - Group presentation of assignment	2 4 2
4	**Rural Development Programmes**	History of rural development in India, current national programmes: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swatchh Bharat, PM Awaas Yojana ,Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA etc.	Describe the benefits received and challenges faced in the delivery of one of these programmes in the rural community; give suggestions about improving implementation of the programme for the rural poor.	- Classroom - Each studentselect soneprogram for fieldvisit** Written assignment	2 4 2

****Recommended** field-based practical activities:

- Interaction with SHG women members, and study of their functions and challenges; planning for their skill building and livelihood activities
- Visit MGNREGS project sites, interact with beneficiaries and interview functionaries at the worksite
- Field visit to Swachh Bharat project sites, conduct analysis and initiate problem solving measures
- Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan(GPDP)
- Interactive community exercise with local leaders, panchayat functionaries, grass-root officials and local institutions regarding village development plan preparation and resource

mobilization

- Visit Rural Schools/ mid-day meal centres, study Academic and infrastructural resources and gaps
- Participate in Gram Sabha meetings, and study community participation
- Associate with Social audit exercises at the Gram Panchayat level, and interact with programme beneficiaries
- Attend Parent Teacher Association meetings and interview school dropouts
- Visit local Anganwadi Centre and observe the services being provided
- Visit local NGOs, civil society organisations and interact with their staff and beneficiaries,
- Organize awareness programmes, health camps, Disability camps and cleanliness camps
- Conducts oil health test, drinking water analysis, energy use and fuel efficiency surveys
- Raise understanding of people's impacts of climate change, building up community's disaster preparedness
- Organise orientation programmes for farmers regarding organic cultivation,rational use of irrigation and fertilizers and promotion of traditional species of crops and plants
- Formation of committees for common property resource management, village pond maintenance and fishing

Teaching & Learning Methods

A large variety of methods of teaching must be deployed:
UGC will prepare an ICT based MOOC for self-paced learning by students for the1 credit to be conducted in the classroom.
Reading & classroom discussions, Participatory Research Methods & Tools, Community dialogues, Oral history, social and institutional mapping, interactions with elected panchayat leaders and government functionaries, Observation of Gram Sabha, Field visits to various village institutions.

Recommended Readings

Books:

1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, NewDelhi,2015.
2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002.
3. United Nations, Sustainable Development Goals, 2015 un.org/sdgs/
4. M.P. Boraian, Best Practices in Rural Development**,** Shanlax Publishers, 2016.

Journals:

1. Journals of Rural development, (published by NIRD & PR Hyderabad)
2. Indian Journal of Social Work, (byTISS,Bombay)
3. Indian Journal of Extension Education (by Indian Society of Extension Education)
4. Journal of Extension Education (by Extension Education Society)
5. Kurukshetra (Ministry of Rural Development, GoI)
6. Yojana (Ministry of Information and Broadcasting, GoI)

Semester III
Core VII :Organic Spectroscopy
Course Code: PG2031

Hours per week	Credits	Total Hours	Marks
6	5	90	100

Objectives:

- To understand the principle and applications of UV, IR, NMR and Mass spectroscopic techniques.
- To elucidate the structure of simple organic compounds usingspectral data.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	understand the principle and applications of various spectroscopic techniques	PSO-1	U
CO-2	apply the spectroscopic concepts to determine the structure of organic compounds	PSO-2,3	A
CO-3	analyze the functional groups, molecular formula, structure and spectral data of compounds	PSO-2,3	Y
CO-4	evaluatethe purity, structureand molecular mass of compounds using various spectroscopic methods	PSO-2,3	E
CO-5	create and characterize novel organic compounds	PSO-3,4	C

Unit I **(18 Hours)**

UV-Visible and IR spectroscopy

UV-Visible spectroscopy: principle - types of electronic excitations -chromophore-auxochrome - bathochromic - hypsochromic - hypochromic and hyperchromicshifts. Woodward-Fieser rules to calculate λ_{max} values of conjugated dienes - α,β-unsaturated carbonyl compounds and aromatic compounds. Fieser-Khun rule.Effect of solvent polarity on λ_{max}.

IR spectroscopy: principle - Hooke's law - types of molecular vibrations. Factors influencing the vibrational frequency.Identification of functional groups in organic compounds.Finger print region.Fermi resonance - overtones and combination bands.

Unit II **(18 Hours)**

^{1}H NMR Spectroscopy:principle - instrumentation - shielding anddeshielding. Chemical shift - factors affecting chemical shift -electronegativity - hybridization - hydrogen bonding - anisotropic effect - double bond - triple bond - aromatic compounds - carbonyl compounds and annulenes. Spin-spin splitting pattern of simple organic compounds.Types of coupling - germinal - vicinal - long range and through space coupling.Karplus equation.Coupling constant - AB, AB_2 and A_2B_3. Simplification of complex spectra - chemical exchange, double resonance and NMR shift reagents. Temperature dependent NMR.

Unit III **(18 Hours)**

^{13}C, $^{19}F$and ^{31}P NMR Spectroscopy

^{13}C NMR spectroscopy: principle - comparison of ^{13} C NMR and ^{1}H NMR.Chemical shift - factors affecting chemical shift.Homo nuclear and heteronuclear coupling.Broad band decoupling and OFF - resonance decoupling. Distortionless Enhancement by Polarization Transfer (DEPT) spectrum - DEPT-45 - DEPT-90 and DEPT-135.2D Correlation spectroscopy (COSY) - HOMCORR - ^{1}H-^{1}H and ^{13}C-^{13}C connectivity.HETCORR - ^{1}H-^{13}C connectivity and MRI.

^{19}F NMRspectroscopy: precessional frequency and heteronuclear coupling. Identification of organofluoro compounds CF_3CO_2Et and CF_3CH_2OH.

^{31}P NMRspectroscopy: chemical shift - heteronuclear coupling and P-P bond in NMR. Identification of organophosphorous compounds $(Me)_3P$ - $(EtO)_3P{=}O$ and Ph_3P.

Unit IV **(18 Hours)**

Mass Spectrometry:principle - production of ions - Electronic Ionization (EI), Chemical Ionization (CI) and Fast Atom Bombardment (FAB). Molecular ion peak - base peak - meta stable peak and isotopic peaks. Nitrogen rule.McLafferty rearrangement and Retro Diels Alder reaction.General modes of fragmentation.Fragmentation pattern of simple organic compounds - alkenes - alkyl and aryl halides - alkylbenzene - benzene - aliphatic alcohols - phenols - aliphatic and aromatic acids - ketones - aldehydes - furan - pyrrole and pyridine.

Unit V(18 Hours)

Structural Elucidationusing Analytical and Spectral Data: Determination of molecular formula of organic compounds using elemental (CHN) analysis data. Structural determination of simple organic compounds using UV - IR - NMR and Mass spectral data.

Text Books

1. Mohan, J. (2001). Organic Spectroscopy Principles and applications. India: Narosa publishing house.
2. Kemp, W. (1991). Organic Spectroscopy. (3rd ed.). New York: Macmillan.
3. Kalsi, P.S. (2004). Spectroscopy of Organic Compounds. (6thed.). India: New Age International Ltd.
4. Silverstein, S.M., Bassler, G.V. &Morril, T.C. (2004). Spectrometric identification of organic compounds. (6th ed.). New York: Wiley.

