ST. JOSEPH'S COLLEGE MOOLAMATTOM (AUTONOMOUS)

UNDER GRADUATE PROGRAMMES

SYLLABUS

SJC-UGP

(2025 Admission Onwards)

Faculty: Science

BoS: Chemistry

Programme: Bachelor of Science (Honours)Chemistry

St. Joseph's College Moolamattom (Autonomous)
Arakulam – 685591, Kerala, India

Contents

Board of Studies

Head of the Department (Chairperson)	**Dr. Sr. Sijo Francis**
Faculty Members	**Dr. Jose James** **Ms. Deena Paul** **Dr. Jobi K V** **Dr. Anu Antony** **Ms. Anjali Raju**
Two Subject Experts outside from SJCU	**Dr. Sindhu Mathai** Assistant Professor Department of Applied Chemistry Cochin University of Science & Technology. **Dr. Prajitha Kumari** Assistant Professor PG and Research Dept. of Chemistry PSMO College, Thirurangadi, Malappuram.
One expert nominated by the Vice Chancellor	**Dr. Cincy George** Assistant Professor Dept of Chemistry Newman College, Thodupuzha
One Representative from industry/corporate	**Dr Joby Jacob** General Manager Vidya Herbs Pvt. Ltd, Bangalore
One member from College Alumni nominated By Principal	**Dr. Radhika S,** Assistant Professor Dept. of Basic Sciences Amal Jyothi College of Engineering, Kanjirapilly

Syllabus Index

Name of Major**: Chemistry**

Semester: 1

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
SJC1DSCCHE100	Fundamentals of Chemistry-1	DSC A	4	5	3		2	
SJC1MDCCHE100	Food Chemistry and Nutrition	MDC	3	4	2		2	

L — Lecture, T — Tutorial, P — Practical/Practicum , O — Others

Semester: 2

Course Code	Title of the Course	Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
					L	T	P	O
SJC2DSCCHE100	Fundamentals of Chemistry-2	DSC A	4	5	3		2	
SJC2MDCCHE100	Dairy Chemistry	MDC	3	4	2		2	

Semester: 3

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
SJC3DSCCHE200	Inorganic Chemistry-1		DSC A	4	5	3		2	
SJC3DSCCHE201	Organic Chemistry-1		DSC A	4	5	3		2	
SJC3DSECHE200	Basic Analytical Chemistry	Any one	DSE	4	4	4		0	
SJC3DSECHE201	Introduction to Nanoscience			4	4	4		0	
SJC3DSECHE202	Safe Laboratory Practices in Chemistry			4	4	4		0	
SJC3VACCHE200	Forensic Chemistry		VAC	3	3	3		0	
SJC3DSCCHE202	Inorganic and Organic Chemistry (Minor for Others)		DSC B	4	5	3		2	

Semester: 4

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
SJC4DSCCHE200	Organic Chemistry-2		DSC A	4	5	3		2	
SJC4DSCCHE201	Physical Chemistry- 1		DSC A	4	5	3		2	
SJC4DSECHE200	Polymer Chemistry	Any one	DSE	4	4	4		0	
SJC4DSECHE201	Food Chemistry			4	4	4		0	
SJC4SECCHE200	Basic Analytical and Cosmetic Chemistry		SEC	3	3	3		0	
SJC4VACCHE200	Basic Environmental Chemistry		VAC	3	3	3		0	
SJC4DSCCHE202	Fundamentals of Physical Chemistry (Minor for Others)		DSC C	4	5	3		2	
SJC4INTCHE200	Internship		INT	2					

Semester: 5

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
SJC5DSCCHE300	Organic Chemistry – 3		DSC A	4	5	3		2	
SJC5DSCCHE301	Physical Chemistry- 2		DSC A	4	5	3		2	
SJC5DSECHE300	Quantum Mechanics, Spectroscopy & Group Theory			4	4	4		0	
SJC5DSECHE301	Green chemistry for sustainable development			4	4	4		0	
SJC5DSECHE302	Environmental Chemistry	Any three	DSE	4	4	4		0	
SJC5DSECHE303	Nanotechnology for Energy Applications			4	4	4		0	
SJC5DSECHE304	Medicinal Chemistry			4	4	4		0	
SJC5DSECHE305	Main Group Elements			4	4	4		0	
SJC5SECCHE300	Analytical Chemistry and Professional skills		SEC	3	3	3		0	

Semester: 6

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week L	T	P	O
SJC6DSCCHE300	Inorganic Chemistry-2		DSC A	4	5	3		2	
SJC6DSCCHE301	Physical Chemistry- 3		DSC A	4	5	3		2	
SJC6DSECHE300	Organic Chemistry-4	Any one	DSE	4	5	3		2	
SJC6DSECHE301	Rubber Technology			4	5	3		2	
SJC6DSECHE302	Industrial Inorganic Chemistry and Nuclear Chemistry	Any one	DSE	4	4	4		0	
SJC6DSECHE303	Spectroscopic Methods of Chemical Analysis			4	4	4		0	
SJC6DSECHE304	Fundamentals of Biochemistry			4	4	4		0	
SJC6SECCHE300	Data Analysis using Python and Soft skills		SEC	3	3	3		0	
SJC6VACCHE300	Intellectual Property Rights	Any one	VAC	3	3	3		0	
SJC6VACCHE301	Research Methodology for Chemistry			3	3	3		0	

Semester: 7

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
SJC7DCCCHE400	Coordination and Organometallic Chemistry		DCC	4	4	4		0	
SJC7DCCCHE401	Organic Chemistry-5		DCC	4	5	3		2	
SJC7DCCCHE402	Molecular Spectroscopy		DCC	4	4	4		0	
SJC7DCECHE400	Drug Therapy and Drug Design	Any three	DCE	4	4	4		0	
SJC7DCECHE401	Industrial Chemistry			4	4	4		0	
SJC7DCECHE402	Advanced Chemistry of Main Group Elements			4	4	4		0	
SJC7DCECHE403	Statistical Thermodynamic s and Bioenergetics			4	4	4		0	
SJC7DCECHE404	Novel Inorganic Solids			4	4	4		0	
SJC7DSECHE400	Analytical Chemistry		DSE*	4	4	4		0	
SJC7DSECHE401	Biophysical Chemistry			4	4	4		0	
SJC7DSECHE402	Nanochemistry and Technology			4	4	4		0	

***Minor**

Semester: 8

Course Code	Title of the Course		Type of the Course DSC, MDC, SEC etc.	Credit	Hours/ week	Hour Distribution /week			
						L	T	P	O
SJC8DCCCHE400	Advanced Coordination and Organometallic Chemistry		DCC	4	6	2		4	
SJC8DCCCHE401	Physical Chemistry- 4		DCC	4	6	2		4	
SJC8DCECHE400	Organic Chemistry-6		DCE	4	5	3		2	
SJC8DCECHE401	Group Theory and Quantum Chemistry	Any two	DCE	4	4	4		0	
SJC8DCECHE402	Instrumental Methods of Chemical Analysis			4	4	4		0	
SJC8DCECHE403	Molecular Modelling			4	4	4		0	
SJC8DCECHE404	Crystallography and Electrochemistry			4	4	4		0	
SJC8PRJCHE400	Project		PRJ	2					

Semester-1

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Fundamentals of Chemistry-1**					
Type of Course	**DSC A**					
Course Code	SJC1DSCCHE100					
Course Level	**100-199**					
Course Summary	This course covers the basic principles and concepts of atoms, elements, compounds, and fundamentals of organic chemistry. Students explore atomic structure, electron displacements in organic chemistry, reactive intermediates, and the periodic table to understand the foundation of chemical interactions.					
Semester	I	Credits			4	Total Hours
Course Details	Learning approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply atomic models to forecast and explain electronic configurations, atomic behaviour, and characteristics.	A	1,2
2	Describe the relevance of organic chemistry, catenation and hybridisation.	U	1,2,10
3	Evaluate electron displacement patterns in organic molecules using arrow notation.	E	1,2
4	Utilize arrow-pushing mechanisms to illustrate and solve simple chemical reactions involving reactive intermediates.	A	1,2
5	Analyse periodic trends, the relationship between electronic configuration and the chemical reactivity of elements, including the formation of chemical bonds.	A	1,2
6	Identify metals through flame and spot tests, chloride in water, and lead in food samples, and acquire skill in organic preparation.	S	1,2,10

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Atomic Structure			
	1.1	Atomic spectrum of hydrogen atom, explanation using Bohr atom model, limitations of Bohr atom model.	4	1
	1.2	Dual nature of matter, de Broglie equation, Heisenberg's uncertainty principle and its significance.	2	1
	1.3	Concept of orbit and orbital. Types of orbitals, shapes of s, p and d orbitals.	2	1

1	1.4	Quantum numbers and their significance.	2	1
	1.5	Pauli's Exclusion Principle, Hund's rule of maximum multiplicity and Aufbau principle.	2	1
	1.6	Electronic configuration of atoms (upto atomic number 30). Stability of half-filled and completely filled electronic configurations.	3	1
2	**Fundamentals of Organic Chemistry**			
	2.1	Relevance of organic chemistry in day-to-day life (with 2-3 examples). Carbon: catenation and hybridisations (with examples ethane, ethene and ethyne).	3	2
	2.2	Arrow notations, bond fissions: curved arrow notation, drawing electron displacements with curved arrows, curved and fishhook arrows in	2	3,4

		organic reaction mechanisms. Polarity of bonds (basic concepts only).		
	2.3	Homolysis and heterolysis with examples. Reactive intermediates: formation, structure and stability of carbocations, carbanions, and free radicals.	4	3,4
	2.4	Electron displacement effects: inductive effect-influence of inductive effect in the acidity of carboxylic acids. Resonance effect (delocalization, contributing structures, and stability) – hyperconjugation	6	3,4
3	**Chemistry of Elements and Molecules**			
	3.1	Modern periodic law – long form periodic table. Classification of elements- s, p, d and f block, metal, non-metals and metalloids.	4	5
	3.2	Diagonal relationship and anomalous behaviour.	1	5
	3.3	Periodicity in properties: Atomic and ionic radii - ionization enthalpy - electron affinity (electron gain enthalpy) – electronegativity. Electronegativity scales: Pauling Scale	5	5
	3.4	Effective nuclear charge – Slater rule and its applications	2	5
	3.5	Valency and oxidation state with examples	1	5
	3.6	Introduction to molecules- types of bonds, ionic bond, covalent bond, coordinate bond	2	5
	Foundation Course 1 Practical			

4	4.1	1. Demonstration of atomic models using software (non-evaluative) 2. Detection of sodium, potassium, calcium, barium and strontium ions through flame test. 3. Spot test of nickel, zinc and copper. 4. Chloride ion detection in well water and tap water. 5. Detection of lead in food samples. 6. Draw structures of simple organic molecules and resonance structures using chem-sketch / chemdraw.	30	6
		7. Preparation of 5-nitrosalicylic acid from salicylic acid. 8. Preparation of *p*-nitroacetanilide from acetanilide. 9. Separation of the Components of a mixture by decantation, extraction, filtration and sublimation techniques.		
5	**Teacher-Specific content**			

Teaching and Learning Approach	Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory(25 marks)** Assignments MCQ Viva Involvement in classroom activities **Practical (15 marks)** Lab skill/ analysis
	B. End Semester Evaluation (ESE) **Theory- 50 marks – 1.5 hrs** i) MCQ 10 questions: 10 X 1 = 10 ii) Short answer 4 questions (out of 6): 4 X 3 =12 iii) Short essay 4 questions (out of 6): 4 X 7 = 28 **Practical -35 marks - 2 hrs** i) Lab report: 10 ii) Viva: 10 iii) Analysis and Procedure: 15

References

1. B. R. Puri, L. R. Sharma and K. C. Kalia, *Principles of Inorganic Chemistry*, Vikas Publishing Co. Jalandhar, 2013.
2. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn. Chapman & Hall, 2009.
3. P. W. Atkins and J. de Paula, *Physical Chemistry*, 11th Edn. Oxford University Press, 2018.
4. R.T Morrison, R.N. Boyd and S.K. Bhattacharjee *Organic Chemistry*, 7th Edn. Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
5. T.W. Graham Solomon, C.B. Fryhle, S.A. Snyder, *Organic Chemistry*, John Wiley & Sons, 2014.
6. A. Bahl, and B.S. Bahl, *Advanced Organic Chemistry*, S. Chand, 2010.
7. F. A. Cotton, G. Wilkinson and P. L. Gaus, *Basic Inorganic Chemistry*, 3rd Edn. John Wiley, 2007.
8. D. F. Shriver and P. W. Atkins, *Inorganic Chemistry*, 4th Edn. Oxford University Press, 2006.
9. Vogels *Textbook of Quantitative Chemical Analysis*, 6th Edn. Pearson Education Ltd.

10. F. P. Miller, A. F. Vandome, McB. John, *Flame Test*, VDM Publishing, 2010.

11. S M. Basavarajaiah, G. Y. Nagesh, K. R. Reddy, *Compendious Practical Organic Chemistry: Preparations, Isolation, and Chromatography*, Notion Press, 2021.

12. T. Brown, C. Murphy, H. LeMay, *Laboratory Experiments for Chemistry*, Pearson, 2018.

SUGGESTED READINGS

1. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry–Principles of Structure and Reactivity*, 4th Edn, Pearson Education, New Delhi, 2013.
2. J.Clayden, N.Greeves, S. Warren and P.Wothers, *Organic Chemistry*, 2nd Edn. Oxford University Press, 2012.

	St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6"></td></tr>
<tr><td>Course Name</td><td colspan="6">Food Chemistry and Nutrition</td></tr>
<tr><td>Type of Course</td><td colspan="6">MDC</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC1MDCCHE100</td></tr>
<tr><td>Course Level</td><td colspan="6">100-199</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a comprehensive understanding of the composition and health implications of various food items.</td></tr>
<tr><td>Semester</td><td>I</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>2</td><td></td><td>1</td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the concept of nutrition	U	1,2,3
2	Identify the use of various food additives	A	1,3,10
3	Describe the health effects of food adulterants	U	1,2,3,6 ,8,10
4	Evaluate different adulterants in food	E	1,2,3,6, 10
5	Apply the concept of food chemistry to conduct simple laboratory experiments.	A	1,2,3,4 ,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Nutrition & Food Additives**			
	1.1	Functions of food, nutrients in food- energy yielding nutrients (carbohydrates, proteins and lipids) and protective nutrients (vitamins and minerals)	3	1
	1.2	Food additives- definition, importance of food additives, types of additives -natural, synthetic and artificial- with one example. E- number	5	2
	1.3	Preservatives, food colours, flavour enhancers, sweeteners, emulsifiers, stabilizer, glazing agents, thickeners, gelling agents. (definition and applications with examples)	7	2
2	**Food Adulteration and Safety**			
	2.1	Food adulterants- definition, types (intentional and incidental contamination) and health effects.	3	3
	2.2	Common adulterants in different foods, their health effects and detection: milk, ghee, butter, honey, sweets, chilli powder, turmeric, tea, sugar and salt, black pepper, wheat and rice.	7	3
	2.3	Food adulteration act- objectives	1	4
	2.4	Modern food habits- introduction, health effects of fast food, junk food and instant food. Composition and health effects of soft drinks. a comparative study of traditional and modern food habits	4	4
	Food Chemistry and Nutrition Practical			
		1. Detection of adulterants in food items-milk, turmeric powder and chili powder. 2. Demonstration of preparation of value added food products- jam, squash.		

3	3.1	3. To find out the moisture content of a given food sample by Lab oven method. 4. Test the solubility of vegetable oils in different solvents.	30	5

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Lecture Sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory (15 marks)** Assignments MCQ **Practical (15 marks)** Lab involvement/ report/Lab test
	B. Semester end examination Theory (35 marks)- 45 minutes MCQ 35 questions : 35 X 1 = 35 **Practical (35 marks) -2 hr.** I) Lab report: 10 II) Viva: 10 III) Analysis and Procedure: 15

References

1. M. Swaminathan, *Food Science and Experimental foods*, Ganesh and Company, 2005.
2. Jayashree Ghosh, *Fundamental concepts of Applied chemistry*, S. Chand & Co. Publishers, 2010.
3. Thankamma Jacob, *Text Books of applied chemistry for Home Science and allied Sciences*, Macmillan, 2015.
4. B. Sreelakshmi, *Food Science*, New Age, 2018.
5. S. Roday, *Food Science and Nutrition*, 3rd Edn. Oxford University Press, 2018.
6. C. M. Weaver, J. R. Daniel, *The Food chemistry Laboratory*, CRC Press, 2005.
7. I. Bevier, *Food and Nutrition Laboratory Manual*, Forgotten Books, 2018.
8. S. Sehgal, *A Laboratory Manual of Food Analysis*, International Publishing, 2016.