Reference Books

1. Dyer, J.R. (1987). Applications of Absorption spectroscopy of Organic Compounds. New York: Prientice Hall.
2. Dani, V.R. (1995). Organic spectroscopy, India: Tata McGraw Hill.
3. Pavia, D.L., Lampman, G.M.,Kriz, G.S.&Vyvyan, J.R. (2009). Introduction to Spectroscopy. (4thed.). USA: CengageLearning.
4. Sharma, Y.R. (2013). Elementary Organic Spectroscopy. (5thed.).New Delhi: S. Chand Publishing.

Semester III
Core VIII: Thermodynamics and Group Theory
CourseCode : PG2032

Hours per week	Credits	Total Hours	Marks
6	5	90	100

Objectives:

- To learn the various concepts of thermodynamics and statistical thermodynamics.
- To apply the concepts of group theory to molecules.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	understand the concepts and applications of thermodynamics and group theory	PSO-1	U
CO-2	apply thermodynamics and group theory to determine thermodynamic parameters, vibrations and hybrid orbitals	PSO-2	A
CO-3	analyze the thermodynamic functions, point groups and normal mode of vibration of molecules	PSO-2	Y
CO-4	evaluate the thermodynamic parameters and delocalization energy in molecules	PSO-2	E

Unit I (18 Hours)

Thermodynamics and Non-Ideal Systems: Concepts of partial molar properties - partial molar free energy and partial molar volume. Gibbs-Duhem equation.Chemical potential - variation of chemical potential with temperature and pressure - Van't Hoff isotherm.Fugacity - determination of fugacity of gases by graphical method - variation of fugacity with temperature and pressure - Lewis Randal rule and Duhem-Margules equation.Determination of activity and activity coefficient of non-electrolyte by e.m.f method - excess functions.

Unit II (18 Hours)

Irreversible Thermodynamics: Nernst heat theorem - Third law of thermodynamics - applications of third law - entropy change -calculation of absolute entropies - apparent exceptions to third law. Non-equilibrium thermodynamics - basic concepts - forces and fluxes - entropy of irreversible processes - entropy production - Clausius inequality - phenomenological equations - Onsager reciprocity relations and coupled reactions.Principle of microscopic reversibility - the Onsager reciprocal relations - verification.Entropy production.

Unit III(18 Hours)

Statistical Thermodynamics: Statistical thermodynamics - concept of distributions -types of particles (bosons, fermions, mesons) - types of ensembles. Thermodynamic probability - most

probable distribution law - classical statistics - Maxwell-Boltzmann (MB) statistics - Quantum statistics - Bose-Einstein (BE) and Fermi-Dirac (FD) statistics - derivation of distribution function - MB, BE and FD statistics - comparison. Partition functions - translational - rotational - vibrational and electronic partition function - calculation of thermodynamic parameters and equilibrium constants in terms of partition function. Debye and Einstein heat capacity of solids.

Unit IV(18 Hours)

Group TheoryI: Molecular symmetry elements - symmetry operations - molecular symmetry and point groups. Group multiplication tables -abelian- non-abelian - cyclic and sub groups - conjugacy relation and classes. Representation of symmetry operations by matrices - representation for C_{2v} - C_{3v} and C_{2h}point groups.Reducible and irreducible representations.The great orthogonality theorem and its consequences. Construction of the character tables - C_{2v} -C_{3v} and C_{2h}point groups.

Unit V **(18 Hours)**

Group Theory II: Standard reduction formula - symmetry of normal modes of vibration in H_2O - NH_3 and CO_2. Application of group theory to normal mode analysis of H_2O and NH_3. Symmetry properties of integrals and symmetry based selection rule for vibrational spectra. Identification of IR and Raman active fundamentals - symmetry of molecular orbitals and symmetry based selection rule for electronic transition - prediction of electronic transitions in ethylene and formaldehyde. Determinationofπ- electron energy in ethylene. HMO theory - HMO calculations and delocalization energy in trans-1,3-butadiene and benzene. Application of Determination of hybridization in CH_4 and BF_3.

Text Books

5. Kuriacose, J.C. &Rajaram, J. (1986). Thermodynamics. (1st ed.). Delhi: Shohanlal and Company.
6. Atkins, P. & Atkins, J.P. (2002). Physical Chemistry. (7th ed.). USA: Oxford university press.
7. Puri, B.R., Sharma, L.R. &Pathania, M.S. (2016). Principles of Physical Chemistry (47th ed.). India: Vishal Publications.
8. Bhattacharya,P.K. (1986). Group Theory and its Chemical Applications. India: Himalaya Publishing house.
9. Cotton, F.A. (2008). Chemical Applications of Group Theory. (3rd ed.). New York: Wiley.

Reference Books

1. Glasstone, S. (1969). Thermodynamics for chemistry. New York: Van Nostrand Company
2. Glasstone, S.A. (1969). Text Book of Physical Chemistry. (2nd ed.). London: Macmillan and Co Ltd.
3. Kapoor, K.L. (1986). Text Book of Physical Chemistry. Delhi: MacMillan India Ltd.
4. Ramakrishnan, V. &Gopinathan, M.S. (1998). Group Theory in Chemistry. India: Vishal Publications.
5. Raman, K.V. (1990). Group Theory and its Applications to Chemistry. India: Tata Mcgraw Hill Publishing Co.

Semester III

Elective III (a) :Advanced Topics in Chemistry

CourseCode: PG2033

Hours per week	Credits	Total Hours	Marks
4	3	60	100

Objectives:

- To acquire knowledge about nanoparticles and green chemistry.
- To gain idea about supramolecular chemistry.
- To study the applications of medicinal and biophysical chemistry.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	understand the principlesand application of advanced areas in chemistry	PSO-1	U
CO-2	apply the principle of nanochemistry and green chemistry to design and synthesise novel compounds	PSO-2,3	A
CO-3	analyze the properties of nanoparticles, supramolecular interactions, therapeutic action of drugs and reactions in biomolecules	PSO-2,3	Y
CO-4	evaluate atom economy in green synthesis, structure and therapeutic action of various drugs and role of singlet oxygen in biology	PSO-2,4	E
CO-5	create novel nanoparticles and compounds using green chemistry techniques	PSO-3,4	C

Unit I **(12 Hours)**

Nanochemistry: General principles of nanotechnology. Nanoparticles - definition - size relationship - nanoparticles of metals - semiconductors and oxides. Synthesis of nanosized compounds - reduction methods and solgel methods. Optical and electrical properties of nanoparticles.Nanosystems - introduction - synthesis and purification of fullerenes.Carbonnanotubes- types - preparation - Arc and chemical vapour deposition methods. Nanoshells - gold and silver nanoshells and its applications. Nanosensors - introduction - nanoscale organization - characterization and optical properties. Nanomedicines - introduction - approach to developing nanomedicines - protocol for nanodrug administration - diagnostic and therapeutic applications.

Unit II **(12 Hours)**

Green Chemistry: Green chemistry and sustainable development - principles and applications of green chemistry. Atom economy - atom economy vs. yield.Prevention of

waste/byproducts.Prevention or minimization of hazardous products.Designing safer chemicals through Sommelet-Hauser - Cope - Wolff - Witting and Bamberger reactions.Energy requirement for synthesis.CFC alternatives - green chemistry in organic synthesis.Selection of appropriate solvent and starting material.Use of protecting groups and catalyst.Methods of greening organic reactions - solvent free reactions and reactions at ambient temperature. Microwave assisted reactions. Sonication assisted reactions -

Reformatsky - Ullmann coupling - Wurtz and Bouveault reaction. Reactions in ionic solvents and super critical fluids.Tandem reactions.

Unit III **(12 Hours)**

Supramolecular Chemistry: Supramolecular interactions - discussion of host-guest systems - cation and anion binding host. Crown ethers - synthesis - properties and applications.Lariat ethers.Podants - properties and3-dimensional podants. Cryptands - synthesis - properties and applications.Spherands - synthesis - structure and uses.Supramolecular chemistry of fullerenes and cyclodextrins.Molecular devices - non-linear optical switches and electrophotoswitching, Liquid crystal display. Supramolecular photochemistry.

Unit IV **(12 Hours)**

Medicinal Chemistry: Modern drugs for diseases. Anticancer drugs - classification - synthesis and assay of cyclophoshamide - chlorambucil - cisplatin -vinblastine and vincristine. Antimalarial drugs - classification - synthesis and assay of chloroquineand primaquine. Diuretics - classification - synthesis and assay of Frusemide and benzthiazide.Anti-inflammatory drug - synthesis and therapeutic action of phenylbutazone and ibuprofen. Antipyretics and non-narcotic analgesics - synthesis and therapeutic action of paracetamol and aspirin

Unit V **(12 Hours)**

Biophysical Chemistry: Thermodynamics in biology andlimitations of equilibrium thermodynamics. Irreversible thermodynamics - postulates and methodologies.Irreversible thermodynamics and biological systems.Biochemical standard state - ATP.Currency of energy - oxidative phosphorylation.Role of singlet oxygen in biology.Reactions in biomolecules - membrate potential and ion pumps.Photoacoustic effect and its application in biology.Biophysical applications of Moss-bauer effect.NMR imaging - applications of spin labeling in membrane research.

Text Books

1. Klabunde, K.J. & Richards, R.M. (2009). (2nded.). Nanoscale Materials in Chemistry. New York: Wiley.
2. Ozin, G. & Arsenault, A. (2005). Nanochemistry: A Chemical Approach to Nanomaterials. USA: Elsevier.
3. Rao, C.N.R. (2001). Nanochemistry. New York: Wiley.
4. Ahluwalia, V.K. (2006). Green chemistry-Environmentally benign reactions. India: Ane Books Publications.
5. Kar, A. (2007). Medicinal Chemistry. (4th ed.), New Age International Publishers.

Reference Books

1. Brechignac, C., Houdy, P. &Lahmani, M. (2006). Nanomaterials and Nano chemistry.New York: Springer.
2. Nalwa, H. (1998). Nanostructured Materials and Nanotechnology. New York: AcademicPress.
3. Ahluwalia, V. K. (2012). Strategies for Green Organic Synthesis. New York: Taylor and Francis group, CRC Press.
4. Matlack, A. (2010). Introduction to Green Chemistry. (2nded.). New York: Taylor and Francis group, CRC Press.
5. Ilango, K. &Valentina, P. (2009). Text Book of Medicinal chemistry. (4thed.). India: Keerthi Publishers.

Semester III

Elective III (b): Medicinal Chemistry

Course Code: PG2034

Hours per week	Credits	Total Hours	Marks
4	3	60	100

Objectives:

- To understand the pharmacology and nomenclature of drugs.
- To gain knowledge on mechanism of drugs action and its function.
- To acquire knowledge on blood grouping and Indian medicinal plants.

Course Outcome (COs)

CO	*Upon completion of this course, the students will be able to*:	PSO Addressed	CL
CO-1	understand the classification, nomenclature and therapeutic action of drugs	PSO-1	U
CO-2	apply the therapeutic values of drugs	PSO-2	A
CO-3	analyze the chemical constituents and its therapeutic values of drugs	PSO-2	Y
CO-4	evaluate the role of metals in drugs	PSO-2	E

Unit I **(12 Hours)**

Classification and Nomenclature of Drugs: Important terminologies - molecular pharmacology - pharmacophore-mutation - metabolites - antimetabolites - virus - bacteria - fungi and actinomycetes. Drugs - classification - nomenclature - non-proprietary names - source - assay - biological - chemical and immunological. Testing of potential of drugs and their side effects.

Unit II **(12 Hours)**

Role of Metals in Drugs: Mechanism of drug action - absorption - drug delivery and drug excretion. Physiological effects of different functional groups in drugs.Indian medicinal plants and trees - Tulsi - Neem - Keezhanelli - Adathode and Thoothuvalai.Biological role of salts - source and deficiency - Na - K - Ca - Cu - Zn and iodine.Disinfectants - Uses of $MgSO_4.7H_2O$ - milk of magnesia - magnesium trisilicate- aluminium hydroxide gel - $HgCl_2$ - HgI_2 and $Hg(CN)_2$.

Unit III **(12 Hours)**

Common Drugs and their Therapeutic Values: Analgesics - salicylates -narcotics - opiates -morphine andpethidine. Anaesthetics - local anaesthetics - procaine and related compounds.General anaesthetics-chloroform - ether and barbiturates.Antipyretics - paracetamol and other p-aminophenol derivatives. Antiseptics and disinfectants - distinction

- phenols - chloramines - cyclohexadiene and organomercurals.Antibiotics - therapeutical values of penicillin - streptomycin - chloromphenicol and tetracyclines. Hypoglycemic drugs - insulin - oral hypoglycaemic agents -sulphonylureas. Hypnotics - tranquilizers and sedatives. Drugs addiction.

Unit IV **(12 Hours)**

Common Diseases and First Aid: Common diseases - causes and treatment - insect borne diseases - malaria and filariasis. Airborne diseases - diphtheria - whooping cough - influenza and TB.Waterborne diseases - cholera - typhoid and dysentery.Jaundice and leprosy.First aid for accidents - cuts - bleeding - fractures - burns - fainting - poisonous bites and poisoning.

Unit V **(12 Hours)**

Blood Grouping and Therapeutic Drugs: Blood grouping - Rh factor. Tests for urea and cholesterol.Role of blood as oxygen carrier and clotting mechanism. Blood pressure - causes and control. causes of anaemia,Antianaemic drugs - cardiovascular drugs - cardiglycosides - antianginal agents and vascodilators(one example for each). Causes of cancer.Antineoplastic agents - cobalt therapy.AIDS -causes - HIV virus - propagation - prevention and treatment.

Text Books

1. Kar, A. (2007). Medicinal Chemistry. (4th ed.). India: New Age International Publishers.
2. Cairns, D. (2012). Essentials of Pharmaceutical Chemistry. (4th ed.). India: Pharmaceutical Press.
3. Barber, J., &Rostron, C. (2013). Pharmaceutical Chemistry. (1st ed.). USA: Oxford University Press.
4. Ghosh, J. (2014). A Textbook of Pharmaceutical Chemistry. India: S. Chand and Company Ltd.