SEMESTER-II

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Fundamentals of Chemistry-2**					
Type of Course	**DSC A**					
Course Code	SJC2DSCCHE100					
Course Level	**100-199**					
Course Summary	This course provides a basic understanding of the physical nature of matter, reactions in organic chemistry and the analytical tools for chemical investigations and identifications.					
Semester	II	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Make use of fundamental principles of analytical chemistry to solve quantitative titrimetric problems.	A	1,2
2	Classify various types of organic reactions based on their mechanisms.	U	1,2
3	Describe the fundamental principles governing the behaviour of different states of matter.	U	1,2
4	Compare and contrast the properties of solids, liquids, and gases.	An	1,2

5	Apply the basic principles of analytical chemistry in preparation of standard solutions, acid-base titrations and in the determination of viscosity and surface tension.	S	1,2,10

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Basic Concepts in Analytical Chemistry**			
	1.1	Molecular mass - mole concept. Oxidation and reduction (electron concept only)	2	1
	1.2	Titrimetric analysis - fundamental concepts-analyte, end point, indicators etc. Methods of expressing concentration: Weight percentage, molality, molarity, normality, mole fraction, ppm and ppb. Primary and secondary standards, quantitative dilution – problems	6	1
	1.3	Acid base concepts Arrhenius definition, Bronsted-Lowry definition and conjugate acid-base pairs, Lewis concept, ionization of acids and bases.	2	1
	1.4	Acid base titrations- strong acid -strong base, strong acid – weak base, weak acid – strong base weak acid – weak base - pH indicators (phenolphthalein and methyl orange), redox titrations	5	1
2	**Introduction to Organic Reactions**			
	2.1	Representation of organic molecules: projection formulae (Fischer, Sawhorse, Flying wedge and Newman)	3	2
	2.2	Types of reagents: electrophiles and nucleophiles	1	2
	2.3	Addition reactions: Markovnikov's addition, peroxide effect. Elimination reactions: E1 and E2 mechanism. Substitution reactions (SN1, SN2	8	2

		reactions of alkyl halides only).		
	2.4	Polymers- Basic concepts. Addition polymerisation (polyethylene, PVC)	3	2
3	**States of matter**			
	3.1	Matter and its different states (elementary idea only), intermolecular forces: dipole-dipole interaction, dipole-induced dipole interaction and induced dipole-induced dipole interaction, ion-dipole interaction, hydrogen bonding: intra and intermolecular hydrogen bonds- effect on physical properties.	4	3,4
	3.2	Gaseous state: - postulates of kinetic theory, ideal and real gas behaviour, compressibility factor deviation from ideal behaviour, van der Waals equation (no derivation)	4	3,4
	3.3	Liquid state: properties of liquids: vapour pressure, boiling point, surface tension, viscosity.	3	3, 4
	3.4	Solid state: types of solids: crystalline and amorphous solids: ionic solids: unit cell, crystal systems, Bravais lattices.	4	3,4
	Fundamentals of Chemistry-2 Practical			
	1. Calibration of apparatus -Standard flask and preparation of standard molar solutions of any two primary standards-Oxalic acid, Mohr's Salt, Na_2CO_3. 2. Determination of pH of different water sources, common acids and bases using pH meter/pH strips 3. Acid base titration- acidimetry and alkalimetry: titration of strong acid vs. strong base, strong acid vs. weak base and weak acid vs. strong base.		30	5

4	4. Estimation of citric acid in citrus fruits. 5. Determination of viscosity of liquids using Ostwald viscometer. 6. Determination of surface tension of liquids using stalagmometer. 7. Identification of substances by physical properties such as colour, melting point, boiling point, solubility, density etc.		
5	**Teacher Specific content**		

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding, encourage students to ask questions during or after the lectures, begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA) Theory (25 marks)** Assignments/MCQ/Viva/Involvement in classroom activitie **Practical (15 marks)** Lab involvement/report /Lab test

	D. Semester end examination Theory **(50 marks)- 1.5 hrs** i) MCQ 10 questions : 10 X 1 = 10 ii) Short answer 4 questions (out of 6): 4 X 3 =12 iii) Short essay 4 questions (out of 6): 4 X 7 = 28 **Practical (35 marks)-3 hr.** Lab report: 10 Viva: 10 Analysis and Procedure:15

References

1. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, *Fundamentals of Analytical Chemistry*, 8^{th} Edn., Brooks/Cole, Thomson Learning, Inc., USA, 2004.
2. J. Mendham, R.C. Denney, J. D. Barnes and M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6^{th} Edn., Pearson Education, Noida, 2013.
3. *Vogels Textbook of Quantitative Chemical Analysis*, 6^{th} Edn. Pearson Education Ltd, 2009.
4. R.T. Morrison, R.N Boyd and S.K Bhattacharjee, *Organic Chemistry*, 7^{th} Edn., Dorling Kindersley Pvt. Ltd (Pearson Education), 2011.
5. T.W. Graham Solomon, C.B. Fryhle, S. A. Snyder, *Organic Chemistry*, John Wiley & Sons, 2014.
6. A. Bahl and B.S. Bahl, *Advanced Organic Chemistry*, S. Chand, 2010.

7. J.Clayden, N.Greeves, S. Warren, and P.Wothers, *Organic Chemistry*, Oxford University Press, 2004.

8. Puri, Sharma and Pathania, "*Principles of Physical Chemistry*", 47th Edn. Vishal Publishing Co, 2020.

9. P W Atkins, *Physical Chemistry*, 11th Edn. Oxford University Press, 2018.

10. K. L. Kapoor, *A Textbook of Physical chemistry* , Volume 1, Macmillan India Ltd, 2020.

11. J.B. Yadav, *Advanced Practical Physical Chemistry,* Krishna Prakashan, 2016.

12. K.K. Sharma, *An Introduction of Practical Chemistry,* Vikas Publishing House, New Delhi, 1984.

13. T. Brown, C. Murphy, H. LeMay, *Laboratory Experiments for Chemistry*, Pearson, 2018

Programme						
Course Name	**Dairy Chemistry**					
Type of Course	MDC					
Course Code	SJC2MDCCHE100					
Course Level	**100-199**					
Course Summary	This course will enable students to understand various types of milk, processing methods and the production of various dairy products.					
Semester	II	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2		1		60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Evaluate the quality and nutritive value of milk by knowing	E	1,2,3,

	the general chemical composition		6,10
2	Describe the techniques of milk processing	U	1,2,3, 10
3	Compare different types of processed milk.	U	1,2,3,6, 10
4	Classify various types of milk products based on their composition and processing methods	An	1,,3,10
5	Demonstrate the preparation of various milk products	A	1,2,3,4,6 10,
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Composition and processing of Milk**			
	1.1	Milk- Definition, general composition of milk (cow, buffalo, goat and human) -water, protein, lactose and fat. Nutritive value of milk. Colostrum: significance, composition, difference between normal milk and colostrum.	6	1
	1.2	Physico-chemical properties of milk- color, odour, density, acidity, germicidal properties, viscosity. Adulteration of milk and detection. Preservatives and neutralizers.	5	1
	1.3	Quality assurance – FSSAI, PFA, AGMARK.	1	1
	1.4	Importance of milk processing- filtration, clarification, boiling, homogenization and pasteurization. Types of pasteurization- LTLT and HTST.	3	2
	Special milk and Milk products			

2	2.1	Standardised milk - definition – merits. Homogenised milk, flavoured milk, vitaminised milk, toned milk, incitation milk, vegetable toned milk, condensed milk - definition composition and nutritive value.	4	3
	2.2	Butter - definition - composition - theory of churning – desi butter, salted butter. Ghee - major constituents - common adulterants added to ghee and their detection - rancidity - definition – prevention. Cream- definition-composition-chemistry of creaming process.	6	4
	2.3	Fermented milk products - fermentation of milk - definition and conditions. Yogurt and Curd (introduction and methods of production). Khoa and chana -definition and preparation - sweets – peda, burfi, gulab jamun, rasogolla. Milk powder – definition	5	4
3	**Dairy Chemistry Practicals**			
	3.1	1. Demonstration of preparation of khoa based products- peda, milk cake 2. Demonstration of preparation of chana based products- paneer 3. Determination of pH of milk 4. Determination of moisture content in paneer by lab oven method	30	5
4	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory (15 marks)** Assignments/MCQ/Viva **Practical(15 marks)** Lab involvement/report /Lab test
	B. Semester End examination **Theory (35 marks) -45 minutes** MCQ 35 questions : 35 X 1 = 35 **Practical (35 marks)- 2 hr.** I) Lab report: 10 II) Viva: 10 III) Analysis and Procedure: 15

References

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SEMESTER 3

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Inorganic Chemistry-1**
Type of Course	DSC A
Course Code	SJC3DSCCHE200
Course Level	**200-299**
Course Summary	This course addresses bonding concepts in molecules, chemistry of p, f and d block elements and discusses the fundamentals of coordination chemistry. The practical component includes preparation of complexes and complexometric titrations.

Semester	III	Credits			4	Total Hours
Course Details	Learning approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply the bonding concepts to molecules.	A	1.2,10
2	Compare the physical and chemical properties of lanthanides and actinides.	An	1, 2
3	Explain different nuclear reactions.	U	1,2
4	Differentiate the theories of coordination complexes of d-block elements.	An	1,2
5	Apply the knowledge for estimation of Zn, Ca and SJC using complexometric titrations and complex preparations.	A, S	1,2,10

Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Chemical Bonding**		
	1.1	Properties of ionic compounds, lattice energy of ionic compounds - Born- Lande equation with derivation - solvation enthalpy and solubility of ionic compounds – Born-Haber cycle and its applications.	3	1
	1.2	Polarisation of ions – Fajan's rule and its applications.	2	1
	1.3	Covalent Bond: VSEPR theory- Postulates and applications .Valence Bond Theory and its limitations. Hybridization: definition, characteristics, and shape of molecules ($BeCl_2$, BF_3, NH_4^+, H_3O^+, PCl_5, SF_6, XeF_2, XeF_4, $XeOF_2$, $XeOF_4$, and XeF_6).	5	1
	1.4	Properties of covalent compounds - polarity of bonds – percentage of ionic character – dipole moment and molecular structure.	2	1
	1.5	Molecular Orbital Theory: LCAO - bonding and antibonding molecular orbitals – bond order and its significance. MO diagrams of homonuclear and heteronuclear diatomic molecules: N_2, O_2, F_2, CO and NO – comparison of bond length, magnetic behaviour and bond energy of O_2, O_2^+, O_2^{2+}, O_2^- and O_2^{2-} .	3	1
		Chemistry of f-block elements and radioactivity		
	2.1	Lanthanides: lanthanide series, abundance and natural isotopes, separation of lanthanides, lanthanide contraction, similarity in properties, occurrence, oxidation states, chemical properties of Ln(III) cations, magnetic properties, colour and electronic spectra of lanthanide compounds.	6	2
	2.2	Chemistry of actinides – actinide series, abundance and natural isotopes, occurrence, preparation of actinides, oxidation states, general properties.	2	2
	2.3	Radioactivity – natural and artificial radioactivity; types of radioactive decay, Group displacement law, rate of disintegration - half life, nuclear fission and nuclear fusion reaction, chain reactions.	4	3
	2.4	Applications of radioactive decay: carbon dating, and nuclear medicine. Nuclear pollution and hazards.	3	3
3		**d-block elements and coordination compounds**		
	3.1	Transition Metals: General characteristics.	2	4

	3.2	Werner's theory, types of ligands, coordination number, oxidation state. Geometry of complexes with coordination numbers 4 and 6.	2	4
	3.3	Stability of complexes: factors affecting the stability of metal complexes. Chelates, chelate effect. Theory of complexometric titrations.	2	4
	3.4	Isomerism in coordination compounds – structural isomerism and stereoisomerism (complexes with 4 and 6 coordination numbers).	2	4
	3.5	Valence bond theory, geometries of tetrahedral, square planar and octahedral (inner and outer orbital) complexes. Limitations of VB theory.	3	4
	3.6	Crystal field theory, splitting of d-orbitals in octahedral, tetrahedral, and square-planar complexes-introduction to Mulliken symbol, low spin and high spin complexes. Spectrochemical series-strong and weak field ligands, CFSE, pairing energy.	4	4
4	**Inorganic Chemistry-1 Practical**			
	4.1	Identify salts visually – Cobalt chloride, copper chloride, copper sulphate, ferrous sulphate, ferric chloride, potassium dichromate and nickel chloride**.**	2	5
	4.2	Preparation of simple coordination complexes such as hexaaquacobalt(II), hexaaquacopper(II), hexaaquanickel(II) ions and prussian blue.	8	5
	4.3	Complexometric titration using EDTA Estimation of Ca, SJC and Zn Determination of hardness of water	10	5
	4.4	Permanganometry 1. Estimation of Fe^{2+} 2. Estimation of oxalic acid 3. Estimation of calcium	10	5
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Peer teaching ● Demonstration of experiments ● Hands-on training
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment Theory(25 marks)** Assignment /**Viva** /Class test **Practical(15 marks)** Lab involvement / Viva
	B. Semester end examination **Theory:** Written examination **(50 Marks)-1.5 hrs.** i) MCQ 10 questions : 10 X 1 = 10 ii) Short answer 4 questions (out of 6): 4 X 3 =12 iii) Short essay 2 questions (out of 3): 2 X 7 = 14 iv) Essay 1 question (out of 2): 1 X 14 = 14 **Practical: (35 marks)- 3 hr.** Lab report: 5 marks Viva: 10 marks Analysis and procedure: 20marks

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1. J. D. Lee, *Concise Inorganic Chemistry*, 5th Edn., Blackwell Science, London, 2008
2. B. R. Puri, L. R. Sharma and Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2020
3. F. A. Cotton, G. Wilkinson and P. L. Gaus, *Basic Inorganic Chemistry*, 3rd Edn., John Wiley, 2007
4. B. Douglas, D. Mc Daniel and J. Alexander, *Concepts and models in Inorganic Chemistry,* 3rd Edn Wiely,2006
5. J.E. Huheey, E.A. Keiter, R.L. Keiter and O.K. Medhi, *Inorganic Chemistry Principles of Structure and Reactivity*, 5th Edn. Pearson Education, 2022.
6. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edn. New Age International Private Limited, 2011.
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9. D. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry,* 8th Edn., Brooks/Cole Nelson, 2004

SUGGESTED READINGS

1. N.N. Greenwood and A. Earnshaw, *Chemistry of the Elements*, Butterworth-Heinemann, 2012.
2. G.L. Miessler, and A. Tarr, Donald *Inorganic Chemistry* 3rd Edn.(adapted), Pearson, 2009
3. C. E. Housecroft, A.G. Sharpe and C. E. Barnes, *Inorganic Chemistry* 4th Edn. Journal of Chemical Education, 2003.

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Orgaic Chemistry-1</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC3DSCCHE201</td></tr>
<tr><td>Course Level</td><td colspan="6">200-299</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course explores the chemical principles underlie alkanes, alkenes, alkynes, and aromatic compounds. Additionally, it covers fundamental stereochemistry concepts. The practical segment of the course focuses on some methods used in organic qualitative analysis.</td></tr>
<tr><td>Semester</td><td>III</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td></td><td>1</td><td></td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Critically analyse the physical properties, industrial applications, and preparation methods of alkanes, alkenes, and alkynes; evaluate their reaction mechanisms and predict reaction outcomes.	E	1,2,10
2	Analyse aromaticity using Hückel's rule, differentiate between aromatic, antiaromatic, and non-aromatic compounds, and examine aromatic substitution reactions.	An	1,2
3	Interpret the stereochemical features of organic molecules by identifying types of isomerism, assigning R, S, E, and Z configurations, and comparing the stabilities of different conformations	An	1,2,10

4	Analyze the structure and properties of organic compounds by identifying aromaticity, unsaturation, and physical constants, and apply green chemistry principles in their synthesis.	S	1,2,4,6, 10

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Alkane, Alkenes and Alkynes**		
	1.1	Alkanes: physical properties, industrial use -LPG and petrol, preparation-Wurtz reaction. Reactions-Free radical substitutions (chlorination) with mechanism and cracking.	3	1
	1.2	Alkenes: physical properties, industrial uses of ethylene, preparation- Saytzeff and Hofmann eliminations, reactions-hydrogenation, hydration, hydrohalogenation, Markovnikov's rule, Kharasch effect, ozonolysis, dihydroxylation using $KMnO_4$ and bromination (with mechanisms).	7	1
	1.3	Alkynes: physical properties, industrial uses of acetylene, preparation of acetylenes-dehydrohalogenation of vicinal dihalides, reactions- acidity of alkynes, formation of metal acetylides, alkylation of terminal alkynes and conversion into higher alkynes, addition of water, bromine and alkaline $KMnO_4$, reduction using Lindlar's catalyst	5	1
2		**Aromatic compounds**		
	2.1	Aromaticity: Definition, Hückel's rule, benzenoid aromatic compounds-benzene, naphthalene, anthracene; non-benzenoid aromatic compounds-cyclopropenyl cation, cyclopentadienyl anion, tropylium cation, heterocyclic aromatic compounds (pyridine, pyrrole and furan). Non-aromatic and antiaromatic compounds	6	2
	2.2	Benzene: molecular orbital picture, resonance energy, reactions - electrophilic aromatic substitution - nitration, halogenation, Friedel-Craft's reactions with their mechanisms.	4	2

	2.3	Ring activating and deactivating groups with examples. Orientation of aromatic substitution-ortho, para and meta directing effects of groups.	2	2
	2.4	Aromatic nucleophilic substitutions of halobenzenes – bimolecular displacement mechanism, elimination-addition (benzyne intermediate) mechanism.	2	2
3		**Basic Stereochemistry**		
	3.1	Stereoisomerism: definition, classification, configuration and conformation, interconversion of wedge formula, Newman, Sawhorse and Fischer projection formulae	1	3
	3.2	Geometrical isomerism: Cis–trans and E/Z nomenclature (upto two C=C systems) with Cahn Ingold Prelog (CIP) rules. Methods of distinguishing geometrical isomers.	4	3
	3.3	Optical isomerism: optical activity, specific rotation, concept of chirality, stereogenic centres, enantiomerism, diastereomerism and meso compounds, optical isomers of lactic acid and tartaric acid, racemic mixture and resolution.	5	3
	3.4	Relative and absolute configuration: D and L, threo and erythro; d and l designations; CIP rules: R/ S notation (up to 2 chiral carbon atoms).	3	3
	3.5	Conformations: conformational analysis with respect to ethane, butane, cyclohexane. Relative stability and energy diagrams.	2	3
		Organic Chemistry-1 Practical		
4	4.1	Microscale organic analysis- test for aromatic character- ignition test, nitration test, picrate test and tests for unsaturation.	15	4
	4.2	Determination of physical constants-melting point, boiling point, specific rotation (Polarimetry)	15	4
	4.3	Preparation Involving Synthetic Sequences by the Green Alternatives Chemical Methods: • 1,1′-bis-2-naphthol (BINOL) from 2- naphthol		

		• Photochemical preparation of benzopinacol from benzophenone, • Acid-catalyzed conversion of benzopinacol to benzopinacolone, • Acetylation of aniline to acetanilide using greener methods.	8	4
	4.4	Microwave assisted Organic Synthesis: • Oxidation reactions • Ester hydrolysis • Esterification • Chalcone synthesis.	7	4
5		Teacher Specific content		

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Classroom lecture Hands on training using models Demonstration and practical training in laboratory Use of molecular visualisation software Industrial Visit

MODE OF ASSESSMEN T	**A. Continuous Comprehensive Assessment (CCA)** **Theory (25 marks)** Pop quiz/ Assigning R and S using molecular models/open book Written tests **Practical(15 marks)** Quiz Lab involvement **B. Semester end examination** Written examination - 50 Marks- 1.5 hrs. I) MCQ 10 questions : 10 X 1 = 10 II) Short answer 4 questions (out of 6): 4 X 3 =12 III) Short essay 2 questions (out of 3): 2 X 7 = 14 IV) Essay 1 question (out of 2): 1 X 14 = 14 **Practical (35 Marks) - 3 hr.** Lab report: 5 marks Viva: 10 marks Analysis and procedure: 20 marks

References

1. Morrison, R. T.; Boyd, R. N. *Organic Chemistry,* 6th ed.; Prentice Hall International, 1992.
2. Finar, I. L. *Organic Chemistry Volume 1;* Pearson Education, 2007.
3. Bahl, A.; Bahl, B. S. *A Textbook of Organic Chemistry;* S. Chand, 2010.
4. Jain, M. K.; Sharma, S. C. *Modern Organic Chemistry;* Vishal Publishing Co., 2010.
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14. Norman, R. O. C.; Coxon, J. M. *Principles of Organic Synthesis*; 3rd ed.; CRC Press: 1993.
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16. Gupta, S. S. *Basic Stereochemistry of Organic Molecules;* 2nd *ed.;* Oxford University Press, 2018.
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18. Eliel, E. L.; Wilen, S. H. *Stereochemistry of Organic Compounds;* John Wiley & Sons, 1994.
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20. Furniss, B. S.; Hannaford, A. J.; Rogers, V.; Smith, P. W. G.; Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry*; 5th ed.; Pearson Education, 2005.