Reference Books

1. Chatwal, G.R., &Arora, M. (2010). Pharmaceutical Chemistry-Inorganic. India: Himalaya Publication House.
2. Chatwal, G.R., &Arora, M. (2008). Pharmaceutical Chemistry Organic. India: Himalaya Publication.
3. Ilango, K. &Valentina, P. (2009). Text Book of Medicinal chemistry. (4th ed.). India: Keerthi Publishers.

Semester III

Project
Course Code : PG20PR

No. of hours per week	Credits	Total No. of hours	Marks
6	**5**	90	100

Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	choose a new topic of their interest	PSO - 1	U
CO - 2	develop the attitude of studying a topic in depth independently	PSO - 4	An
CO - 3	express their views with confidence in a group	PSO - 1	U
CO - 4	relate with the group members and reap the best harvest	PSO - 3	Ap
CO - 5	develop communication skills through oral presentation	PSO - 4	An
CO - 6	create a taste for research in mathematics	PSO - 5	C
CO - 7	develop confidence to face interviews	PSO - 5	C
CO - 8	Interpret and analyze data mathematically	PSO - 4	An

Guidelines

- All the students must undertake dissertation work at the final year (III semester).
- The students, with the consent of the Supervisor, HoD and the Principal can pursue their project in another institution, especially with MoU/ Collaboration for the successful completion of the project work.
- Evaluation

Evaluation	Marks	Month/ Date	Evaluator
Proposed title, review of literatureand objectives.	-	3rd Week of III Semester	-
I Review	10	July	Supervisor
II Review	10	August	Supervisor
Final- Internal	20	September/ October	Supervisor
External - Dissertation	40	October /November	Ext. examiner

*Viva-voce (individual & open)	20		
Total marks	100		

* Mode of presentation by Power Point

Dissertation framework

1. The Project format should be in:

o **Font - Times New Roman**

o **Heading - Font size 14 (Bold) - Uppercase**

o **Sub headings - Font size 12 (Bold) — Lowercase; should be numbered.(Eg: Introduction 1; Subheading 1.1; 1.2)**

o **Text, the content of the dissertation — Font size -12 (Normal).**

o Citation - Any works of other researchers, if used either directly or indirectly should be indicated at appropriate places in the text.

The citation may assume any one of the following forms:

i) A paper, a monograph or a book with single author may be designated by the name of the *fast* author followed by the year of publication, placed inside brackets at the appropriate places in the text.

ii) A paper, a monograph, or a book with two authors may be designated by the name of the first and second author followed by the year of publication, placed inside brackets at the appropriate places in the text.

iii) A paper, a monograph, or a book with more than two authors may be designated by the name of the first author followed by et al, and the year of publication, placed inside brackets at the appropriate places in the text.

o **Line space - 1.5**

o **Margin - 2" on the left and 1" on the right, Gutter -0.5.**

o **Page Numbering — Bottom middle alignment; excluding initial pages and reference** o **Total number of pages - Minimum 30 - Maximum 50 (excluding initial pages andreference).**

o **The Tables and Figures should be included subsequently after referring them in thetext of the Thesis.**

o **The thesis from Chapters should be printed on both sides.**

II. Project Report must be completed within the stipulated

time.

III Submission of Project Report:

o one soft copy (PDF format in CD)

o three hard copies (soft binding) duly signed and endorsed by the Supervisor and the Head.

The Project Report **will have three main parts:**

I. Initial Pages - in the following sequence

i. Title Page

ii. Certificate from the Supervisor

iii. Declaration by the candidate endorsed by the Supervisor and HOD.

iv. Acknowledgement (within one page - signed by the candidate).

v. Table of Contents

vi. List of abbreviations

vii. Abstract

II. Main body of the dissertation

i. Introduction with Literature review and Objectives

ii. Methodology

iii. Results

iv. Discussion

v. Summary

vi. References

III Reference

The guidelines for reference

Journal Article : with Single Author

Waldron, S 2008, "Generalized Welch bound equality sequences are tight frames", IEEE Transactions on Information Theory, vol. 49, no. 9, pp. 2307-2309.

Journal Article : with Two Authors

Conley, TG & Galeson, DW 1998, "Nativity and wealth in mid-nineteenth century cities", Journal of Economic History, vol. 58, no. 2, pp. 468-493. **Journal Article : with more than two Authors**

Alishahi, K, Marvasti, F, Aref, VA & Pad, P 2009, „Bounds on the sum capacity of synchronous binary CDMA channels", Journal of Chemical Education, vol. 55, no. 8, pp. 3577-3593.

Books

Holt, DH 1997, Management Principles and Practices, Prentice-Hall, Sydney. Centre forResearch, M S University - Ph.D. Revised Guidelines Page | 39 / 41

E-book

Aghion, P &Durlauf, S (eds.) 2005, Handbook of Economic Growth, Elsevier, Amsterdam.Available from: Elsevier books. [4 November 2004]. **Conference Proceeding Paper with editors**

Riley, D 1992, „Industrial relations in Australian education", in Contemporary Australasian industrial relations: proceedings of the sixth AIRAANZ conference, ed. D. Blackmur, AIRAANZ, Sydney, pp. 124-140. **Conference Proceeding Paper without editors**

Fan, W, Gordon, MD & Pathak, R 2000, "Personalization of search engine services for effective retrieval and knowledge management", Proceedings of the twenty-first internationalconference on information systems, pp. 20-34. **Website**

Australian Securities Exchange 2009, Market Information. Available from: . [5 July 2009].

Thesis

Unpublished Hos, JP 2005, Mechano chemically synthesized nano materials for intermediatetemperature solid oxide fuel cell membranes. Ph.D. thesis, University of Western Australia.

Newspaper Print Ionesco, J 2001, 'Federal election: new Chip in politics', The Advertiser 23October, p. 10.

Semester III
Life Skill Training - II
Course Code: LST202

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:
1. To aid students in making right choices and decisions
2. To create awareness on practical methods that lead to personal and societal development

Course Outcome (CO)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	Identify the root cause of social evils and it's consequences	PSO-	An
CO-2	Understand the importance of personal and emotional well being	PSO-	Un
CO-3	Empathise with the needy and disabled	PSO-	Ap

Unit I

Corruption - causes and types. Seeds and remedies of corruption.

Casteism - causes and consequences.

Communalism - characteristics - causes and remedial measures.

Regionalism - characteristics - causes and remedial measures.

Unit II

Abortion - reason and methods. Birth control

Alcoholism - alcoholism and causes of drinking. Harmful effects of liquor.

Drug addiction - causes - effects and control of drug addiction.

Unit III

Depression - signs - causes and treatments.

Suicide - signs and treatments. Child labour.

Unit IV

Divorce - causes and effects. Steps to avoid divorce.

Dowry system in India - Legislations to inhibit dowry system. Cases and problems.

Unit V

Care and concern for the aged and disabled - need to take care of elders. Caring of someone with physical disability.

HIV and aids - basic facts - causes - prevention and treatment.

Text Book:

(Compilation will be provided to the students)

Reference Books:

1. CN. Shankar Rao, India Social Problems - A Sociological Perspective. S. Chand and Company Limited. New Delhi. 2015.
2. CN. Shankar Rao, Sociology of Indian Society. S. Chand and company limited. New Delhi. 2004
3. Gawain, Shakti and Laurel King. Living in the Light. - A Guide to Personal Transformation. Natraj Publishing. Canada. 1998.