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1. Hegstrom, R. A.; Kondepudi, D. K. *The Handedness of the Universe*. Sci. Am. 1990, *262* (1), 108–115. DOI:10.1038/scientificamerican0190-108
2. Service, R. F. *Does life's handedness come from within?* Science 1999, *285*, 1282-1283

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Basic Analytical Chemistry**
Type of Course	DSE
Course Code	SJC3DSECHE200
Course Level	**200-299**
Course Summary	This course covers the fundamentals of analytical chemistry, and discusses topics such as SI Units, significant digits, precision, accuracy, errors, statistical treatment, calibration graphs, and Origin for data analysis. Additionally, it encompasses qualitative analysis techniques, safety protocols, titrimetric analysis, and the principles and applications of chromatography.

Semester	III	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain the fundamental concepts of statistical analysis and graphical representation of dataset and qualitative analysis of chemical samples in order to foster essential skills for success in analytical chemistry	U	1,2,3, 10
2	Demonstrate proper use and maintenance of chemicals laboratory apparatus and safe laboratory practices.	A	1,2,3
3	Discuss the principles of quantitative analytical methods, with an emphasis on volumetric titrations and gravimetric analysis;	A	1,2,3
4	Analyse various separation and purification techniques including chromatography.	An	1,2,3

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO
1		**Evaluation of Analytical Data and Qualitative Analysis**		
	1.1	SI Units, significant digits, rounding. Elementary idea of population and sample. Precision and accuracy. Types of errors – determinate and indeterminate errors. Ways to reduce determinate errors. Statistical treatment of analytical data (with Simple problems)-mean, variance and standard deviation. Limit of detection and limit of quantification.	6	1
	1.2	Graphical representation of data: calibration graphs. Introduction to software in data analysis – MS Excel, and Origin. Regression analysis-importance of coefficient of determination.	3	1
	1.3	Qualitative analysis: separation of cations into groups and group reagents. Principle of intergroup separation– solubility, ionic product, solubility product and common ion effect in the precipitation of cations. Identification test of anions-carbonate, chloride, acetate, nitrate, oxalate, fluoride, borate and phosphate ions. Elimination of interfering anions - oxalate, fluoride, borate and phosphate ions.	6	1
2		**Chemicals apparatus and unit operations of analytical chemistry**		
	2.1	Selecting and handling reagents and other chemicals	2	2
	2.2	Cleaning and marking of laboratory ware	2	2
	2.3	Evaporating liquids, measuring mass, equipment and manipulations associated with weighing, measuring volume, calibrating volumetric glassware	5	2
	2.4	The laboratory notebook	1	2
	2.5	Safety in the laboratory- the four principles of safety, personal protective equipment: eye protection, lab coat, shoes and long pants, gloves, respiratory protection and masks, hair, lead apron and shields.	5	2
		Titrimetric and Gravimetric Analysis		

3	3.1	Titrimetric analysis – basic concepts of redox reactions, redox titrations involving $KMnO_4$, and $K_2Cr_2O_7$, titration curves, redox indicators.	4	3
	3.2	Complexometric titrations – direct, indirect, back and replacement titrations, EDTA titrations. Precipitation titration - methods of argentometric titration-indicators (action not required).	6	3
	3.3	Conductometric and potentiometric titrations – principle, examples and graphical representation.	2	3
	3.4	Gravimetric analysis: unit operations in gravimetric analysis - illustrations using iron and barium estimation.	3	3
4	**Separation and Purification of compounds**			
	4.1	Separation and purification techniques: filtration, recrystallization, precipitation, distillation, fractional distillation, solvent extraction and sublimation.	4	4
	4.2	Chromatography- principle and classification. Chromatographic techniques: paper chromatography, thin layer chromatography, R_f-values.	3	4
	4.3	Principle and applications of column chromatography, high-performance liquid chromatography (HPLC), gas chromatography, gel permeation chromatography (GPC), ion exchange chromatography, and reverse phase chromatography.	8	4
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Peer teaching ● Demonstration of experiments ● Hands-on training

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory: (30 marks)** Assignments/MCQ/Class test/Viva

	B. End Semester examination (70 marks)- 2 hrs. i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 9th Edn, Cengage Learning, 2013.
2. Vogel's *Textbook of Quantitative Chemical Analysis*, 6th Edn. Pearson Education Ltd, 2009.
3. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons, 2020.
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6. Crouch and F. J. Holler, *Applications of Microsoft Excel in Analytical Chemistry*, Cengage Learning, 2013.
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Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Introduction to Nanoscience**					
Type of Course	DSE					
Course Code	SJC3DSECHE201					
Course Level	**200-299**					
Course Summary	This course explores basic concepts, synthesis, properties and applications of nanomaterials					
Semester	III	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the fundamental concepts of nanomaterials and compare bottom-up and top-down approaches in the synthesis of nanomaterials	An	1,2,3
2	Describe various characterisation techniques of nanomaterials.	U	1,2,3
3	Explain the properties of different types of nanomaterials.	U	1,2, 3
4	Analyse the applications of nanomaterials in various fields.	An	1,2 3,10

***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Classification and Synthesis of Nanomaterials**		
	1.1	Feynman's hypothesis- scales of nanosystems- Moore's law	1	1
	1.2	Different types of nanomaterials. Classification of nanomaterials based on dimensions, and based on origin.	3	1
	1.3	Nano in nature: lotus-leaf effect, gecko's feet, butterfly wings, and magneto-tactic bacteria.	3	1
	1.4	Bottom-up approach: chemical precipitation, reduction technique, and sol-gel method.	4	1
	1.5	Top-down approach: mechano-chemical method, laser ablation, and arc-discharge method.	4	1
2		**Characterisation of Nanomaterials**		
	2.1	Imaging through electron microscopy: Interaction of electron beam with sample. Scanning electron microscope and transmission electron microscope- comparison, advantages, applications and basic instrumental features.	5	2
	2.2	Scanning probe microscopy: scanning tunneling microscope and atomic force microscope- comparison, applications and basic instrumental features.	5	2
	2.3	Characterisation through spectroscopy (elementary idea only): UV-visible, IR, X-ray photoelectron and Auger electron spectroscopy. Secondary ion mass spectrometry.	5	2
3		**Properties of Nanomaterials**		
	3.1	Metal Nanoparticles (Au, Ag) – synthesis (any one method), properties and applications	3	3
	3.2	Carbon nanotubes– classification, synthesis (any one method), properties and applications	3	3
	3.3	Quantum dots – semiconductor QDs and carbon dots – synthesis (any one method), properties and applications	3	3
	3.4	Magnetic nanoparticles – synthesis (any one method), properties and applications	3	3

	3.5	Metal oxide nanoparticles – synthesis (any one method), properties and applications	3	3

4		**Applications of Nanoparticles**		
	4.1	Medicine and Healthcare: applications of nanomaterials in medical diagnosis, advanced drug delivery systems, targeted drug delivery and therapy.	5	4
	4.2	Applications of nanotechnology in integrated circuits, data storage and displays	3	4
	4.3	Applications of nanotechnology in water purification and air pollution control	2	4
	4.4	Piezoelectric nanomaterials, hydrogen generation and storage, batteries and solar energy harvesting	3	4
	4.5	Chemical and biosensors using nanomaterials and defence applications of nanotechnology	2	4
5		**Teacher Specific content**		

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** • Interactive instruction (chalk& board method,multimedia presentation) • Group discussion • Peer teaching • Experimental demonstrations • Practical training
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory: (30 marks)** Assignments/MCQ/Class test/Viva
	B. End Semester examination (70 marks)- 2 hrs. i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. N. Kumar, K. Sunita, *Essentials in Nanoscience and Nanotechnology*, Wiley, 2016.

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10. Ngô, C.; Van de Voorde, M. *Nanotechnology in a Nutshell: From Simple to Complex Systems*; Atlantis Press, 2014.

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St. Joseph's College Moolamattom
(Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Safe Laboratory Practices in Chemistry**					
Type of Course	DSE					
Course Code	SJC3DSECHE202					
Course Level	**200-299**					
Course Summary	This course deals with proper procedures for handling, storing, and transporting chemicals safely, including the use of appropriate containers and labelling.					
Semester	III	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply safe laboratory practices by recognizing hazards, minimizing risks, adopting green methods, and effectively using protective equipment	A	1,2,10
2	Apply proper handling, storage, transport, and disposal practices for hazardous chemicals and wastes by interpreting safety data, labels, and hazard codes	A	1,2,10
3	Analyze laboratory hazards, equipment risks, emergency responses, and case studies like the Bhopal tragedy to identify causes and recommend effective safety strategies	An	1,2,10
4	Apply laboratory safety practices by demonstrating the correct use of equipment, interpreting chemical safety data, and evaluating hazards through reports and analysis	A	1,2,10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to Laboratory Safety**		
	1.1	The four principles of safety: recognising hazards, assessing the risks of hazards, minimising the risks of hazards and preparing for emergencies.	3	1
	1.2	Safety ethic. Food, beverages, and smelling in the lab. Basic safety rules for handling laboratory chemicals.	3	1
	1.3	Going green in the lab: examples for using safer solvents, reducing volumes and quantity, minimising wastes and hazardous by products, using less toxic reagents.	3	1
	1.4	Personal protective equipment: eye protection, lab coat, shoes and long pants, gloves, respiratory protection and masks, hair, lead apron and shields.	3	1
	1.5	The laboratory: hazards, safety features, biological storage, chemical storage, gas storage and use, glassware, electrical safety.	3	1
2		**Chemicals**		
	2.1	Safety data sheets, chemical labels, toxic compounds, corrosives -acids and bases, gases, explosives, flammable compounds and oxidizers, cryogenics	4	2
	2.2	Working with extremely hazardous chemicals, permanent and temporary storage containers.	2	2
	2.3	Transporting Chemicals, ethers and other peroxide-forming chemicals, picric acid and nitro compounds, hazard and precautionary statements (H- and P-codes).	4	2
	2.4	Chemical Waste Management: waste disposal rules and regulations, labelling of hazardous waste, waste containers, sorting of hazardous chemicals, disposal of biological samples and biohazards.	5	2
3		**Hazard Control Measures**		

	3.1	Hazard control measures: fume hoods, other laboratory ventilation, safe work procedures, emergency showers and eyewash stations.	4	3
	3.2	Fire and explosion safety: types of fire, fire safety and precautions, preventive measures, fire extinguishers, explosion safety, explosive mixtures.	3	3
	3.3	Laboratory equipment safety: vacuum pumps and systems safety, heat sources safety, heating mantles, oil and sand baths, ovens and furnaces safety, refrigerators and freezers safety, decontamination of laboratory equipment.	5	3
	3.4	Emergency procedures: chemical spills, fire and explosion, compressed gas leaks. Case study: Bhopal tragedy	3	3
	Demonstration experiments and Theory*			
4		1. Use of Electronic Balance for weighing chemicals 2. Measurement of volume and determination of density of liquids. 3. Safe use of burners and glassware in the laboratory 4. Use of safety glasses or goggles, apron, and gloves. 5. Use of eyewash station 6. Fire extinguishers 7. Safety Evaluation of common chemicals in the laboratory 8. Fume Hood 9. Interpretation of MSDS datasheets of flammable liquids, toxic, carcinogenic, corrosive and flammable chemicals in the laboratory. 10. Reports on the safe use of acids, bases, oxidising agents and reducing agents. 11. Reports on first aid in the laboratory. 12. Analysis of labels of common chemicals in the laboratory.	15	4
5	**Teacher Specific content**			

***Theory of the demonstration experuments need to be studied, can be asked for examination**

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.

Assessment Types	MODE OF ASSESSMENT **A. Continuous Comprehensive Assessment (CCA) Theory: (30 marks)** Assignments/MCQ/Class test/Viva
	B. End Semester examination (70 marks)- 2 hrs. i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. H H Robert Jr, C F, David, *Laboratory Safety for Chemistry Students*, 2nd Edn. Wiley, 2016.
2. R S Benjamin, G Sveinbjorn, *Handbook for laboratory safety*, Elsevier, 2022.
3. E Mohamed, *Chemical Laboratory- Safety and Techniques*, de Gruyter, 2022.
4. American Chemical Society, *Safety in Academic Chemistry Laboratories*, 8th Edn, 2017.
5. P Carson, C Mumford, *Hazardous Chemicals Handbook*, 2nd Edn. Hazardous Chemicals Handbook, 2002.
6. T. S. S. Dikshith, *Safe use of chemicals: a practical guide*, CRC Press, 2009.
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8. J I García, J A.Dobado, F C Flores, H M García, *Experimental Organic Chemistry: Laboratory Manual*, Elsevier Inc., 2016.
9. FENS Laboratory Safety Team, *Laboratory Safety Handbook*, Sabancı University, 2016.

St. Joseph's College Moolamattom
(Autonomous)

Programme						
Course Name	**Chemistry in Everyday Life**					
Type of Course	MDC					
Course Code	SJC3MDCCHE200					
Course Level	**200-299**					
Course Summary	This course provides a comprehensive understanding of how chemistry permeates various aspects in our daily life.					
Semester	III	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		0		45
Pre-requisites, if Any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain the uses of fertilizers and pesticides and their impact on the environment.	U	1,2,3.6,7, 10
2	Compare various types of drugs	An	3,6,7,10
3	Classify soaps and understand its cleansing action	U	1,2,3.6,7, 10
4	Investigate the chemical components in personal care products.	An	1,2,3.6,7, 10
5	Make use of theories to prepare cosmetics	A,S	1,2,3,6.7. 10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		Chemistry in Agriculture and Medicine		
1	1.1	Fertilizers – introduction. Types of fertilizers - natural, synthetic, NPK fertilizers. Excessive use of fertilizers and its impact on the environment. Bio-fertilizers and organic manures.	4	1
	1.2	Pesticides - Introduction. Classification (brief idea only) - insecticides, fungicides, herbicides (structures not required). Excessive use of pesticides - environmental hazards. Biopesticides.	4	1
	1.3	Classification of drugs - analgesics, antipyretics, antihistamines, antacids, antibiotics and antifertility drugs with examples (structures not required). Psychotropic drugs - tranquilizers, antidepressants and stimulants with examples (structures not required). Drug addiction and abuse. Prevention and treatment.	7	2
		Chemistry in personal care products		
2	2.1	Soaps – introduction, types of soaps - toilet soaps, washing soaps, liquid soap, TFM and grades of soaps, cleansing action, environmental aspects.	5	3
	2.2	Composition of different types of cosmetics - toothpaste, hair dye, face and skin powders, lipsticks and perfumes, shaving creams Shampoos- ingredients and functions – different kinds of shampoos (anti-dandruff, anti-lice, herbal and baby shampoos). Herbal cosmetics- definition, natural ingredients used- aloe vera, turmeric, henna, amla, neem, clove Harmful effects of cosmetics.	10	4
		Demonstration Experiments and Theory *		

3	3.1	1. Synthesis of Organic manure 2. Preparation of Toilet soap 3. Evaluate TFM value of soap 4. Preparation of Shampoo	15	5
		5. Preparation of Perfume 6. Preparation of Sanitizers		
4		**Teacher Specific Content**		

*Theory of the demonstration experiments need to be studied, can be asked for examination

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture sessions, interactive sessions including discussions, demonstrations, and experiments to engage students actively and visual aids like presentations, videos, and models to enhance understanding. Encourage students to ask questions during or after the lectures. Begin with safety instructions and guidelines for lab work. Allow students to conduct experiments under supervision (for lab work).
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory: (25 marks)** Assignments Viva Classroom participation (participation in class activities) Examination
	B. End Semester examination Theory: (50 marks)- 1.5 hrs **i)** MCQ 9 questions : 10 X 1 = 10 ii) Short answer 10 questions (out of 12): 10 X 4 =40

References

1. T. Coultate, *Food: The Chemistry of Its Components*, 6th Edn. RSC. 2015.

2. S. Chowla, *Engineering Chemistry*, Danpat Rai Publication, 2020.

3. B.K. Sharma. *Industrial Chemistry*, Krishna Prakashan, 2023.

4. CNR Rao- *Understanding chemistry*, Universities Press, 1999.

5. A. K. De, *Environmental Chemistry*, New age International Ltd. 2021.

6. S. S. Dara, *A Textbook of Environmental chemistry and pollution control*, S.Chand & Company Ltd, 2004.
7. Tisdale, S.L., Nelson, W.L. and Beaton, J. D. *Soil Fertility and Fertilizers*, Macmillian Publishing Company, New York, 1990.
8. Buchel, K.H. *Chemistry of Pesticides*, John Wiley & Sons, New York, 1983. .
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St. Joseph's College Moolamattom (Autonomous)

Programme	
Course Name	**Forensic Chemistry**
Type of Course	VAC
Course Code	SJC3VACCHE200
Course Level	**200-299**
Course Summary	This course provides a comprehensive understanding of the basic principles of chemistry as they apply to forensic science. It focuses on enabling non-chemists to comprehend and utilize chemical concepts in forensic analysis.

Semester	3	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand and apply principles of toxicology to identify, analyze, and manage poisoning cases.	A	1,2,6,10
2	Investigate and analyze explosive incidents and security threats using forensic science principles	A	1,2,6,8,10
3	Detect and analyze forgery, counterfeiting, and authenticity in documents, currency, and precious items	An	1,2,6,10
4	Analyze physical and biological evidence using forensic techniques to aid criminal investigations	An	1,2,6,8, 10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Poisons**		
	1.1	Poisons-types and classification- diagnosis of poisons in the living and the dead – clinical symptoms - post-mortem appearances.	4	1
	1.2	Heavy metal contamination (Hg, Pb, Cd) of sea foods.	3	1
	1.3	use of neutron activation analysis in detecting Arsenic in human hair	2	1
	1.4	Treatment in cases of poisoning - use of antidotes for common poisons.	3	1
2		**Crime Detection**		
	2.1	Accidental explosion during manufacture of matches and fireworks.	2	2
	2.2	Human bombs- possible explosives (gelatine sticks and RDX)	3	2
	2.3	metal detector devices and other security measures for VVIP	2	2
	2.4	Composition of bullets and detecting powder burn	2	2
	2.5	Analysis of incendiary and timed bombs - spill of toxic and corrosive chemicals from tankers.	3	2
3 (a)		**Forgery and Counterfeiting**		
	3.1	Documents - different types of forged signatures- simulated and traced forgeries – inherent signs of forgery methods - writing deliberately modified - uses of ultraviolet rays - comparison of typewritten Letters	5	3
	3.2	Checking silver line watermark in currency notes, alloy analysis using AAS to detect counterfeit coins	4	3
	3.3	Detection of gold purity in 22 carat ornaments - detecting gold plated jewels - authenticity of diamond.	3	3

3 (b)	**Tracks and Traces**			
	3.4	Tracks and traces - small tracks and police dogs-footprints- walking pattern or tyre marks	3	4
	3.5	Glass fracture – tool mark paints – fibres.	2	4
	3.6	Analysis of biological substances - blood, saliva, urine and hair	2	4
	3.7	DNA Finger printing for tissue identification in dismembered bodies -detecting steroid consumption in athletes and race horses	2	4
4		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture sessions, interactivesessions including discussions and demonstrations to engage students actively and visual aids like presentations and videos to enhance understanding. Utilize case studies to illustrate how forensic analysis is applied.
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA) 25 marks** Assignments Viva Classroom participation (participation in class activities) Examination
	D. End Semester examination 50 marks- **1.5 hrs.** **i)** MCQ 9 questions : 9 X 1 = 9 ii) Short answer 5 questions (out of 7): 5 X 4 =20 iii) Short essay 3 questions (out of 5): 3 X 7 = 21

References

1. T.H.James, *Forensic Sciences*, Stanley Thornes Ltd, 1987.
2. Richard, Criminalistics - *An Introduction to Forensic Science* (College Version), 8th Edition, Sofestein, Prentice Hall, 2003.
3. B R Sharma, *Forensic Science in Criminal Investigation and Trials*, 6th Edn. LexisNexis, 2020.
4. B.S. Nabar, *Forensic Science in Crime Investigation*, Asia Law House, 2022.
5. Glencoe, *Forensic Laboratory Manual*, McGraw Hill, 2001.
6. S Bell, *Forensic Chemistry*, CRC Press, 2022.
7. K M Elkins, *Introduction to Forensic Chemistry*, CRC Press, 2019.

St. Joseph's College Moolamattom (Autonomous)

Programme						
Course Name	**Inorganic and Organic Chemistry**					
Type of Course	DSC B					
Course Code	SJC3DSCCHE202					
Course Level	**200-299**					
Course Summary	This course provides a comprehensive understanding of the various aspects of inorganic and organic chemistry.					
Semester	III	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe radioactivity, its applications and nuclear reactors in India	U	1,2
2	Describe the basic principles of bioinorganic chemistry and the importance of metals in biological systems	U	1,2
3	Discuss the importance of functional groups, aromatic stability and aromatic electrophilic substitution.	U	1,2
4	Investigate the adulterants present in food	An	1,2
5	Describe the basic principles behind geometrical and optical isomerism and conformations	U	1,2
6	Apply basic principles of chemistry in volumetric analysis and organic preparations.	A	1,2,10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		Nuclear Chemistry and Bioinorganic Chemistry		
1	1.1	Natural and induced radioactivity, radioactivity – detection, units of radioactivity. Modes of decay – group displacement laws. Isotopes, isobars and isotones with examples. Nuclear fission - atom bomb, nuclear fusion – hydrogen bomb.	6	1
	1.2	Nuclear reactors - nuclear reactors in India. application of radioactive isotopes, ^{14}C dating, rock dating, isotopes as tracers, radiodiagnosis and radiotherapy	4	1
	1.3	Haemoglobin and myoglobin, pH of blood, cytochromes, ferredoxin, mechanism of O_2 and CO_2 transportation and chlorophyll and photosynthesis (mechanism not expected) elementary idea of photophosphorylation.	4	2
	1.4	Photosynthesis and respiration – comparison. – Elementary idea of structure and mechanism of action of sodium potassium pump. Biochemistry of zinc and cobalt.	3	2
2		**Food Additives & Adulterants**		
	2.1	Food Additives: Food preservatives, artificial sweeteners, flavours, emulsifying agents, antioxidants, leavening agents and flavour enhancers (definition and examples, structures not required) – Natural pigments in fruits and vegetables (carotenoids, chlorophylls and flavonoids). Artificial ripening of fruits. Common food adulterants in various food materials and their identification: Milk, vegetable oils, tea, coffee powder and chilli powder.	5	4
	2.2	Commonly used permitted and non-permitted food colours BHT, BHA and MSG - (structures not required) Fast foods and junk foods & their health effects – Soft drinks and their health effects	4	4
3		**Aromatic Hydrocarbons and Stereochemistry**		
	3.1	Nomenclature and isomerism in substituted benzene. Benzene-Structure and stability: Kekule, resonance and molecular orbital description. Mechanism of aromatic electrophilic substitution: Halogenation, nitration,	5	3

		sulphonation and Friedel-Crafts reactions, orientation effect of substituents.		
	3.2	Aromaticity and Huckel's rule: Application to benzenoid (benzene, naphthalene and anthracene) and non-benzenoid (pyrrole, pyridine and indole) aromatic compounds.	4	3
	3.3	Conformations: Conformations of ethane, butane and cyclohexane– explanation of stability.	3	5
	3.4	Geometrical isomerism: definition – condition – geometrical isomerism in but-2-ene and but-2-ene-1,4-dioic acid – methods of distinguishing geometrical isomers using melting point and dipole moment.	4	5
	3.5	Optical Isomerism: optical activity, chirality, – enantiomers, meso compounds, diastereoisomers, optical isomerism in lactic acid and tartaric acid.	3	5
4	**Inorganic and Organic Chemistry Practicals**			
		1. <u>Permanganometry</u> i Standardization of $KMnO_4$ using (i) oxalic acid (ii) Mohr's salt i Estimation of Fe^{2+} in Mohr's salt and crystalline Ferrous Sulphate using standard $KMnO_4$. 2. <u>Dichrometry</u> i. Estimation of Ferrous ions (external indicator) ii. Estimation of Ferrous ions (internal indicator) Determination of physical constants: melting point, boiling point and density. 4. Preparation of m-dinitrobenzene from nitrobenzene 5. Benzoylation of phenol	30	6
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** • Lecture (chalk& board, power point presentation) • Group discussion • Peer teaching • Demonstration of experiments • Hands-on training

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory (25 marks)** Pop quiz/Problem based assignments /Written/MCQ tests **Practical (15 marks)** Quiz/Lab involvement
	B. Semester end examination **Theory: Written examination (50 Marks)-1.5 hrs.** i) MCQ 10 questions : 10 X 1 = 10 ii) Short answer 4 questions (out of 6): 4 X 3 =12 iii) Short essay 2 questions (out of 3): 2 X 7 = 14 iv) Essay 1 question (out of 2): 1 X 14 = 14 **Practical: 35 marks-3 hr.** Lab report: 5 marks Viva: 10 marks Analysis and procedure: 20marks

References

1 H.J. Arnikar, *Essentials of Nuclear Chemistry* (Revised IV edn.), New Age, 1995

2. T.P. Coultate, *Food- The Chemistry of its components*. Royal Society of Chemistry, London.

3. B. R. Puri, L. R. Sharma, M.S. Pathania, *Elements of Physical Chemistry*, 3rd Edn. Vishal Pub Co., 2008.

4 I. L. Finar, *Organic Chemistry*, Vol. 1 & 2, 6th Edn. Pearson, 2002.

5. C.N. R. Rao, *University General Chemistry*, Macmillan 2009.

6. B. R. Puri, L.R. Sharma and K.C. Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers New Delhi. 2013.

7. Puri and Sharma. Advanced Organic Chemistry.

8. R. T. Morrison, R. N. Boyd, *Organic Chemistry*, 7th Edn., Pearson Education, New Delhi, 2013.

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10. M. K. Jain, S. C. Sharma, *Modern Organic Chemistry*, 3rd Edn., Vishal Publishing Company Co., 2010.

11. Swaminathan M., *Food Science and Experimental foods*, Ganesh and Company.

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13. J. Mendham, R. C. Denney, J.D. Barnes, M. Thomas, *Vogel's Text Book of Quantitative Chemical Analysis*, 6th Edn. Pearson Education 2003.

14. R. Gopalan, *Analytical Chemistry*, S. Chand and Co., New Delhi, 2003.

15. O. P. Pandey, *Practical Chemistry*, S. Chand, 2010.

SEMESTER 4

St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Organic Chemistry-2</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC4DSCCHE200</td></tr>
<tr><td>Course Level</td><td colspan="6">200-299</td></tr>
<tr><td>Course Summary</td><td colspan="6">A study of the reactions of alcohols, aldehydes, ketones, carboxylic acids, and its derivatives. Practical part includes Qualitative Microscale analysis of organic compounds.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td></td><td>1</td><td></td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Summarize the structure and uses of alcohols, aldehydes, ketones, acids, and acid derivatives.	U	1,2
2	Predict the product and reasonable mechanism for reactions of alcohols, aldehydes, ketones, carboxylic acids, and its Derivatives	E	1, 2
3	Apply the functional group chemistry to interconvert alcohol, aldehyde, ketone and acid.	A	1, 2
4	Design synthetic pathways to higher and lower homologous series in acids and alcohols.	A	1, 2
5	Analyse the functional groups and systematically record the observations. (Practical)	An, S	1, 2, 4, ,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Alcohols**		
	1.1	Alcohols-classification (monohydric, dihydric, polyhydric, primary, secondary and tertiary), Luca's test, preparation of alcohols using Grignard reagents.	2	1, 2, 3
	1.2	Chemical Properties: esterification, reactions with sodium and $KMnO_4$, pinacol-pinacolone rearrangement (with mechanism), ascend and descend in homologous series, alcohol metabolism in human body.	4	1, 3, 4, 5
	1.3	Phenol- acidity of phenol, effect of substituent on acidity, comparison of acidity of phenols with alcohols. Hydrogen bonding (inter and intramolecular) in phenols, effect of H-bonding on boiling point and solubility in water.	4	1, 3
	1.4	Chemical reactions of phenol: electrophilic substitution reactions-nitration, halogenation, Reimer-Tiemann reaction (with mechanisms) Structure and uses of catechol, resorcinol, quinol and picric acid.	5	3, 4, 5
2		**Aldehydes and Ketones**		
	2.1	Structure and industrial uses of representative aldehydes and ketones-formaldehyde, acetaldehyde, benzaldehyde and acetone.	2	1
	2.2	Nucleophilicity of carbonyl compounds- comparison between aldehydes and ketones Nucleophilic addition reactions-reaction with HCN, ammonia derivatives (reaction with primary amine, hydroxylamine, phenylhydrazine).	4	1, 3, 4, 5

	2.3	Acidity of alpha-hydrogen in aldehydes and ketones, aldol condensation, Claisen condensation, Knoevenagel reaction, Claisen-Schmidt reaction, Perkin condensation,	6	1, 3, 4, 5
		benzoin condensation, Cannizzaro reaction (with mechanisms)		
	2.4	Clemmensen reduction, Wolff-Kishner reduction, iodoform reaction, Beckmann rearrangement (with mechanisms) Tollen's and Fehling's reaction	3	2, 3, 4, 5
3	**Carboxylic acids and acid derivatives**			
	3.1	Structure and uses of formic acid, acetic acid, benzoic acid, oxalic acid, phthalic acid, and salicylic acid.	1	1
	3.2	Acidity of carboxylic acid- effect of substituents on acid strength for aromatic carboxylic acids.	1	1, 2
	3.3	Reactions of carboxylic acids: - reduction, decarboxylation and Hell – Volhard - Zelinsky reaction. Ascend and descend in carboxylic acid homologous series.	4	1, 2
	3.4	Acid derivatives-Conversion of acid to acid chlorides, amides, esters and anhydrides Comparative study of nucleophilicity of acyl derivatives.	3	1, 2
	3.5	Reactions of acid derivatives with mechanisms: conversion of acid chloride to acid anhydride, ester, amide, aldehyde, and alcohol; conversion of acid anhydride to acid, ester, and amide; conversion of ester to acid, amide, primary and secondary alcohols; conversion of amide to acid, nitrile and primary amine. Reformatsky reaction.	6	1, 2
4	**Organic Chemistry-2 Practicals**			
	4.1	Qualitative microscale analysis of organic compounds-identification and preparation of derivatives of alcohols, phenols, aldehydes, ketones, carboxylic acid, and carboxylic acid derivatives.	30	1, 2, 4
5		**Teacher Specific Content**		

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (mode of transaction)

● Lecture (chalk & board, powerpoint presentation)
● Group discussion
● Peer teaching
● Demonstration of experiments
● Hands-on training</td></tr>
<tr><td>Assessment Types</td><td>MODE OF ASSESSMENT

A. Continuous Comprehensive Assessment (CCA)
Theory (25 marks)

Pop quiz

Problem based assignments

Written/MCQ tests

Practical (15 marks)

Quiz

Lab involvement

B. Semester end examination
Theory: Written examination (50 Marks)-1.5 hrs.

i. MCQ 10 questions : 10 X 1 = 10
ii. Short answer 4 questions (out of 6): 4 X 3 =12
iii. Short essay 2 questions (out of 3): 2 X 7 = 14
iv. Essay 1 question (out of 2): 1 X 14 = 14

Practical: 35 marks-3 hrs.

Lab report: 5 marks
Viva: 10 marks
Analysis and procedure: 20marks</td></tr>
</table>

References

1. R.T. Morrison, R.N. Boyd and S.K. Bhattacharjee, *Organic Chemistry*; 7th Edn. Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
2. T.W. Graham Solomon, C.B. Fryhle and S.A. Snyder, *Organic Chemistry*; Wiley, 2014.
3. J. McMurry, *Organic Chemistry*; 7th Edn. Cengage Learning, 2013.