Semester IV

Core IX: Inorganic Spectroscopy, Photochemistry and Organometallics
Course Code: PG2041

Hours per week	Credits	Total Hours	Marks
6	6	90	100

Objectives:

- To understand the principle, interpretation and applications of various spectroscopic techniques to inorganic compounds
- To know the applications of photochemistry, organometallics and bio-inorganic chemistry

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to*:	PSO Addressed	CL
CO-1	understand the principles and concepts of inorganic spectroscopy, photochemistry and organometallics.	PSO-1	U
CO-2	apply the principles of spectroscopy, photochemistry and organometallic chemistry to inorganic compounds.	PSO-2	A
CO-3	analyse the structure, reactions and functions of inorganic compounds.	PSO-2	Y
CO-4	evaluate the spectral data and properties of inorganic compounds	PSO-3	E

Unit I **(18 Hours)**

IR, Raman and NMR Spectroscopy

IR spectroscopy: introduction - selection rules - stretching frequency of some inorganic ions - effect of coordination on the stretching frequency of sulphato - carbonato - sulphito - aqua - nitro - thiocyanato - cyano - thiourea and DMSO complexes.
Raman spectroscopy: introduction - combined applications of IR and Raman spectroscopy in the structural elucidation of N_2O - ClF_3 - NO_3^- - ClO_4 and metal carbonyls.
NMR spectroscopy: introduction - structural assessment of simple inorganic compounds - applications of ^{1}H -^{15}N - ^{19}F and ^{31}P NMR spectroscopy in structural problems. Fluxional molecules and effect of quadrupolar nuclei in NMR spectroscopy.

Unit II **(18 Hours)**

Mössbauer and Photoelectron Spectroscopy

Mössbauer (MB) spectroscopy: introduction - principle - recoil energy - doppler effect - number of MB signals - isomer shift - quadrupole splitting and magnetic hyperfine splitting. Applications of MB spectroscopy to ^{57}Fe -^{119}Sn and ^{129}I compounds.

Photoelectron Spectroscopy (PES): theory - types - origin of fine structures - shapes of vibrational fine structures - adiabatic and vertical transitions. PES and evaluation of vibrational constants of homonuclear diatomic molecules - N_2 and O_2 - heteronuclear diatomic molecules - CO and HCl - polyatomic molecules H_2O - CO_2 - CH_4 and NH_3. Koopman's theorem- applications and limitations.

Unit III **(18 Hours)**

Inorganic Photochemistry: Importance of photochemistry. Photochemistry of Co(III) complexes - photosubstitution-photooxidation-photoreduction and photoanation reactions. Photochemistry of Cr(III) complexes - Adamson's rule - photoaquation - photoisomerization - photoracemization - photoanation - photosubstitution in non-aqueous solvents and photoredox reactions. Photochemistry of ruthenium polypyridyls - preparation and characteristics of $[Ru(bpy)_3]^{2+}$ complex. Ground state and excited state properties of $[Ru(bpy)_3]^{2+}$ complex. Reactions of $[Ru(bpy)_3]^{2+}$ complex - photosubstitution - photoredox and reductive quenching reactions.

Unit IV **(18 Hours)**

Organometallic Chemistry: Organometallic compounds - types. EAN rule - 18e- and 16e- rules - determination of oxidation state - configuration - coordination number of the metal centre - types and application 18e- / 16e- rules. Carbonyls - isolated concept - structure of simple and polynuclearcarbonlys. Nitrosyls - bridging and terminal nitrosyls - bent and linear nitorsyls. Synthesis, properties and structural features of metal complexes with carbene- alkene - alkyne and arene. Hapticity.Metallocenes-synthesis - properties and bonding in ferrocene. Covalent versus ionic bonding in beryllocene.Reactions of organometallic compounds - substitution - oxidative addition and reductive elimination - insertion and deinsertion (elimination) reactions.

Unit V **(18 Hours)**

Bio Inorganic Chemistry: Photosynthesis - photosystem I and II. Photosynthetic reaction center.Metallo enzymes - Zinc enzymes - structure and functions of carbonic anhydrase and carboxy peptidase.Iron enzymes -catalase and peroxidase. Super oxide dismutase (SOD) - superoxide toxicity - structure and function of Cu,Zn-SOD. Trace elements in biological system. Metal ion toxicity - classes of toxic metal compounds and detoxification. Metals in medicine - anti-arthritis drugs - Au and Cu in rheumatoid arthritis - Li in psychiatry - Pt, Au and metallocenes in anti-cancer drugs.Metals in radiodiagnosis and magnetic resonance imaging.

Text Books

5. Roundhill, D.M. (1994). Photochemistry and Photophysics of Metal Complexes. (1st ed.). New York: Plenum Press.
6. Kaur, H. (2006). Spectroscopy. (3rded.).Meerut: PragatiPrakasan Publications.
7. BanWell, C.N. &Mccash, E.M. (1997). Fundamentals of Molecular Spectroscopy. New Delhi: Tata Mc Grow Hill.
8. Malik, W.U., Tuli, G.D. &Madan, R.D. (2012). Selected topics Inorganic Chemistry. (5th ed.). New Delhi: S. Chand Company Ltd.
9. Chatwal, G.R. &Bhagi, A.K. (2005). Bio-inorganic Chemistry. (2nd ed.). India: Himalaya Publishing House.

Reference Books

1. Rohatgi, K.K. & Mukherjee, K.K. (2014). Fundamentals of Photochemistry. (3rd ed.). India: New Age International.
2. Iggo, J.A. (2000). NMR Spectroscopy in Inorganic Chemistry. USA: Oxford Scientific Publications.
3. Brisdon, A.K. (1998). Inorganic Spectroscopic Methods. USA: Oxford Scientific Publications.
4. Horwood, E. (2010). NMR, NQR, EPR and Mössbauer Spectroscopy in Inorganic Chemistry. (1sted.). New York: Ellis Horwood Ltd.
5. Puri, B.R., Sharma L.R. &Kalia, K.C. (2012). Principles of Inorganic Chemistry. (4th ed.), India: Milestone publishers.
6. Miessler, G.L. (2004). Inorganic Chemistry. (3rd ed.), India: Pearson Education.
7. Huheey, J.E., Keiter, E.A., Keiter, R.L. &Medhi, O.K. (2011). Inorganic Chemistry, Principles of Structure and Reactivity. (4thed.). India: Pearson Education.

Semester IV
Core X: Photochemistry and Natural Products
Course Code: PG2042

Hours per week	Credits	Total Hours	Marks
6	5	90	100

Objectives:

- To understand various organic reactions with their mechanism and synthetic utility.
- To elucidate the structure and synthesise natural products.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	understand various organic reactions and their mechanism	PSO-1	U
CO-2	apply the reaction mechanism in organic synthesis	PSO-2	A
CO-3	analyzethe structure and mechanism of reactions	PSO-2	Y
CO-4	evaluate the synthetic utility of reactions	PSO-2	E

Unit I **(18 Hours)**

Organic Photochemistry: Introduction - Thermal versus photochemical reactions and Jablonski diagram. Photochemical reactions of ketones - photosensitization - Norrish type - I and Norrish type - II reactions and mechanisms - Paterno-Buchi reaction - photooxidation and photoreduction of ketones.Photochemistry of arenes - Photodimerisation - photoisomerisation.Reactions involving free radicals - Barton - Hundsdiecker - Pschorr and Gomberg-Bauchman reactions.