4. J. Clayden, N. Greeves, S. Warren, *Organic chemistry*; Oxford University Press, 2012.
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9. R. O. C. Norman, J. M. Coxon, *Principles of Organic Synthesis*; Routledge, 2017.
10. S. H. Pine, *Organic Chemistry*; Tata McGraw-Hill, 2014.
11. B. S. Furniss, A. J. Hannaford, V. Rogers, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*; 5th ed.; Pearson Education, 2005.
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St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Physical Chemistry- 1**					
Type of Course	DSC A					
Course Code	SJC4DSCCHE201					
Course Level	**200-299**					
Course Summary	This course deals with the fundamental concepts of gaseous state, ionic and phase equilibria, and solutions.					
Semester	IV	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Interpret the properties of real and ideal gases and calculate the critical constants theoretically.	E	1,2
2	Distinguish the different types of molecular velocities and define various terms involved on molecular motion.	An	1,2
3	Utilize the concepts of acids, bases and buffer solutions to calculate ionic product, pH and ionic strength.	A	1,2
4	Interpret different phases coexist in phase diagram.	E	1,2
5	Identify different types of solutions and its properties.	A	1,2
6	Distinguish the colligative properties of solutions and calculate the molar mass.	U	1,2
7	Make use of theoretical knowledge and execute experiments in phase equilibria, critical solution temperature and colligative properties.	A,S	1,2,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1		**GASEOUS STATE**		
	1.1	Deviation of real gases from ideal behaviour: causes of deviation, van der Waals equation of state for real gases. Boyle temperature. Critical phenomena and Andrew's isotherms of CO_2, continuity of states, critical constants and their calculation from van der Waals equation. Virial equation of state, van der Waals equation expressed in Virial form.	5	1
	1.2	Maxwell Boltzmann distribution laws of molecular velocities (graphical representation – derivation not required) and their importance. Temperature dependence of these distributions.	5	1, 2
	1.3	Collision properties: Collision cross section, collision number, collision frequency, collision diameter and mean free path of molecules (No derivation). Relation between mean free path and coefficient of viscosity.	5	2
2		**IONIC EQUILIBRIA**		
	2.1	Introduction – Concepts (Lowry-Bronsted and Lewis concept) of acids and bases, relative strength of acid-base pairs, influence of solvents, Dissociation constants – acids, bases, and polyprotic acids. Ostwald's dilution law.	4	3
	2.2	Degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water- pH. Effects of solvents on ionic strength.	3	3
	2.3	Buffer solutions – Mechanism of buffer action, Henderson equation. Hydrolysis of salts (concepts only).	3	3
		PHASE EQUILIBRIA		

3(a)	3.1	The phase rule (no-derivation). One component system – water and sulphur systems.	2	4

	3.2	Two component systems- simple eutectic; lead- silver system. Application to metallurgy-Pattinson's process.	3	4
3(b)	**SOLUTIONS**			
	3.3	Introduction , binary liquid solutions, Raoult's law, ideal and non-ideal solutions, Vapour pressure – composition and temperature – composition curves of ideal and non-ideal binary liquid solutions.	5	5
	3.4	Critical solution temperature (CST). Solubility of gases in liquids – Henry's law and applications. Distribution of a solute between two solvents– Nernst distribution law.	5	6
	3.5	Colligative properties of dilute solutions – vapour pressure lowering, boiling point elevation and freezing point depression. Molar mass determination (no derivation) - related problems – osmotic pressure –laws of osmotic pressure – reverse osmosis – purification of seawater. Abnormal molecular masses – van't Hoff factor – degree of association and degree of dissociation.	5	6
4	**Physical chemistry 1 - Practicals**			
	4.1	Determination of CST of Phenol-water system Effect of KCl/Succinic acid on Critical Solution Temperature of phenol-water system Determination of unknown concentration of KCl/Succinic acid using CST method Transition temperature of salt hydrates. (Sodium thiosulphate, sodium acetate) Determination of mass of solvent/molecular mass of solute using transition temperature. Construction of phase diagram of simple eutectics (Naphthalene-Biphenyl System) Molecular weight determination by Rast's method. (Using naphthalene, camphor or biphenyl as solvent and acetanilide, p-dichlorobenzene etc. as solute.)	30	7
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** ● Lecture (chalk & board and powerpoint presentations) ● Interactive sessions and simulations, ● Visual aids like videos and models to enhance understanding. ● Peer discussions. ● Laboratory experiments and hands-on training
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA)** **Theory: (25 marks)** Pop quiz Assignment Class test(MCQ/written) **Practical: (15 marks)** Lab involvement / skill/ Report of lab works done
	Semester end examination **Theory: Written examination (50 Marks)- 1.5 hrs** MCQ 10 questions : 10 X 1 = 10 Short answer 4 questions (out of 6): 4 X 3 =12 Short essay 2 questions (out of 3): 2 X 7 = 14 Essay 1 question (out of 2): 1 X 14 = 14 **Practical: 35 marks-3 hr.** Lab report: 5 marks Viva: 10 marks Analysis and procedure: 20marks

References

1. Puri, Sharma, Pathania, *Principles of Physical Chemistry*, 48th Edn. Vishal Publishing Company, 2012
2. F. Daniels and R. A. Alberty, *Physical Chemistry*, 3rd ed., John Wiley and Sons, Inc., New York, 2021.G.M. Barrow, *Physical Chemistry*, Tata McGraw-Hill, 2007.

3. G. W. Castellan, *Physical Chemistry,* 4th Edn. Narosa Publishing House, 2018.
4. K. L. Kapoor, *A Textbook of Physical chemistry*, Volume 5, 4^{th} edition, Macmillan India Ltd., 2018.
5. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approac*h, Viva Books Pvt. Ltd., 2019.
6. G. Raj, *Advanced Physical Chemistry*, Goel Publishing House, 2016.
7. I.N. Levine, *Physical Chemistry*, Tata McGraw Hill, 2011.

Suggested Readings

1. R P W Atkins, *Physical Chemistry*, Oxford University Press; 12th edition (5 December 2022)
2. R J Silby and R A. Alberty, M G Bawendi, *Physical Chemistry*, (4^{th} Edition) John Wiley & Sons, 2004.
3. J. C. Kotz, P. M. Treichel, J. R. Townsend, *General Chemistry*, Cengage Learning India Pvt. Ltd. New Delhi (2009).
4. Glasstone, Lewis, Elements of Physical Chemistry, Macmillan student editions, 2nd revised, Van Nostrand, 1960.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Polymer Chemistry**					
Type of Course	DSE					
Course Code	SJC4DSECHE200					
Course Level	**200-299**					
Course Summary	This course explores synthesis, structure, properties and applications of important polymers.					
Semester	IV	Credits			4	Total Hour s
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if Any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the fundamental concepts of polymers, polymerisation reactions and techniques	U	1,2,3
2	Analyse basic determinants of polymer properties	An	1,2,3
3	Develop a comprehensive idea of tacticity in polypropylene and Ziegler-Natta polymerisation of alkenes.	A	1,2,3
4	Examine the structures, properties, and applications of addition polymers, condensation polymers and polymer resins	U	1,2,3
5	Identify the importance of the vulcanization process and the practical aspects of formulating rubber compounds.	A	1,2,3
6	Analyse the applications of advanced polymers	An	1, 2
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1.		**Introduction to polymers and polymerisation reactions**		
	1.1	Monomers, oligomers, and polymers. Classification of polymers-based on origin, structure and intermolecular forces Importance of polymers in life- proteins and DNA. (Elementary idea only).	5	1,2
	1.2	Addition polymerisation of olefins - classification (cationic, anionic and free radical), mechanism.	4	1
	1.3	Mechanism of condensation polymerisation (polyamides and polyesters) and ring opening polymerisation (Nylon 6). Living polymerisation -definition and applications only	5	1,2
	1.4	Self-healing polymers and shape-memory polymers- definition and applications only	1	1,2
2.		**Polymerisation Techniques**		
	2.1	Definition, advantages, disadvantages and examples of bulk polymerisation, suspension polymerisation, solution polymerisation and emulsion polymerisation.	5	1
	2.2	Structure-property relationships of polymers: tacticity in polypropylene –isotactic, syndiotactic and atactic. Ziegler-Natta polymerisation of alkenes. Crystalline and amorphous polymers. Basic determinants of polymer properties: Polymer chain flexibility, Factors affecting chain flexibility.	5	1,4
	2.3	Molecular weight of polymers: Number average (M_n), weight average (M_w), Polydispersity index. Glass transition temperature (T_g): Definition. Factors influencing glass transition temperature (T_g). Importance of T_g.	5	3
3.		**Chemistry of Commercial Polymers**		

	3.1	Brief introduction to the structure, properties and applications of the following addition polymers: polyolefins (LDPE, HDPE and PP), poly (vinyl chloride), polystyrene, poly (vinyl acetate), acrylic polymers (PAN and PMMA), fluoropolymers (PTFE).	5	5
	3.2	Brief introduction to the structure, properties and applications of the following polymers: aliphatic polyamides (Nylon 6,6 and Nylon 6), aromatic polyamides (Kevlar), polyesters (PET).	4	5
	3.3	Brief introduction to structure, properties and applications of the following resins: Formaldehyde resins (PF, UF and MF), polyurethanes, polycarbonates and epoxy resins.	3	5
	3.4	Introduction to vulcanisation of natural rubber-types of vulcanisation (EV, semi-EV and CV), activator system, accelerator system. Formulation of a rubber compound – rubber mat.	3	6
4	**Polymeric Materials for Special Applications**			
	4.1	Support materials: materials based on polystyrene-cross linking with divinylbenzene-applications.	3	6
	4.2	Drug release agents: biodegradable polyurethane Temperature sensitive polymers as drug delivery agents: LCST polymers-examples and applications.	5	6
	4.3	Conducting polymers:polyacetylene- doping, synthesis and applications	3	6
	4.4	Photo-conducting polymers: applications of poly(vinyl carbazole)	2	6
	4.5	Heat and flame retardant polymers: nomex-applications	2	6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) 30 marks**
	Assignments MCQ **Class test** **Viva**
	B. End Semester examination **70 marks- 2 hrs.** i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. V. R. Gowariker, N. V. Viswanathan, J. Sreedhar, *Polymer Science*, Wiley, 1986.
2. F. W. Billmeyer, *Textbook of Polymer Science,* John Wiley & Sons, 2007.
3. C. E. Carraher, *Seymour/Carraher's Polymer Chemistry*: 6th Edn. CRC Press, 2003.
4. G. Odian, *Principles of Polymerization*, 4th Edn. Wiley, 2004.
5. P. Ghosh, *Polymer Science & Technology*, 2nd Edn. Tata McGraw-Hill, New Delhi, 2002.
6. R. W. Lenz, *Organic Chemistry of Synthetic High Polymers*; Interscience Publishers, New York, 1967.
7. R. Bahadur, N. V. Sastry, *Principles of Polymer Science*; Narosa, New Delhi, 2003.
8. R. O. Ebewele, *Polymer Science and Technology*; CRC Press, 2000.
9. M. N. Subramanian, M. N. *Basics of Polymer Chemistry*; River Publishers, 2022.
10. J. M. Garcia, Smart *Polymers*, De Gruyter, 2022.
11. A. Ravve, *Principles of Polymer Chemistry*, Springer, 2012.

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Food Chemistry**					
Type of Course	DSE					
Course Code	SJC4DSECHE201					
Course Level	**200-299**					
Course Summary	This course covers the scientific principles behind the composition, structure, properties, and reactions of food components. It also deals with topics related to the various substances added to food to enhance flavour and taste, improve texture and prolong shelf life.					
Semester	IV	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Analyse the chemical composition of various food components such as proteins, carbohydrates, lipids, vitamins, and minerals.	An	1,2,3
2	Apply principles of food chemistry to understand and predict the behaviour of food during processing, storage and cooking.	A	1,2,3
3	Explain the significance of food additives.	U	1,2,3
4	Analyse the impact of food practices in the society	An	1,2,4,5, 6, 8
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Food Additives**		
	1.1	Food additives – definition. Preservatives- natural food preservatives, traditional food preservation methods, artificial preservative agents, modern food preservation techniques, safety concerns of food preservatives.	3	2,3
	1.2	Food Colours- classification, chemistry of food colourants, non-permitted food colours, quality assurance of food colourants.	2	2,3
	1.3	Fragrances, flavouring agents and enhancers- classification, chemistry, quality control of flavour compounds.	2	2,3
	1.4	Emulsifiers- mechanism, role, types with examples.	1	2,3
	1.5	Stabilisers, gums, thickeners and gelling agents	1	2,3
	1.6	Antioxidants- types, chemistry, safety concerns of antioxidants.	2	2,3
	1.7	Food acids and acidity regulators, flour treatment/ improving agents, leavening agents, anticaking agents, minerals and mineral salts, dietary supplements- vitamins	3	2,3
	1.8	FSSAI, Food safety and standards act	1	2,3
2		**Role of Water, Carbohydrates, Lipids and Proteins in Food**		
	2.1	Structure and chemical properties of water, solute effects on water: state of water in foods, water activity: principles, measurement, control, effects and related concepts.	4	1
	2.2	Carbohydrates- basic chemistry, reactivity and sweetness of simple sugars and oligosaccharides, sugar derivatives: sugar alcohols, glycosides. Browning and related reactions. Polysaccharides- starch, cellulose, gums.	4	1,2

	2.3	Lipids- content and role in food, chemical, nutritional and physical properties, processing of fats and oils, degradation reactions.	3	1,2
	2.4	Proteins- amino acids and proteins, physical properties of proteins,: hydration, ionization, colloidal behaviour, functional properties, effects of food processing: changes occurring in chemical, functional & nutritional properties of proteins	4	1,2
3		**Enzymes, Vitamins and Minerals**		
	3.1	Food enzymes: enzymes acting on carbohydrates, proteins and lipids.	3	1,2
	3.2	Vitamins- fat-soluble vitamins, water-soluble vitamins, sources of vitamins, general causes of variation/losses of vitamins in food, biological function of vitamins, toxicity of vitamins.	5	1,2
	3.3	Essential mineral elements, nutritional aspects of minerals, bioavailability, effect of processing on mineral bioavailability, chemical and functional properties of minerals in foods.	5	1,2
	3.4	Societal role of food chemists	2	4
4		**Herbs and Spices**		
	4.1	Black Pepper: black pepper and white pepper, blackening of pepper, piperine- properties. Health benefits.	3	
	4.2	Ginger: components, medicinal uses.	2	
	4.3	Turmeric: uses, components and medicinal applications.	2	
	4.4	Cinnamon: components and uses.	2	
	4.5	Cardamom: Components and uses.	2	
	4.6	Adulteration of herbs and spices.	2	
	4.7	Wine: production of wine grapes and wine.	2	
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) 30 marks** **Assignments/MCQ/Class test/Viva**
	B. End Semester examination (70 marks)- 2hrs. i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. S. Damodaran, K. L. Parkin, Fennema's *Food Chemistry*, 5th Edn. CRC Press 2017.
2. H. D. Belitz, W.Grosch and P. Schieberle, *Food Chemistry*, 4th Edn. Springer, 2009.
3. T. Coultate, *Food: The Chemistry of Its Components*, 6th Edn. RSC. 2015.
4. T. A. M. Msagati, *Chemistry of Food Additives and Preservatives*, John Wiley & Sons, 2013.
5. V. Kontogiorgos, *Introduction to Food Chemistry*, Springer, 2021.
6. N. Agarwal and A. Srivastava, *Food Chemistry*, Anu Books, 2023.
7. C. M. Weaver and J. R. Daniel, *The Food chemistry Laboratory*, CRC Press, 2005.
8. S. S. Nielsen, *Food Analysis Laboratory Manual*, 3rd Edn. Springer, 2019.
9. D. D. Miller and C. K. Yeung, *Food Chemistry A Laboratory Manual*, Wiley, 2022.
10. A. V. Ramani, *Food Chemistry*, Mjp Publishers. 2011.
11. J. M. deMAn, *Principles of Food Chemistry*, Springer, 2018.
12. V. Kontogiorgos, *Introduction to Food Chemistry*, Springer, 2021.

Programme						
Course Name	**Basic Analytical and Cosmetic Chemistry**					
Type of Course	SEC					
Course Code	SJC4SECCHE200					
Course Level	**200-299**					
Course Summary	This course covers hand care, nail, personal hygiene, and oral care product formulation along with an introduction to Analytical Chemistry. Emphasizing practical skills in product formulation and analytical techniques.					
Semester	IV	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Illustrate the chemistry behind hand care and hygiene products	U	1,3,10
2	Formulate a range of personal care and hygiene products, preparing them for roles in the cosmetic and pharmaceutical industries.	S	2,3,10
3	Discuss the fundamentals of analytical chemistry	U	1,3
4	Apply techniques for soil and water analysis	A,S	2,3,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1	**Hand Care Products and nail preparation**			
	1.1	Hand Care Products: Introduction, formulation of hand sanitizers and hand wash. General ingredients and preparation of: (a) Hand wash (b) Antibacterial hand wash (c) Hand sanitizer	8	1,2
	1.2	Nail preparation: Structure of nail, Nail lacquers, Nail polish remover. General Ingredients and Preparation of: Nail polish and nail polish remover	7	1,2
2	**Personal hygiene products and oral hygiene products**			
	2.1	Personal hygiene products: Total fatty matter, alkali content, and pH of soaps. Bathing soap and toilet soap. Antiperspirants and deodorants. General Ingredients and preparation of (a) Soaps (b) Cream Soaps (c) Liquid soaps (hands on training)	8	1,2
	2.2	Oral hygiene products: Common problems associated with teeth and gums. Principles of formulation of Oral hygiene products. Role of herbs in oral care: neem and clove. Flavors and essential oils. General Ingredients and preparation of (a) Tooth powder (chemical-based and herbal) (b) Toothpaste (hands on training)	7	1,2
3	**Analytical Chemistry**			
	3.1	Introduction: Introduction to analytical chemistry and its interdisciplinary nature. Concept of sampling.	3	3

	3.2	Analysis of soil: composition of soil, concept of pH and pH measurement. a. Determination of pH of soil samples. (hands on training)	5	4
	3.3	Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, and water purification methods. a. Determination of pH, acidity, and alkalinity of a water sample. (hands on training)	7	4
4		**Teacher Specific content**		

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** **Lectures, discussions, hands-on training, presentations and group activities**
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) (25 marks)** Performance in activities/Assignments/MCQ examination
	B. End Semester examination (50 marks)-1.5 hrs. Short answer 10 questions (out of 12): 10 X 2 =20 Short essay 6 questions (out of 8): 5 X 6 = 30

References

1. H. Butler , *Poucher's Perfumes, Cosmetic and Soap*, Springer,2000
2. E.W. Flick , *Cosmetic and toiletry formulations*, Noyes Publications, New York,2001
3. D.A. Skoog and J.J. Leary, *Instrumental Methods of Analysis*, Saunders College Publications, New York, 1992
4. D.A. Skoog, D.M. West and F.J. Holler, *Fundamentals of Analytical Chemistry* 6th Edn., Saunders College Publishing, Fort Worth, 1992
5. D.C. Harris, *Quantitative Chemical Analysis* 7th Ed., W. H. Freeman and Co., New York, 2007

St. Joseph's College Moolamattom (Autonomous)