Unit II **(18 Hours)**

Pericyclic Reactions: Characteristics and classifications of pericyclic reactions - electrocyclic - cycloaddition and sigmatropic reactions. Woodward Hofmann rule.Retro-Diels Alder reaction - Diels Alder reaction - 2+2 - 2+4 reactions. Cope rearrangements and Claisenrearrangements.Conservation of orbital symmetry. Prediction of reaction conditions using FMO - correlation diagrams and Zimmerman (Mobius-Huckel) approaches.

Unit III **(18 Hours)**

Retrosynthetic Analysis: Retrosynthetic terminologies - linear and convergent approach - protecting groups - activating groups - synthons and synthetic equivalents. Target molecule - one functional group disconnection - two functional groups disconnection- 1,3- 1,5- and 1,4-dicarbonyl compounds. Functional group addition and interconversions.Umploung synthesis.Latent polarity.Retrosynthetic analysis - bisabolene - cis-jasmone - longifolene and cubane.Synthetic uses of nitrocompounds and alkenes.

Unit IV **(18 Hours)**

Alkaloids: Extraction - general properties - classification and general methods for determining structure. Structural elucidation - atropine - cocaine -dictamnine -reserpine - aeronycineand morphine.

Unit V **(18 Hours)**

Heterocyclic Compounds: Synthesis - reactions - structure - carbazole - oxazole - imidazole - thiazole - pyrones - pyrazole - pyrimidine - pyrazine - coumarins and chromone. Structural elucidation - flavones - isoflavone - anthocyanins - caffeine - theobromine and theopylline.

Text Books

1. Singh, J &Singh, J. (2012). Photochemistry and Pericyclic Reactions. (3rded.). India: New Age InternationalPvt. Ltd.
2. Tewari, K. S., Vishnol, N. K. &Mehrotra, S.N. (2002). A Text Book of Organic Chemistry. India: VikasPublishing House Ltd.
3. Warren, S. (2014). Organic Synthesis: The Disconnection Approach.India: Wiley Pvt. Ltd.
4. Finar, I.L. (2002). Organic Chemistry Volume II. (5th ed.). India: Pearson Education
5. Bansal, R.K. (2014).Heterocyclic Chemistry. (5thed.). India: New Age International Pvt. Ltd.
6. Clayden, J. Greeves, N& Warren, S. (2012). Organic Chemistry. (2nded.). Oxford University Press**.**

Reference Books

1. Depuy, C.H., & Chapman, O.S. (1988). Molecular Reactions and Photochemistry. India: Prentice Hall Pvt. Ltd.
2. Gill, G.B.&Wills, M.R. (1974). Pericyclic Reactions. London: Chapman and Hall
3. Agarwal, O.P. (1947). Chemistry of Organic Natural Product Vol. I& II India: Goel Publishing House.
4. Joule, J.A. &Mills, K. (2010). Heterocyclic Chemistry.(5thed.). India: Wiley Pvt. Ltd.
5. Ireland, R.E. (1969). Organic Synthesis. Prentice Hall, Englewood Cliffs, New Jersey, U.S.A.
6. Carruthers, W. (2015). Modern Methods of Organic Synthesis. (4thed), Cambridge University Press.

Semester IV
Core XI: Polymer chemistry
Course Code: PG2043

Hours per week	Credits	Total Hours	Marks
6	5	90	100

Objectives:

- To gain knowledge about applications of polymers.
- To know the importance of various polymerization techniques.
- To study about synthetic polymers.

Course Outcome (COs)

CO	Upon completion of this course, the students will be able to:	PSO Addressed	CL
CO -1	Understand the concept of polymer chemistry	PSO - 1	U
CO -2	Apply the processing techniques in the manufacture of synthetic polymer	PSO - 5	A
CO -3	Analyze glass transition temperature, crystallinity and degradation in polymers.	PSO - 3	Y
CO -4	Evaluate molecular weight and size of the polymer	PSO - 3	E

UnitI(18hours)
Chemistry of Polymerization: Basic concepts of polymer chemistry - repeat unit - degree of polymerization -classification - chain polymerization - free radical polymerization - ionic polymerisation - coordination polymerisation: Zeigler- Natta catalyst - stereo regulating polymerization - step polymerization - ring openingpolymerization - copolymerisation - types - free radicalcopolymerisation - ioniccopolymerization -copolycondensation - block and graft copolymers.

UnitII (18hours)
Polymerisation Techniques Molecular Weight and Size: Polymerisation techniques - bulk -solution -suspension - emulsion - polymerizations -melt polycondensation - solution polycondensation interfacialcondensation - solid and gas phase polymerization - molecular weight and size -number average and weight average molecular weights - sedimentation and viscosityaverage molecular weights -polydispersity and molecular weight distribution in polymers - practical significance of polymer molecular weight.

UnitIII(18hours)
Polymer Processing: Processing techniques - calendering - die casting - rotational casting - film casting -compression moulding - injection moulding - blow moulding - extrusion moulding - thermoforming, foaming and reinforcingtechniques - hand lay-up technique - filament winding technique - spray-up technique. Fibre spinning - dry spinning - wet spinning - uniaxial orientation - post treatment for fibres.

UnitIV (18hours)

Synthetic Polymers: Synthetic resins - plastics -manufacture - applications - polyethylene - PVC - teflon -polystyrene - polymethylmethacrylate -polyurethane - phenol-formaldehyde resins - urea- formaldehyde and melamine-epoxypolymers.Synthetic fibers - rayon -nylons - polyesters -acrylics – modacrylics. Natural rubber -production -constitution - vulcanization (hot and cold) - fillers andaccelerators - antioxidants - synthetic rubber -SBR - butyl rubber - nitrile rubber -neoprene -silicone rubberand polysulphides.

UnitV (18hours)

Polymer Degradation and Additives: Polymerdegradation - types- thermaldegradation - mechanicaldegradation - photodegradation – degradation by ultrasonic waves - degradation by high energy radiation -hydrolyticand oxidative degradations -additives for polymers - fillers - plasticisers - thermal stabilizers - photo stabilizers -antioxidants and colourants.

Text Books

1. Billmeyer, F. (1971). Textbook of Polymer Science.(2nded), New York : John Wiley and Sons.
2. Gowariker, V.R (2009). Polymer Science. (2nded), New Age international .). India: New Age International Pvt. Ltd.
3. Braun, D. (1982). Simple Methods for Identification of Plastics. New York : Macmillan Publishing Co.
4. Robert Weast,C. (1985). Handbook of Chemistry and Physics. (65thed), Boca Raton, FL : CRC Press.
5. Hightstown, N.J. (1990). Modern Plastics, Encyclopedia, Volume 67: McGraw Hill.

Reference Books

1. Odian, G. (2004). Principles of Polymerization. (4thed): John Wiley and Sons
2. ManasChanda. (2000). Advanced Polymer Chemistry: Marcel Dekker Inc.
3. Malcolm. P.Stevens. (1999).Polymer Chemistry: An Introduction. (3rd edition): USA :Oxford University Press
4. Misra .G.S. (1993). Introductory Polymer Chemistry :New York : J. Wiley and Sons.
5. Charles E. Carraher Jr. (2017). Introduction to Polymer Chemistry. (4thed):CRC Press.
6. Rodriguez, F., Cohen, C., Ober, C.K. &Archer, L. (2015). Principles of Polymer Systems. (6thed), CRC Press.

Semester IV
Elective IV (a): Energy for Future
Course Code: PG2044

Hours per week	Credits	Total Hours	Marks
4	3	60	100

Objectives:

- To acquire knowledge on conventional and non-conventional energy sources.
- To enlighten the students with knowledge of solar radiation and its measurement.
- To gain knowledge on wind energy, biogas and hydrogen energy.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	understand the importance of various sources of non-conventional energy	PSO-1	U
CO-2	apply the principle of energy conversion totheproduction of energy for the future	PSO-2,3,4	A
CO-3	analyze the advantages and disadvantages of different non-conventional energy sources	PSO-2,3	Y
CO-4	evaluate solar energy radiation, wind energy data and conversion efficiency of fuel cells	PSO-2,3	E
CO-5	create fuel cells	PSO-3,5	C

Unit I **(12 Hours)**

Introduction to Energy Sources: Introduction - conventional energy sources - coal - oil - gas - agricultural and organic wastes - water power - thermal power and nuclear power. Non-conventional energy sources - solar energy - wind energy - energy from bio-mass and bio-gas - ocean thermal energy - tidal energy - geothermal energy and hydrogen energy. Advantages of renewable energy.

Unit II **(12 Hours)**

Solar Energy: Solar radiation and its measurement -introduction - solar constant - solar radiation at the earth's surface - solar radiation geometry and solar radiation data. Solar energy collectors - introduction - physical principles of the conversion of solar radiation into heat - flat plate and concentration collectors. Advantages and disadvantages of concentration collectors over flat collectors. Energy balance equation and collector efficiency.

Unit III **(12 Hours)**

Wind Energy: Introduction - basic principles of wind energy conversion - power of the wing and forces on the blades. Wind energy conversion - wind data and estimation - site selection. Types of wind machines - horizontal axis and vertical axis machines.Analysis of

aerodynamic forces acting on the blade and performance of wind machines. Generating systems -introduction - schemes of electric generation - generator control - load control and energy storage. Application of wind energy.

Unit IV **(12 Hours)**

Bio-energy: Introduction - biomass conversion techniques - wet processes and dry processes. Biogas generation.Classification of biogas plants - floating drum plant and fixed dome type plant.Biogas from plant waste. Materials used for biogas generation - selection of site for a biogas plant and digester design. Problems related with biogas plants. Fuel properties of biogas and utilization of biogas.

Unit V **(12 Hours)**

Chemical Energy Sources: Fuel cells -introduction - conversion efficiency of fuel cells - types of electrodes - work output and EMF of fuel cells. Applications of fuel cells.Hydrogen energy.Hydrogen production - electrolysis - thermo-chemical - fossil fuel and solar energy methods.Hydrogen storage and hydrogen transportation.Utilization of hygrogen gas.Hydrogen as an alternative fuel for motor vehicles.Safety and management.

Text Books

1. Rai, G.D. (2004). Non-conventional Energy Sources. India: Khanna Publications.
2. Wengenmayr, R., Bührke, T. &Brewer, W.D. (2012). Renewable Energy: Sustainable Energy Concepts for the Energy Change. (2nded.). New York: Wiley VCH.
3. Nelson, V. (2011). Introduction to Renewable Energy (Energy and the Environment). New York: CRC Press.
4. Twidell, J. & Weir, T. (2006). Renewable Energy Resources. (2nded.). New York: Taylor and Francis.

References Books

1. Chiras, D. (2006). Achieving Energy Independence through Solar, Wind, Biomass and Hydropower. Mother Earth News Wiser Living.
2. Tester, J.W., Drake, E.M., Driscoll, M.J., Golay, M.W., & Peters, W.A. (2006). Sustainable Energy. (2nded.). New Delhi: Prentice-Hall of India

Semester IV
Elective IV (b): Nanochemistry
Course Code: PG2045

Hours per week	Credits	Total Hours	Marks
4	3	60	100

Objectives:

- To acquire knowledge about basic concepts of nanochemistry.
- To understand the applications of carbon clusters.
- To learn about nanodevices and its applications.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PO Addressed	CL
CO-1	understand the basic concept of nanochemistry and its applications	PSO-1	U
CO-2	apply the principle of nanotechnology for the synthesis and characterization of nanomaterials in various fields	PSO-2,3	A
CO-3	analyze the physical and chemical properties of nanoparticles	PSO-2,3	Y
CO-4	evaluate the properties of nanoparticles using various analytical techniques	PSO-2,3	E
CO-5	create and characterize novel nanomaterials	PSO-3,4	C

Unit I **(12 Hours)**

Basic Concepts of Nanochemistry: Introduction to nanoscience and nanotechnology - discussion on various phenomenon at nanoscale - size - shape - surface - surface energy - surface stabilization - characteristic length - self-assembly - defects - size quantization - surface plasmon - conductivity - tunneling - magnetism and defects.

Unit II **(12 Hours)**

Synthesis of Nanomaterials: Basics of nanofabrication method - top-down - bottom-up approaches - gas phase - liquid phase - solid phase synthesis - self-assembly - templated synthesis - sol-gel - electrodepostion - fundamentals of nanoparticle formation - thermodynamic approach - supersaturation - nucleation - growth and homo vs hetero nucleation. Synthesis of nanoparticles - metallic - semiconducting - quantum dots - oxides - hybrids - micelles and microemulsion as templates for synthesis.0D, 1D and 2D nanoparticles - core-shell nanoparticles - special nanoparticles and shaped nanoparticles.

Unit III **(12 Hours)**

Characterization Techniques: Discussion on various techniques available for characterizing the nanomaterials - size - shape - morphology - crystalline phase - oxidation states - textural properties - surface area - pore volume - pore size - thermal stability - light absorption and band gap. Scanning electron microscope (SEM) - Transmission electron microscope (TEM) - X-ray powder diffraction (XRD) - X-ray photoelectron spectroscope (XPS) - Scanning tunneling microscope (STM) and Atomic force microscope (AFM). Thermal analysis - N_2 sorption techniques for textural properties of the material.Solid state NMR for characterizing functionalized materials.

Unit IV **(12 Hours)**

Carbon Clusters and Nanostructures: Bonding in carbon - new carbon structures - carbon clusters - discovery of C_{60} - alkali doped C_{60} - superconductivity in C_{60} - larger and smaller fullerenes. Carbon nanotubes - synthesis - single walled carbon nanotubes - structure and characterization - mechanism of formation - chemically modified carbon nanotubes - doping - functionalizing nanotubes - application of carbon nanotubes - nanowires - synthetic strategies - gas phase and solution phase growth - growth control and properties.