Programme						
Course Name	**Basic Environmental Chemistry**					
Type of Course	VAC					
Course Code	SJC4VACCHE200					
Course Level	**200-299**					
Course Summary	This course explores various aspects of environmental chemistry such as greenhouse effect, air and water pollution and renewable energy sources.					
Semester	4	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe basic concepts of environmental chemistry.	U	1,2, 3, 4, 5, 6, 8
2	Describe strategies for the remediation and purification of contaminated soil, air and water.	U	1,2,10
3	Apply principles of green chemistry to propose sustainable solutions for minimizing environmental contamination.	A	1,2,6,8,10
4	Discuss the basic chemical processes involved in air and water pollution and global warming identifying key sources.	U	1,2,8
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to the Environment**		
	1.1	Classification of the environment-troposphere, stratosphere, mesosphere, thermosphere, exosphere, hydrosphere, lithosphere and biosphere	5	1
	1.2	Greenhouse gases and global warming: natural occurring greenhouse gases, anthropogenic greenhouse gases, other greenhouse gases, ozone, global warming potential (GWP), emission metrics, influence of technology on global warming.	8	4
	1.3	Schemes to reduce greenhouse gases: capture and storage of carbon dioxide, sequestration of CO_2. other schemes to reduce greenhouse gases, removing CO_2 from the atmosphere: direct air capture, carbon dioxide emissions in the future	7	2,4
2		**Air and Water Pollution**		
	2.1	Water pollution causes, categories of water pollution, the long-term consequences of water pollution, basic idea of waste water purification and disinfection	5	2,3,4
	2.2	Air pollution: particulates, fog smog, acid rain, ozone umbrella, depletion- causes, basic idea of air quality improvement methods.	5	2,3,4
3		**Renewable Energy and Sustainability**		
	3.1	Renewable energy: hydroelectric, wind, solar, geothermal, and marine energy and their storage and hydrogen as sustainable energy	6	3
	3.2	Biomass energy: biofuels and their resources, decarbonization with biomass utilization. Conversion of biomass to other fuels- ethanol fuel, biodiesel fuel, fuel from algae. Biogas	6	3
	3.3	Sustainable materials: environmental effects of mining and mineral extraction, sustainable utilization of geospheric mineral resources- metals and nonmetal mineral resources	3	3
4		**Teacher Specific content**		

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Lecture-based approach, interactive discussions, laboratory sessions, flipped classroom, peer teaching and collaborative learning.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) 25 marks** Assignments Viva Classroom participation (participation in class activities) Examination
	B. Semester end examination 50 **marks-1.5 hrs.** i) MCQ 10 questions : 9 X 1 = 9 ii) Short answer 5 questions (out of 7): 5 X 4 =20 iii) Short essay 3 questions (out of 5): 3 X 7 = 21

References

1. *Chemistry in the Community*, A Project of the American Chemical Society, W H Freeman & Company, 2011.
2. C H. Middlecamp, *Chemistry in Context: Applying Chemistry to Society*, A Project of the American Chemical Society, McGraw-Hill, 2012.
3. C Baird, M Cann, *Environmental Chemistry*, W. H. Freeman and Company, 2012.
4. D W. Connell, *Basic Concepts of Environmental Chemistry*, 2nd Edn. CRC Press, 2005.
5. A K De, A K De, *Environmental Chemistry*, 10th Edn. New Age International, 2021.
6. S.S. Dara Dara, D. D. Mishra, *A Text Book Of Environmental Chemistry & Pollution Control*, S. Chand, 2004.
7. V. Subramanian, *A Text Book Of Environmental Chemistry*. Wiley, 2020.

<table>
<tr><td>Programme</td><td colspan="6"></td></tr>
<tr><td>Course Name</td><td colspan="6">Fundamentals of Physical Chemistry</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC C</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC4DSCCHE202</td></tr>
<tr><td>Course Level</td><td colspan="6">200-299</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides the student a thorough knowledge about solids and surface chemistry. It also gives basic information on green chemistry and nano chemistry along with an introduction on spectroscopy.</td></tr>
<tr><td>Semester</td><td>IV</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td></td><td>1</td><td></td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

<table>
<tr><td>CO No.</td><td>Expected Course Outcome</td><td>Learning Domains *</td><td>PO No</td></tr>
<tr><td>1</td><td>Describe types of solids, crystals and properties of solids</td><td>U</td><td>1,2</td></tr>
<tr><td>2</td><td>Discuss the adsorption of gases by solids</td><td>U</td><td>1,2</td></tr>
<tr><td>3</td><td>Analyse the properties and applications of colloids</td><td>An</td><td>1,2</td></tr>
<tr><td>4</td><td>Apply the basic principles of electrochemistry to conductance and emf measurements.</td><td>A</td><td>1,2</td></tr>
<tr><td>5</td><td>Apply the principles of electrochemistry to conduct simple laboratory experiments.</td><td>A, S</td><td>1,2</td></tr>
<tr><td colspan="4">*Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)</td></tr>
</table>

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Solid State			
1	1.1	Classification of solids: amorphous and crystalline – differences. Crystal lattice, unit cell, examples of simple cubic, bcc and fcc lattices, calculation of number of atoms in a unit cell, calculation of lattice parameters of cubic unit cell.	6	1
	1.2	Electrical properties: Conductors, semiconductors and insulators, band theory, superconductors. Magnetic Properties: classification-paramagnetic, diamagnetic, ferromagnetic, antiferromagnetic and ferrimagnetic. Permanent and temporary magnets.	6	1
2	**Surface chemistry and colloids**			
	2.1	Adsorption – types of adsorption of gases by solids, factors influencing adsorption, Freundlich and Langmuir adsorption isotherm (derivation not required).	3	2
	2.2	True solution, colloidal solution and suspension. Classification of colloids: lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples. Purification of colloids by electrodialysis and ultrafiltration.	4	3
	2.3	Properties of colloids: Brownian movement, Tyndall effect, electrophoresis. Origin of charge and stability of colloids, zeta potential, coagulation, Hardy-Schulze rule, protective colloids, gold number. Emulsions.	3	3
	2.4	Applications of colloids: delta formation, medicines, emulsification, micelle formation, cleaning action of detergents and soaps.	2	3
3	**Electrochemistry**			
	3.1	Introduction, Faraday's laws of electrolysis, electrochemical equivalent and chemical equivalent	3	4

	3.2	Specific conductance, equivalent conductance and molar conductance , variation of conductance with dilution - Kohlrausch's law - degree of ionization of weak electrolytes	4	4
	3.3	Application of conductance measurement: s determination of degree of dissociation of weak electrolytes, conductometric titrations involving strong acid- strong base, strong acid-weak base, weak acid-strong base, and precipitation titrations.	5	4
	3.3	Galvanic cells - Cell and electrode potentials - IUPAC sign convention, Types of electrodes: reference electrodes – standard hydrogen electrode and calomel electrode, indicator electrodes-metal-metal ion electrodes, Quinhydron electrode and Redox electrodes. Standard electrode potential - Nernst equation, electrochemical series. Gibb's Helmholtz equation and EMF of a cell.	7	4
	3.4	Potentiometric titrations of acid-base, redox and precipitation reactions.	2	4
4	**Physical Chemistry Practicals**			
	1. Viscosity-percentage composition of sucrose solution. . Transition temperature of salt hydrates, e.g. Sodium thiosulphate Sodium acetate etc. 3. Critical solution temperature of phenol water system 4. Conductometric titration of strong acid Vs. strong base 5. Potentiometric titrations : Fe^{2+} Vs. $Cr_2O_7^{2-}$ and Fe^{2+} Vs. $KMnO_4$ 6. Determination of molecular weight by Rast's method. 7. Phase diagram of two component systems		30	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Peer teaching ● Demonstration of experiments ● Hands-on training
Assessment Types	**MODE OF ASSESSMENT** **B. Continuous Comprehensive Assessment**

	Theory (25 marks) Assignment Class test (MCQ/Written) **Practical (15 marks)** Lab involvement Quiz
	B. Semester end examination **Theory:** Written Examination **(50 Marks)- 1.5 hrs.** i) MCQ 10 questions : 10 X 1 = 10 ii) Short answer 4 questions (out of 6): 4 X 3 =12 iii) Short essay 2 questions (out of 3): 2 X 7 = 14 iii) Essay 1 question (out of 2): 1 X 14 = 14 **Practical: (35 marks)- 3 hr.** Lab report: 5 marks Viva: 10 marks Analysis and procedure: 20marks

References

1. B. R. Puri, L. R. Sharma and M. S. Pathania, *Principles of Physical Chemistry*, 48th Edn., Vishal Publishing Company, New Delhi, 2020.
2. F. Daniels, R. A. Alberty, *Physical Chemistry*, 5th Edn., John Wiley and Sons, Canada, 1980
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Delhi, 2006.

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SEMESTER 5

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Organic Chemistry – 3**
Type of Course	DSC A
Course Code	SJC5DSCCHE300
Course Level	**300-399**
Course Summary	This course explores nitro compounds, amines, cyanides, isocyanides ethers and epoxides, heterocyclic compounds, active methylene compounds and organic photochemistry. Practical part of the course includes qualitative microscale analysis and reactions of nitrogen containing compounds

Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3	0	1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Predict the product and reasonable mechanism for the reactions of nitro compounds, amines, diazonium salts, cyanides, and isocyanides	A	1,2
2	Explain the reactions of ethers and epoxides	U	1
3	Identify the aromaticity, properties and biological significance of heterocyclic compounds	A	1,2,3
4	Outline synthetic applications of active methylene compounds	U	1,2
5	Apply photochemical methods to organic synthesis	A	1,2
6	Analyse and prepare nitrogen containing compounds and systematically record the observation	An, S	1,2,4,10

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Nitrogen Containing Compounds**		
	1.1	Nitro Compounds: Preparation of aliphatic and aromatic nitro compounds Tautomerism of nitromethane.	1	1
	1.2	Reactions of nitro compounds: Reduction products of nitrobenzene in acidic, neutral and alkaline media. Electrolytic reduction, and selective reduction of polynitro compounds.	3	1
	1.3	Preparation of amines: Gabriel's phthalimide synthesis, Hoffmann bromamide reaction (with mechanisms).	2	1
	1.4	Basicity of aliphatic and aromatic amines – a comparative study, Hinsberg test, Quaternary amine salts as phase-transfer catalysts.	4	1
	1.5	Preparation of diazonium salts from aromatic amines, conversion of diazonium salts to benzene, phenol, chloro, bromo, iodo and fluoro benzenes, nitro benzene and azo dyes with mechanisms.	3	1
	1.6	Cyanides- Preparation from alkyl halides and carboxylic acids. Reactions- hydrolysis, reduction, reaction with Grignard reagent Isocyanides- preparation from alkyl halides and primary amines. Reactions-hydrolysis, reduction.	2	1
2		**Ethers, Epoxides and Heterocyclic Compounds**		
	2.1	Williamson's ether synthesis. Reactions of ethers - cleavage with HI, Claisen Rearrangement, Zeisel's method of estimation of alkoxy groups.	3	2
	2.2	Structure of epoxides, Reactions of epoxides with alcohols, ammonia derivatives and LAH.	2	2

	2.3	Classification of heterocyclic compounds, structure and aromaticity of furan, thiophene, pyrrole, pyridine and indole	3	3
	2.4	Synthesis and reactions- furan, thiophene, pyrrole (Paal Knorr synthesis and Knorr pyrrole synthesis), Pyridine (Hantzsch synthesis), Indole (Fischer Indole Synthesis),	5	3
	2.5	Importance of purines and pyrimidines in biological systems- adenine, thymine, guanine, cytosine and uracil	2	3
3	**Active Methylene Compounds and Organic Photochemistry**			
	3.1	Structure and synthetic applications of ethyl acetoacetate and diethyl malonate (synthesis of carboxylic acids and ketones)	5	4
	3.2	Photochemistry: introduction. Photochemical versus Thermal reactions. Electronic excitation and fate of excited molecules.	2	5
	3.3	Photochemical reactions: Norrish type I and II reactions of acyclic ketones, Paterno-Buchi reaction and photo- Fries reaction (with mechanisms), Barton reaction (nitrite ester), di-π methane rearrangement Photochemistry of vision	8	5
4		**Organic Chemistry – 3 Practicals**		
		Qualitative Microscale analysis of organic compounds- Identification and preparation of derivatives of amines, amides and nitro-compounds, amides Preparation of m-dinitro benzene from nitro benzene Synthesis of methyl orange Biginelli Reaction	30	6
5		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture - offline ● Practical

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory (25 marks)** Pop quizzes Problem based assignments Written/MCQ Tests **Practical** (15 marks) Quiz Lab involvement
	B. End Semester examination **Theory: Written examination - 50 Marks-1.5 hrs.** i. MCQ 10 questions : 10 X 1 = 10 ii. Short answer 4 questions (out of 6): 4 X 3 =12 iii. Short essay 2 questions (out of 3): 2 X 7 = 14 iv. Essay 1 question (out of 2): 1 X 14 = 14 **Practical (35 Marks)-1 hr.** Viva voce-10 Marks Written test of practical procedures-15 Marks Certified report of lab works done -10 Marks

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1. Clayden, J.; Greeves, N.; Warren, S. *Organic Chemistry;* Oxford University Press, USA, 2012.
2. Solomons, T. W. G.; Fryhle, C. B. *Organic Chemistry;* John Wiley & Sons, 2008.
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12. Bruice, P. Y. *Organic Chemistry;* Pearson, 2017.
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	St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Physical Chemistry- 2**					
Type of Course	DSC A					
Course Code	SJC5DSCCHE301					
Course Level	**300-399**					
Course Summary	This course covers the basic ideas of solid state, photochemistry and thermodynamics.					
Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Illustrate the basic aspects of ionic solids and identify the crystal structure.	An	1, 2
2	Explain the types of defects in solids and properties of semiconductors and liquid crystals.	U	1, 2
3	Apply the fundamental principles of photochemistry to photochemical reactions.	U	1, 2
4	Explain the fundamental laws of thermodynamics and its application in isothermal, adiabatic and Joule-Thomson expansion processes.	U	1, 2
5	Apply the principles of chemical thermodynamics to thermochemical processes and systems of variable compositions.	A	1, 2
6	Apply principles of physical chemistry to conduct laboratory experiments.	A, S	1,2,4, 10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		SOLID STATE		
1	1.1	Anisotropy in crystals, Laws of Crystallography – Law of constancy of interfacial angles, Law of rational indices. Weiss and Miller indices. X–Ray diffraction by crystals, Bragg's law	4	1
	1.2	Structure of ionic compounds of the type AX (NaCl, CsCl, ZnS) and AX_2 (CaF_2, Na_2O) Defects in crystals – stoichiometric and non-stoichiometric defects. Electrical conductivity, semiconductors- n-type, p-type, Superconductivity (Elementary ideas)	6	1,2
	1.3	Liquid crystals - Classification, structure thermographic behavior and applications.	5	2
		PHOTOCHEMISTRY		
2	2.1	Laws of photochemistry-Grothus-Draper law, Stark-Einstein law. Jablonski diagram-fluorescence, phosphorescence, non-radiative processes, internal conversion, intersystem crossing.	3	3
	2.2	Quantum yield, examples of low and high quantum yields, photochemical reactions (decomposition of HBr, isomerisation of maleic acid to fumaric acid), photosensitised reactions (photosynthesis, isomerization of 2-butene), chemiluminescence, bioluminescence.	3	3
		THERMODYNAMICS		

3	3.1	Internal energy and enthalpy. Heat capacities at constant volume (C_v) and at constant pressure (Cp), relationship between C_p, C_v and R First law of thermodynamics –Mathematical statement of first law. Reversible process and maximum work. Calculation of work, heat, internal energy change and enthalpy change for the expansion of an ideal gas under reversible isothermal and adiabatic condition.	7	4
	3.2	The Joule-Thomson effect – derivation of the expression for Joule-Thomson coefficient. Significance of Joule-Thomson coefficient, inversion temperature.	2	4
	3.3	Limitations of first law. Second law – Different statements of second law, thermodynamic scale of temperature. Carnot cycle and its efficiency, Carnot theorem. Concept of entropy – Definition and physical significance. Entropy as a function of volume and temperature, entropy as a function of pressure and temperature. Criteria of spontaneity and equilibrium. Gibbs and Helmholtz free energies and their significances- criteria of equilibrium and spontaneity. Gibbs-Helmholtz equation	10	5
	3.4	Third law of thermodynamics-statement and determination of absolute entropies of substances. Partial molar quantities – Chemical potential – Gibbs–Duhem equation Zeroth law of thermodynamics	5	5
		Physical chemistry II- Practicals		

4		1. Heat of neutralization 2. Heat of solution – KNO_3, NH_4Cl (Determination of heat of solution from solubility measurements) 3. Surface tension - Determination of the surface tension of a liquid (Drop number method or Drop weight method). 4. Surface tension - Determination of Parachor values 5. Determination of the composition of two liquids by surface tension measurements 6. Determination of CMC of surfactants by surface tension measurements	30	6
5		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture Sessions, (chalk & board, powerpoint presentation) ● Interactive sessions and simulations, ● Visual aids like videos and models to enhance understanding. ● Peer discussions. ● Laboratory experiments and hands-on training
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA)** **Theory: 25 marks** Pop quiz Assignment Class test (MCQ/written) **Practical : 15 marks** Lab involvement and skill Report of lab works done

	Semester end examination **Theory:** Written examination (50 Marks)-1.5 hrs. i. MCQ 10 questions : 10 X 1 = 10 ii. Short answer 4 questions (out of 6): 4 X 3 =12 iii. Short essay 2 questions (out of 3): 2 X 7 = 14 iv. Essay 1 question (out of 2): 1 X 14 = 14 **Practical: (35 Marks)-1 hr.** Viva voce: 10 marks Writing procedure:1 5 marks Certified lab report: 10 marks

References

1. K. J. Laidler, *Chemical kinetics*, 3rd Edn. Pearson education, 2004.
2. L V Azaroff, "*Introduction to Solids*", McGraw Hill, 2017.
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4. Anthony R. West, "*Solid State Chemistry and its Applications*", Wiley Eastern, 2022.