Unit V **(12 Hours)**

Nanotechnology and Nanodevices: DNA as a nanomaterial. DNA - knots and junctions. DNA nanomechanical device designed by Seeman. Force measurements in simple protein molecules and polymerase. DNA complexes. Molecular recognition and DNA based sensor. Protein nanoarray - nanopipettes- molecular diodes - self-assembled nanotransistors and nanoparticle mediated transfection.

Text Books

1. Rao, C.N.R., Muller, A. &Cheetam, A.K. (2004). The Chemistry of Nanomaterials. Vol. I. New York: Wiley-VCH.
2. Poole, C.P. & Owens, F.J. (2003). Introduction to Nanotechnology. New Jersey: Wiley Interscience
3. Klabunde, K.J. (2001). Nanoscale materials in Chemistry. New York: Wiley-Interscience.
4. Pradeep, T. (2007). Nano: The Essentials in Understanding Nanoscience and Nanotechnology. New Delhi: Tata McGraw Hill.

Reference Books

1. Tang, T. & Sheng, P. (2004). Nano Science and Technology-Novel Structures and Phenomena. New York: Taylor and Francis.
2. Heiz, U. &Landman, U. (2006). Nanocatalysis. New York: Springer.

Semester III and IV

Practical III: Inorganic Chemistry

Course Code: PG20P3

Hours per week	Credits	Total Hours	Marks
4	4	40	100

Objectives:

- To separate and estimate the metal ions from a mixture volumetrically and gravimetrically.
- To prepare inorganic complexes.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	understand the principle for the separation, estimation and preparation of inorganic compounds	PSO-1	U
CO-2	apply the principle of volumetric and gravimetric analysis for the separation andestimation of metal ions in a mixture	PSO-2,3	A
CO-3	analyze the procedure for the estimation and preparation of inorganic compounds	PO-2	Y
CO-4	evaluate the amount of metal ions present in a mixture	PSO-2,3	E
CO-5	create novel inorganic complexes	PSO-3,4	C

1. Separation and estimation of metal ions in a mixture by volumetric and gravimetric methods. Some typical recommended mixtures are:

Cu(II) and Ni(II)

Fe(II) and Cu(II)

Cu(II) and Zn(II)

Ca(II) and Ba(II)

Fe(II) and Ni(II)

2. Preparation of complexes:

Tris(thiourea)copper(I) chloride

Tetraamminecopper(II) sulphate

Potassium trioxalatoferrate

Potassium trioxalatoaluminate(III)

Potassium trioxalatochromate(III)

Hexamminecobalt(III) chloride

3. Spectrophotometric Analysis

   Characterisation of any three metal complexes prepared during the practicals by UV and IR spectral techniques (Course Work)

References

1. Vogel, A.I. (2000). Text Book of Quantitative Inorganic Analysis. (6th ed.). New Delhi: Longman.
2. Ramanujam, V.V. (1988). Inorganic Semimicro Qualitative analysis. (3rd ed.). Chennai: The National publishing Company.

Semester III and IV

Practical IV: Physical Chemistry

Course Code: PG20P4

Hours per week	Credits	Total Hours	Marks
4	4	40	100

Objectives:

- To determine the strength unknown solution by conductometric and potentiometric titrations methods.
- To determine the heat of solution of the given solid in liquids.
- To determine the values of the adsorption constants.

Course Outcomes (COs)

CO	*Upon completion of this course, the students will be able to:*	PSO Addressed	CL
CO-1	understand the principle of conductometric and potentiometric titrations	PSO-1	U
CO-2	apply the principles of conductometry and potentiometry to determine the strength of unknown solutions.	PSO-2	Ap
CO-3	analyze the strength of acids by adsorption method	PSO-3	Y
CO-4	evaluate conductance ,dissociation constant and heat of solution	PSO-5	E

Potentiometric Titration

1. Redox titrations
   (i) Fe^{2+} vs $Cr_2O_7^{2-}$
   (ii) Fe^{2+} vs Ce^{4+}
   (iii) HCl/CH_3COOH vsNaOH

2. Precipitation titrations
   (i) Cl^- vs $AgNO_3$
   (ii) I^- vs $AgNO_3$
   (iii) Mixture of Cl^- and I^- vs$AgNO_3$

Conductometric Titration

1. Acid- Base Titrations
   (i) Strong acid vs strong base
   (ii) Weak acid vs strong base

(iii) Mixture of acidsvs strong base

2. Precipitation titrations
(i) $MgSO_4$vs $BaCl_2$

(ii) KClvs $AgNO_3$

Thermometric Experiments: Heat of solution

(i) Ammonium oxalate and water

(ii) Oxalic acid and toluene

Adsorption

Determination of strength of oxalic acid from the study of its adsorption on activated charcoal

References

1. Viswanathan, B. & Raghavan, P.S. (2005). Practical Physical Chemistry. India: Viva Books Ltd.
2. Sienko, M.J., Plane, R.A. &Martu, S.T. (1984). Experimental Chemistry. International student Edn.
3. Shoemaker, D.P., Garland, C.W., &Nibler, J.W. (1974). Experiments in Physical Chemistry. McGraw-Hill International.
4. Levitt, B.P. (1972). Findlay's Practical Physical Chemistry. (9^{th}ed.). New York: Longman Group Ltd.

Semester IV
Life Skill Training - II
Course Code: LST202

No. of hours per week	Credit	Total no. of hours	Marks
1	1	30	100

Objectives:

- To improve the integral growth of human being towards sustainable development.
- To create awareness about human rights, values and their significance and their role.

Course Outcome (CO)

CO No.	*Upon completion of this course, the students will be able to:*	PSO Addressed	Cognitive Level
CO-1	Understand the pros and cons of organ donation and transplant.	PSO-	
CO-2	To recognise their rights and address the issues pertaining to human rights violation.	PSO-	
CO-3	To acquire the skills required for a successful personal and professional life.	PSO-	

Unit I

Generation gap - causes. Bridging the generation gap.

Donate life - pros and cons of organ donation - organ donation and transplant.

Unit II

Impact of mass media on society - functions and social impacts of media.

Responsible freedom - freedom and responsibility.

Unit III

Violation of human rights - the right to live free. Freedom to move - freedom of thought and freedom of expression. Right to democracy - types of violations and safeguarding of human rights.

Unit IV

Impact of materialism on youth.

Terrorism - causes - solutions to rid the world of terrorism and remedy.

Unit V

Marriage preparation - Fidelity and permanence. Values to practice for a successful marriage. Tips for a successful marriage.

Professional ethics and human values - work ethics - ethics and character. Civic virtues and respect for others. Types of value and its nature. Professional value and duty ethics - how to face challenges in the work place.

Text Book:

(Compilation will be provided to the students)

Reference Books:

1. Baghel, Dr. Sanjay Singh. *Social Media and Indian Youth*. Apple Books. New Delhi.2015.
2. Bhagwan , Dada. *Generation Gap* . mahavideh Foundation. Ahmedabad. 2000.
3. M. Govindarajan, S. Natarajan and V.S. Senthil Kumar. Professional Ethics and Human Values. PHI Learning Private Limited. New Delhi. 2013.
4. Don Miguel Riuz and Heather Ash Amara. *The Seven Secrets to Healthy, Happy Relationships.* Hierophant Publishing . 2018.