5. R. P. Rastogi, R. R. Misra, *An Introduction to Chemical Thermodynamics*, 6th Edn. Vikas Pub. Pvt. Ltd., 2003.
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7. K. L. Kapoor, *A Textbook of Physical chemistry*, Volume 5, 4th Edn., Macmillan India Ltd., 2018.
8. Puri, Sharma and Pathania, *Principles of Physical Chemistry*, 48th Edn. Vishal Publishing Company, 2020.

Suggested Readings

1. R P W Atkins, "*Physical Chemistry*", Oxford University Press, 2019.
2. J. Rajaram, J. C. Kuriakose, *Chemical thermodynamics: classical, statistical and irreversible,* Dorling Kindersley (India), New Delhi, 2013
3. Glasstone and Lewis, *Elements of Physical Chemistry*, Macmillan, 1963.
4. I.N. Levine, *Physical Chemistry*, Tata McGraw Hill, 2011.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Quantum Mechanics, Spectroscopy & Group Theory**					
Type of Course	**DSE**					
Course Code	SJC5DSECHE300					
Course Level	**300-399**					
Course Summary	This course covers fundamental principles and applications in the realm of molecular structure, behaviour, and interactions. This course deals with the basic principles of quantum chemistry, spectroscopic techniques like rotational, vibrational, electronic and NMR and group theory.					
Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Demonstrate the fundamental concepts of quantum mechanics and describe its application to simple systems.	U	1
2	Examine the correlation between angular and radial wave functions in determining orbital shapes	An	2
3	Illustrate the basic concepts of various spectroscopic techniques.	U	2
4	Deduce various symmetry elements and point groups in molecules	E	4,5
5	Develop the group theoretical rules to generate group multiplication tables, matrix representations and classes.	A	2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		Quantum Mechanics		
1	1.1	Classical mechanics: Concepts – Newtonian equations of motion and Hamiltonian equation of motion.	1	1
	1.2	Failures of Classical mechanics: Blackbody radiation, photoelectric effect, Compton effect and atomic spectra.	3	1
	1.3	Schrodinger wave equation; postulates of quantum mechanics – wave function postulate, operator postulate, Hermitian operator, eigen function postulate, expectation value postulate, time dependent postulate.	3	1
	1.4	Application of quantum mechanics to simple systems – Particle in 1-D box, normalization of wave function, application to 1,3 butadiene.	3	1
	1.5	Schrödinger equation for hydrogen atom – Coordinate system – cartesian and spherical polar coordinates, wave equation in spherical polar coordinates and its components - Radial and angular functions (derivation not required)	3	1
	1.6	Shapes of orbitals (s and p) – sketch of angular and radial wave functions. Radial distribution function	2	2
		Molecular Spectroscopy-I		
2	2.1	Introduction: electromagnetic radiation, regions of the spectrum, interaction of electromagnetic radiation with matter, various types of molecular spectroscopic techniques, Beer-Lambert's law, intensity of absorption, Factors affecting intensity - signal to noise ratio, natural line width. Doppler broadening, Born-Oppenheimer approximation	4	3
	2.2	*Rotational spectroscopy:* Rigid rotor and derivation of moment of inertia. Rotational energy levels, selection rules, relative population	5	3

		of energy levels, appearance of rotational spectra, calculation of bond length in diatomic molecules		
	2.3	*Vibrational spectroscopy*: harmonic oscillator (concept only), calculation of force constant and energy levels, selection rules, concept of anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, Fermi resonance. Degrees of freedom for polyatomic molecules, IR spectrum of water & carbon dioxide.	6	3
		Molecular Spectroscopy-II		
3	3.1	*Electronic spectroscopy*: singlet and triplet states, selection rules (Spin and Laporte selection rule), Franck-Condon principle – transition, dissociation and predissociation, Polyatomic molecules – qualitative description of σ, π and n- molecular orbitals, their energy levels and the respective transitions.	9	3
	3.2	*Nuclear Magnetic Resonance (NMR) spectroscopy:* Nuclear spin quantum number, energies of nuclei in magnetic field, Larmor precession, chemical shift and δ scale. Factors affecting chemical shift, spin-spin coupling, coupling constant.	6	3
		Group Theory		
4	4.1	Symmetry elements and operations, determination of distinct symmetry operations of C_n and S_n.	2	4
	4.2	Mathematical groups: Properties	1	4
	4.3	Point group, classification into MLS, MHS and MSS. Determination of point groups of molecules belonging to C_n, C_s, C_i , C_{nv}, C_{nh}, $C_{\infty v}$, D_{nh}, $D_{\infty h}$, D_{nd}, T_d and O_h point groups.	5	4
	4.4	Abelian groups, cyclic groups, sub groups. Similarity transformation, classes - C_{2v} and C_{3v}. Group multiplication tables (GMTs) - C_{2v} and C_{3v}. Matrix representation of symmetry elements of E, C_n, S_n, i, σ.	7	4,5
5		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture (chalk & board, powerpoint presentation, flipped classroom) Group Discussion – thought problems; mind mapping Peer interaction Demonstration using simulations / models
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** ***Theory (30 marks)*** Quiz Assignment Problem based test - Open book Written exam
	B. Semester end examination 70 marks- **2 hrs.** MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

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1. P.W. Atkins, R.S. Friedman, *Molecular Quantum Mechanics*, 4th Edn. Oxford University Press, 2005.
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St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Green chemistry for sustainable development**
Type of Course	DSE
Course Code	SJC5DSECHE301
Course Level	**300-399**
Course Summary	This course explores fundamentals of green chemistry covering aspects from synthesis design to waste management and energy usage.

Semester	V	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		60
Pre-requisites, if any	Basic concepts on green chemistry					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Familiarize the basic concepts of green chemistry	U	1,2,3,6,7
2	Recognize twelve principles and importance of green chemistry	U	1,2,3,6,7
3	Identify alternative methods and solvents for green synthesis	A	1,2,3,6,7
4	Evaluate the adverse effects of chemicals to environment and select safer green methods for synthesis	E	1,2,3,6,7
5	Deduce the importance of green technologies in sustainable growth of Industry and society	E	1,2,3,6,7
6	Apply suitable energy efficient processes	A	1,2,3,6,7
7	Develop cleaner production and treatment mechanisms for pollution prevention.	A	1,2,3,6,7

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to green chemistry**		
	1.1	Introduction. Goals and challenges of Green Chemistry: Introduction of Green protocol**:** Rules - Rio declaration-Montreal protocol, Kyoto protocol.	3	1
	1.2	Twelve principles of Green Chemistry with their explanations and special emphasis on the following with examples: Designing a Green Synthesis using these principles; prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products Atom Economy, calculation of atom economy, Atom economic and atom uneconomic reactions: rearrangement (Claisen and fries rearrangements), addition (Michael and Diels Alder reactions), substitution and elimination reactions.	7	2
2		**Prevention and minimization of toxic materials (Green alternatives)**		
	2.1	Prevention/ minimization of hazardous/ toxic products: reducing toxicity, measuring toxicity- LD_{50} & LC_{50}, Ames test Sources of waste, cost of waste, problems caused by waste, waste minimization techniques, on site waste treatment, reuse and recycling.	5	4
	2.2	Catalysis and green chemistry-Parameters that affect the inherent greenness of a catalyst, comparison of heterogeneous and homogeneous catalysts, elementary ideas on asymmetric catalysts, photocatalysts, biocatalysts and phase transfer catalysts (definition only)	5	4
	2.3	Prevention of chemical accidents- designing greener processes, inherently safer design (ISD), subdivisions of ISD- Minimization, simplification, substitution, moderation and limitation	5	4
	2.4	Energy requirements for reactions - alternative sources of energy: use of microwaves- microwave heating, microwave assisted reactions (in water and solvent free reactions) and ultrasonic energy.	5	6

3		**Green synthesis**		
	3.1	Green strategies for organic synthesis, green solvents- water, supercritical fluids (supercritical carbon dioxide, supercritical water), ionic liquids, fluorous biphasic solvent, PEG, immobilized solvents and greenness of solvents, solventless processes.	8	3
	3.2	Organic synthesis using green reagents- oxygen, singlet oxygen, ozone, hydrogen peroxide and peroxy acids. Polymer supported reagents- poly-n-bromosuccinimide, polymeric organotin dihydride reagent, polystyrene carbodiimide, polystyrene sulfide, polymer supported peracid, organic synthesis using biocatalyst- biochemical (microbial) oxidations, biochemical (microbial) reductions.	9	3
4	**Phase Transfer Catalysts and Green Industrial Processes**			
	4.1	Organic synthesis using phase transfer catalysts- mechanism, types of phase transfer catalysts and its advantages. Applications of PTC in organic synthesis: synthesis of nitriles, alcohols, azides and alkyl fluorides from alkyl halides. Green synthesis of following compounds: adipic acid, adiponitrile, ibuprofen, alcohols, aromatic nitriles, cyclohexane oxime, 1-octanol, 3-phenyl catechol.	9	3
	4.2	Green industrial processes: Pollution statistics from various industries, polymer industry, textile industry, greener approach of dyeing, eco-friendly pesticides, pharmaceutical industry, wastewater treatment.	4	7
5		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** • Lecture (chalk & board, powerpoint presentation) • Group discussion • Case studies • Debates • Quizzes
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (Total 30 marks) Theory** Assignment/ Quiz/ Class test – written/ Class test – MCQ

	B. Semester end examination **Theory: Written examination (70 Marks)-2 hrs.**
	MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

References

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St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Environmental Chemistry**					
Type of Course	DSE					
Course Code	SJC5DSECHE302					
Course Level	**300-399**					
Course Summary	This course provides an overview of environmental planning, energy sources and its conservation, impact assessment, chemical toxicology, water pollution and air pollution. It also addresses soil composition, waste management, effluent treatment methods, emphasizing the use of plants, animals, and microorganisms for pollution control and waste recycling.					
Semester	V	Credits				Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		60
Pre-requisites, if any	Basic understanding of energy conservation, toxicity effects of various chemicals, water pollution, air pollution and waste management.					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Recognize the importance of environmental management and impact assessment	U	1,2,6,7,8
2	Identify the toxic effects of chemicals	A	1,2,6,7,8
3	Develop a comprehensive knowledge of water pollution, including its various types, effects, and sources.	A	1,2,6,7,8
4	Discuss sampling and measurement of diverse water quality parameters	U	1,2,6,7,8
5	Explain environmental impacts of atmospheric pollution sampling and analysis of key pollutants	U, E	1,2,6,7,8
6	Analyse the soil composition, reactions, soil sampling techniques and management of sustainable agricultural and environmental practices.	An	1,2,6,7,8

7	Build a comprehensive idea about effluent, water and wastewater treatment methods, biological agents in pollution control and waste management principles	A	1,2,6,7,8
8	Analyse sustainable waste management practices	An	1,2,6,7,8, 10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Environmental Management, Impact Assessment and Chemical Toxicology**			
	1.1	Basic principles, concepts and scope of environmental planning, Conservation of energy - Renewable and non-renewable energy sources- nuclear energy, solar energy, hydrogen, non-conventional energy sources.	3	1
	1.2	Environmental pollution - concepts and definition. Impact assessment- aim, concepts and methods. Environmental management system - ISO-14001.	3	1
	1.3	Toxicity -effects, toxic chemicals in the environment, impact of toxic chemicals on enzymes, biochemical effects of As, Cd, Pb, Hg, CO, NOx, SO_2, O_3, PAN, CN, pesticides and carcinogenic substances	9	2
2	**Water Pollution**			
	2.1	Types, effects and sources of water pollution. Thermal pollution.	3	3
	2.2	Sampling and measurement of water quality - odour, colour, EC, turbidity, TDS, salinity, COD, BOD, DO, coliform, pH, acidity, CO_2, alkalinity, hardness, phosphate, fluoride, chloride, cyanide, sulphide, sulphate and metals- As, Cd, Fe, Pb and Hg.	12	4
3	**Air Pollution and Lithosphere**			
	3.1	Primary pollutants, hydrocarbons-photochemical smog, particulates, radioactivity, effects of atmospheric pollution - acid rain, ozone layer depletion.	4	5

	3.2	Air pollution accidents - Bhopal and Chernobyl, air quality standards. Sampling and analysis of pollutants - CO, SO_2, H_2S, hydrocarbons, SPM.	4	5

	3.3	Composition of soil - reactions in soil. Wastes and pollutants in soil. Sampling procedures and analysis of soil- cation exchange capacity, lime status, lime requirement, gypsum requirement, pH, N, P, K, S, Ca, and SJC. Management of solid waste.	7	6
4	**Effluent and Waste Management**			
	4.1	Effluent - definition and characteristics. Methods for water and wastewater treatment and systems (physical, chemical, and biological).	5	7
	4.2	Plants, animals and microorganisms for controlling pollution and treatment of effluents. Waste management- definition, characterization, sources and classification.	5	7
	4.3	Waste Management – 3Rs. Waste treatment and disposal –Methods for management for hazardous and toxic wastes.	5	8
5	**Teacher Specific content**			
Teaching and Learning Approac h	**Classroom Procedure (Mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Case studies ● Debates ● Quizzes			
Assessme nt Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment Theory (Total 30 marks)** Assignment- Quiz Class test Class test – MCQ			

	B. Semester end examination **Theory: Written examination (70 Marks)- 2 hrs.** MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos)

Essay type question – 15 marks (1 out of 2 nos)

References

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2. G. T. Tyler, *Living in the Environment*, Tomson Brooke/Cole, 1995.
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St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Nanotechnology for Energy Applications**
Type of Course	DSE
Course Code	SJC5DSECHE303
Course Level	**300-399**
Course Summary	This course explores the intersection of nanotechnology and energy systems. It covers the applications of nanotechnology in the field of energy conversion and storage.

Semester	V	Credits				Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any	Basic understanding of synthesis and properties of nanomaterials.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Develop a comprehensive knowledge base regarding global energy needs, consumption patterns, classification of energy sources and the energy conservation.	A	1, 2,3,6,7
2	Differentiate between conventional and non-conventional energy sources.	An	1, 2,3,6,7
3	Analyse various photovoltaic technologies, including Solar Cells.	An	1, 2,3,6,7
4	Explain the working principle and architecture of energy storage devices including batteries and capacitors	U	1, 2,3,6,7
5	Discuss about hydrogen storage technologies	U	1, 2,3,6,7
6	Develop a comprehensive knowledge of nanostructured materials	U	1, 2,3,6,7
7	Build a strong foundation in the role of MOFs and two-dimensional materials in energy related applications	A	1, 2,3,6,7

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Introduction to energy technologies			
1	1.1	Global energy requirements and consumption. Classification of renewable and non-renewable energy technologies. Conventional energy sources – pros and cons (*with relevant case studies*). Challenges in the development and implementation of renewable energy technologies	9	1
	1.2	Non-conventional sources of energy: Tidal energy, geothermal energy and biomass.	2	1,2
	1.3	Energy conversion, transport, and storage- challenges and outlooks	4	1
	Nanomaterials for Energy Conversion			
2	2.1	Principles of photovoltaic energy conversion (PV): Types of Solar cells: DSSC, OPV , Bulk Hetero Junction (BHJ-SC) , Quantum dots, ,Perovskites and Silicon Solar cells	8	3
	2.2	Nano, micro, poly crystalline and amorphous silicon solar cells. Nano and micro Si-composite structure, various techniques of Si deposition.	4	3
	2.3	Fuel Cells: Working principle and architecture, micro-fuel cell technologies.	3	3
	Nanomaterials for Storage Technology			
3	3.1	Introduction to battery technology (*working principle and architecture*), primary and secondary batteries (Lithium-ion Batteries), cathode and anode materials.	5	4,6
	3.2	Capacitors- Principles and materials design. Electrical double layer model. Pseudocapacitor, electrochemical supercapacitors.	5	4,6
	3.3	Hydrogen storage: Materials and methods, MOFs, metal hydrides and hydrogen storage capacity.	5	5,6
		State-of-the-art materials in Energy storage and conversion		

4	4.1	Nanostructured carbon-based materials, nano-oxides, novel hybrid electrode materials.	5	6
	4.2	Introduction to MOFs and its role in energy storage and conversion. COFs (*elementary idea only*).	5	7
	4.3	Elementary idea of the state-of-the-art two-dimensional materials: graphene, boron nitride, carbon nitride, metal chalcogenides (MoS_2, $MoSe_2$, etc.).	5	7
5	**Teacher Specific content**			
Teaching and Learning Approac h	**Classroom Procedure (Mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Case studies ● Debates ● Quizzes			
Assessme nt Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory** Assignment Quiz Class test – written Class test - MCQ			
	B. Semester end examination: 70 marks-2 hrs. MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)			

References

1. B. Raj, Marcel V. de Voorde, Y. Mahajan, "*Nanotechnology for Energy Sustainability (Applications of Nanotechnology)*", 1st Edn, Kindle Edition, Wiley-VCH, 2017.
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11. D. Infield, *Hydrogen from Renewable Energy Sources*, 2004

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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Medicinal Chemistry</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC5DSECHE304</td></tr>
<tr><td>Course Level</td><td colspan="6">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course explores fundamental aspects of medicinal chemistry such as drug discovery, drug action, different classes of drugs, adverse effects of drugs and drug delivery systems.</td></tr>
<tr><td>Semester</td><td>V</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td>0</td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse the fundamental aspects of medicinal chemistry such as drug discovery and drug effectiveness.	An	1, 2,3
2	Examine various aspects of drug action.	An	1, 2,3
3	Describe different classes of drugs with suitable examples.	U	1, 2,3,6
4	Explain adverse effects of drugs.	U	1, 2,3
5	Discuss advanced drug delivery systems.	U	1, 2,3,7

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to Medicinal Chemistry**		
	1.1	Overview of medicinal chemistry: definition and scope of medicinal chemistry. Drugs: classification, sources and routes of administration.	5	1
	1.2	Drug discovery: target identification and validation, lead identification and optimisation, preclinical testing, pharmacology/toxicology and clinical studies- phase I, II and III. Ways of identification of lead compounds.	7	1
	1.3	Effectiveness of a drug: chemotherapeutic index and therapeutic index. Drug selectivity.	3	1
		Drug Action		
2	2.1	The pharmacokinetic phase: absorption, distribution, metabolism and elimination (ADME) of the drug. Bioavailability of a drug. The pharmacodynamics phase.	5	2
	2.2	Drug metabolism: sites of drug metabolism and phase I and phase II reactions. Prodrugs.	6	2
	2.3	Drug receptors (elementary idea only), agonists and antagonists, partial agonists. Elementary idea of induced fit theory of drug action.	4	2
		Classes of Drugs		
3	3.1	Definition of the following classes of drugs with use of the given example: anaesthetics- thiopentone sodium, sedatives- phenobarbital, anti-epileptic drugs- clobazam, anxiolytic agents- benzodiazepine, narcotic analgesics – morphine and anticancer drugs- cisplatin.	5	3
	3.2	Definition of the following classes of drugs with use of the given example: adrenergic stimulants- adrenaline, adrenergic blockers- tolazoline, cholinergic stimulants- acetylcholine, cholinergic blockers- dicyclomine and cardiotonic drugs- digoxin.	5	3
	3.3	Definition of the following classes of drugs with use of the given example: antibiotics- chloramphenicol, antiviral drugs:	5	3

		amantadine, antimalarials- chloroquine, tranquilisers: benzodiazepines and antipsychotics- phenothiazine.		
4	**Adverse Drug Effects and Drug Delivery Systems**			
	4.1	Adverse drug effects: predictable and unpredictable drug reactions and severity. Classification of adverse drug effects, pharmacovigilance and prevention of adverse drug effects.	7	4
	4.2	Drug formulations- sustained-release, controlled release, programming the release and prodrugs. Nanomaterials in drug delivery: liposomes, polymer nanoparticles, chitosan nanoparticles, nanosponge and targeted drug delivery in cancer using nanoparticles. Gene delivery: applications of nanoparticles in gene delivery.	8	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** • Lecture (chalk & board, powerpoint presentation) • Group discussion • Peer teaching • Demonstration of experiments
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment Theory (Total 30 marks)** Assignment Quiz Class test – written Class test – MCQ
	D. Semester end examination **Theory: Written examination (70 Marks) – 2hrs.** MCQ – 10 marks (1 mark each – 10 nos)

	Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2)

References

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St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Main Group Elements**					
Type of Course	DSE					
Course Code	SJC5DSECHE305					
Course Level	**300-399**					
Course Summary	This course explores the basic aspects of main group elements					
Semester	V	Credits				Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand the classification of S block elements in the periodic table: general trends and properties of elements and structure of molecules	U	1,2
2	Apply knowledge of fundamental chemical principles to explain and predict the behavior of P-block elements and compounds	A	1,2
3	Analyse the structural aspects of boron and silicon compounds	An	1,2
4	Apply knowledge of halogens and interhalogens to predict the outcomes of simple reactions.	A	1,2
5	Apply Valence Bond and Molecular Orbital theories to explain bonding in noble gas compounds	A	1,2
ber (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) an ation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Chemistry S Block Elements**			
	1.1	General characteristics: melting point, flame colouration, reducing nature, diagonal relationships and anomalous behaviour of first member of each group. Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water. Common features such as ease of formation, thermal stability, energetics of dissolution, and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.	8	1
	1.2	Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium. Solutions of alkali metals in liquid ammonia and their properties	7	1
2	**Chemistry of p-Block Elements**			
	2.1	Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Catenation, Allotropy of C, P, S; inert pair effect, diagonal relationship between B and Si and anomalous behaviour of first member of each group. Synthetic diamonds (elementary idea)	8	2
	2.2	Catenation and heterocatenation` in inorganic compounds. Types of inorganic polymers. Comparison with organic polymer, preparation and uses of borazine - similarities in structure with benzene. Boron nitrides- comparison with graphite.	7	2
		Important Group 13 and Group14 compounds		

3	3.1	Comparative studies including diagonal relationship of group 13 and 14 elements. Anomalous behaviour of Boron. Preparation, structure, and bonding of diborane, uses of diborane. STYX numbers and WADE's rule, (Closo, nido, arachno) e.g. $B_{12}H_{12}{}^{2-}$, B_5H_9 and B_4H_{10}	8	3
4	3.2	Boron nitrides, boranes, carboranes and metallocarboranes. Silicates and classification, aluminosilicates, natural and synthetic zeolites and application of zeolites as molecular sieves. Silicon based polymers-silicones, silicon rubbers (preparation, important properties and uses)	7	3
	Halogen and Noble Gas Compounds			
	4.1	Properties of halogens. Interhalogens - classification- general preparation- structures of AB, AB_3, AB_5 and AB_7 types. Reactivity (ClF, ICl_3, ClF_3, IF_5 and IF_7). Comparison of pseudohalogens with halogens.	7	4
	4.2	Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Bonding in noble gas compounds (Valence bond and MO treatment for XeF_2), Shapes of noble gas compounds (VSEPR theory).	8	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures (chalk & board, multimedia presentations) Group Discussions Case studies Quizzes

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory: 30 marks** Quiz Assignment Problem based test - Open book Written exam
	B. Semester end examination **Theory: Written examination theory (70 Marks)- 2 hrs.** MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

References

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St. Joseph’s College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Analytical Chemistry and Professional skills**					
Type of Course	SEC					
Course Code	SJC5SECCHE300					
Course Level	**300-399**					
Course Summary	This course provides a comprehensive introduction to analytical chemistry, focusing on interdisciplinary concepts, precision in analysis, and practical applications in soil and water studies. It incorporates hands-on experiences, including workshops, interview training, industrial visits, and expert interactions, culminating in a career-oriented project for enhanced professional readiness.					
Semester	V	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Outline the fundamentals of analytical chemistry	U	1,2
2	Conduct soil and water analysis	An	1,2,4,10
3	Explain the principles of chromatographic techniques	U	1,2
4	Apply the principles of Thin Layer Chromatography and column chromatography for purification and separation purposes.	A	1,2,10
5	Develop professional skills effectively and contribute meaningfully to their chosen fields.	E	4,9, 10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT
Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
	Analytical Chemistry			
1	1.1	**Introduction**: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision, and sources of error in analytical measurements.	3	1
	1.2	**Analysis of soil:** Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators. a. Determination of pH of soil samples. b. Estimation of Calcium and Magnesium ions in soil by complexometric titration.	6	2
	1.3	**Analysis of water:** Definition of pure water, sources responsible for contaminating water, water sampling methods, and water purification methods. . Determination of pH, acidity, and alkalinity of a water sample. b. Determination of the Hardness of water.	6	2
		Chromatographic techniques		
2	2.1	Introduction to chromatography: Basic principles of chromatography, types of chromatography	2	3
	2.2	Theory and Application -Gas chromatography, High-Performance Liquid Chromatography (HPLC)	5	3
	2.3	Theory, application, and demonstration of Thin Layer Chromatography and Column Chromatography (Hands on Training)	8	4
3		**Professional Development**		
		• Workshop on career awareness • Training sessions for interviews • Industrial visit • Interaction with industrial experts • Create minor project	15	5
4		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** **Lectures, discussions, group activities, seminars, industrial visits and study tours**
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Total :** **25 marks** **Performance in activities Industrial visit** **report Project work**
	B. Semester end examination (50 marks)-1.5 hrs. Short answer questions – 20 marks (2 marks each – 10 out of 12 nos) Long answer questions – 30 marks (5 marks each – 6 out of 8 nos)

References

1. D .A. Skoog, J. J. Leary, *Instrumental Methods of Analysis*, Cengage India Private Limited, 2020.
2. D. A. Skoog, D. M. West, F. J. Holler, *Fundamentals of Analytical Chemistry*, 6th Ed., Cengage Learning India Pvt. Ltd., 2022.
3. D. C. Harris, *Quantitative Chemical Analysis* 7th Edn. W. H. Freeman and Co., New York, 2007
4. E. Helfman, *Chromatography*, Van Nostrand, Reinhold, New York
5. E. Lederer and M. Lederer, *Chromatography*, Elsevier, Amsterdam.
6. J. A. Dean, *Chemical separation methods*, Von Nostrand Reinhold, New York
7. R.P.W Scott, *Techniques and Practice of Chromatography*, Marel Dekker Inc., New York

SEMESTER 6

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Inorganic Chemistry-2**					
Type of Course	DSC A					
Course Code	SJC6DSCCHE300					
Course Level	**300-399**					
Course Summary	This course explores concepts of coordination chemistry, organometallic compounds and bioinorganic chemistry. This course also provides the basic analytical skills on qualitative and quantitative analysis of inorganic ions.					
Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any	**Inorganic Chemistry-1**					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Compare the theories of coordination chemistry	An	1,2
2	Explain the mechanisms of substitution reactions	U	1,2
3	Describe the key concepts of inorganic and organometallic chemistry	E	1,2
4	Illustrate stability of organometallic compounds, clusters and their application in industrial catalysts.	U	1, 2, 10
5	Explain the importance of various metal ions in biological systems	U	1,2,10
6	Analyse different complexes based on colourimetry and electronic spectra	An	1,2,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Coordination Chemistry- 2**		
	1.1	Merits and demerits of VBT and CFT	1	1
	1.2	Crystal field splitting in tetragonally distorted octahedral geometry, Jahn-Teller distortion in Cu (II) complexes.	2	1
	1.3	MO theory, evidences for metal-ligand covalency- Nephelauxetic effect, MO diagram of complexes of octahedral symmetry (sigma bonding only)	3	1
	1.4	Spectral and magnetic properties of metal complexes- d-d transition, electronic absorption spectrum of $[Ti(H_2O)_6]^{3+}$ ion. Charge transfer spectra e.g. $KMnO_4$, $K_2Cr_2O_7$ (Elementary idea). Types of magnetic behaviour, spin-only formula, calculation of magnetic moments.	3	1
	1.5	Reactivity of metal complexes-Labile and inert complexes	1	2
	1.6	Ligand substitution reactions : -S_N1 and S_N2 , ligand substitution reactions in square planar and octahedral complexes	3	2
	1.7	Trans effect- theories and applications- polarization and π-bonding theory.	2	1
2		**Organometallic Compounds**		
	2.1	Introduction to organometallic compounds, hapticity	1	3
	2.2	18- electron rule, numerical problems and stability	2	3
	2.3	Ferrocene: Preparation, structure, aromaticity and reactions (acetylation, alkylation).	2	3
	2.4	Metal-alkene complexes – Preparation and structure of Zeise's salt	1	3
	2.5	Catalytic properties of organometallic compounds - Zeigler Natta catalyst in the polymerization of alkene. Wilkinson catalyst in the hydrogenation of alkene (mechanism not expected).	2	4

	2.6	Preparation and structure of mononuclear carbonyls- $Mo(CO)_6$, $Fe(CO)_5$ and $Ni(CO)_4$	3	4
	2.7	Polynuclear carbonyls, bridged carbonyls and bonding in metal carbonyls – $Mn_2(CO)_{10}$ and $Fe_2(CO)_9$.	2	4
	2.8	Synergic effect and use of IR data in metal carbonyls to explain extent of back bonding	1	4
	2.9	Quadruple bond structure of $[Re_2CI_8]^{2-}$. Quintuple bond (non-evaluative)	1	4
3		**Introduction to Bioinorganic Chemistry**		
	3.1	Essential and non – essential metals	1	5
	3.2	Mechanism of ion transport- Ion pump (Na^+ and K^+)	2	5
	3.3	Porphyrins, Oxygen carriers- hemoglobin and myoglobin- structure and functions, oxygen transport mechanism, cooperativity effect, Bohr effect	3	5
	3.4	Cytochromes- Structure and functions of Cytochrome P-450	1	5
	3.5	Non-heme proteins- structure and functions of hemocyanin & hemerythrin	1	5
	3.6	Photosynthesis- Chlorophylls (Structure not needed) – Z-scheme (only)	2	5
	3.7	Electron transfer proteins- structure and functions of ferredoxin, rubredoxin. Zinc containing metalloenzymes: carbonic anhydrase and carboxypeptidase. Vitamin B_{12} (structure not expected)	3	5
	3.8	Toxicity of metals - Cd, Hg, Pb and Cr, with specific examples.	1	5
	3.9	Treatment of metal toxicity by chelation therapy (EDTA)	1	5
		Inorganic Chemistry-2 Practicals		
4	4.1	Colorimetric estimation of Fe, Cu, Ni, Mn, Cr, NH_4^+, nitrate and phosphate ions. Or UV- Visible spectral studies of different coordination compounds	15	6

	4.2	Study of the reactions of the following radicals with a view to their identification and confirmation. Pb^{2+}, Al^{3+}, Zn^{2+}, Mn^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, SJC $^{2+}$, NH_4^+, CO_3^{2-}, SO_4^{2-}, Cl^-, Br^-, CH_3COO^- Systematic qualitative analysis of mixtures containing two acid and two basic radicals from the above list without interfering radicals by Semi- micro method only. (Minimum of 5 mixtures to be analysed)	15	6
5	**Teacher-Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Peer teaching ● Demonstration of experiments ● Hands-on training
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment Theory: 25 marks** Quiz Assignment Class test **Practical : 15 marks** Lab involvement and skill Report of lab works done
	B. Semester end examination **Theory:** Written examination (50 Marks)-1.5 hrs i. MCQ 10 questions : 10 X 1 = 10 ii. Short answer 4 questions (out of 6): 4 X 3 =12 iii. Short essay 2 questions (out of 3): 2 X 7 = 14 iv. Essay 1 question (out of 2): 1 X 14 = 14 **Practical: (35 Marks)- 1 hr.**

	Viva voce: 10 marks Writing procedure: 15 marks Certified lab report: 10 marks

References

1. F.A. Cotton and G. Wilkinson, *Advanced Inorganic Chemistry*, 6th Edn., Wiley India Pvt. Ltd., New Delhi, 2009 (Reprint).
2. J.E. Huheey, E.A. Keitler and R.L. Keitler, *Inorganic Chemistry–Principles of Structure and Reactivity*, 4th Edn., Pearson Education, New Delhi, 2013.
3. D.F. Shriver and P. Atkins, *Inorganic Chemistry*, 5th Edn. Oxford University Press, New York, 2010. 4

   J.D. Lee, *Concise Inorganic Chemistry*, 5th Edn. Oxford University Press, New Delhi 2008.
5. R. Gopalan and V. Ramalingam, *Concise Coordination Chemistry*, 1st Edn., Vikas Publishing House, New Delhi, 2001.
6. B. D. Guptha and A. J. Elias *Basic Organometallic Chemistry, Concepts, Synthesis and Applications*, 2nd Edn. University Press 2013
7. I. Bertini, H. B. Gray and S. J. Lippard, J. S. Valentine, *Bioinorganic chemistry*, University Science Books, 1994.
8. J. A. Cowan, *Inorganic Biochemistry: An Introduction*, VCH Publishing, 1993.
9. W. Kaim, B. Schwederski, B. *Bioinorganic chemistry: Inorganic Elements in the Chemistry of Life*, Wiley, 2006
10. Jeffery, G.H., Bassett, J., Mendham, J. and Denney, R.C., Eds., *Vogel's Textbook of Quantitative Chemical Analysis*, 5th Edn., Longman Scientific and Technical, Harlow, 1989

SUGGESTED READINGS

1. W. Pfennig, *Principles of Inorganic chemistry*. John Wiley & Sons, 2015.
2. N. N. Greenwood, A. Earnshaw, *Chemistry of the Elements*, Butterworth-Heinemann, 2012.
3. Catherine E. Housecroft, Alan G. Sharpe C. E. Barnes, *Inorganic Chemistry* 4th Edn. Journal of Chemical Education, 2003.
4. *Synthesis of a Stable Compound with Fivefold Bonding Between Two Chromium(I) Centers*. SCIENCE, 4 Nov 2005 844-847, 10.1126/science.1116789

St. Joseph’s College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Physical Chemistry- 3</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSC A</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC6DSCCHE301</td></tr>
<tr><td>Course Level</td><td colspan="6">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course deals with the principles of surface chemistry, colloids, chemical kinetics, electrochemistry, and electromotive force.</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td></td><td>1</td><td></td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Assess different kinds of adsorption and adsorption isotherms.	E	1,2
2	Explain different types of colloidal systems, purification methods and properties of colloidal particles.	U	1,2
3	Interpret nature of various chemical reactions and describe the kinetics of parallel and chain reactions.	An	1,2
4	Make use of the principles of chemical kinetics to study the mechanism of homogeneous and heterogeneous catalysis.	A	1,2
5	Describe the mechanism and factors affecting electrolytic conductance. Analyse properties of electrolytic conductance.	A	1,2
6	Utilize conductance measurements in quantitative analysis.	A	1,2
7	Categorise different electrodes based on their function and apply Nernst equation to calculate electrode potential.	A	1,2
8	Apply the theoretical concepts of electrolytic conductance, adsorption and viscosity in practical experiments.	A	1, 2, 10
**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	SURFACE CHEMISTRY AND COLLOIDAL STATE			
1	1.1	Adsorption – types, adsorption of gases by solids – factors influencing adsorption, Freundlich adsorption isotherm, Langmuir adsorption isotherm –derivation of Langmuir adsorption isotherm.	5	1
	1.2	Types of solutions – true, colloid and suspensions, Classification of colloids: Lyophilic, lyophobic, macromolecular, multimolecular and associated colloids with examples, purification of colloids – ultra filtration and electrodialysis.	5	2
	1.3	Properties of colloids: Brownian movement, Tyndall effect, electrophoresis. Electrical double layer and zeta potential. Coagulation of colloids, Hardy- Schulz rule. Micelles and critical micelle concentration, sedimentation and streaming potential.	5	2
2	**CHEMICAL KINETICS**			
	2.1	Arrhenius equation, concept of activation energy, Collision theory - kinetic theory of collisions, steric factor. Types of complex reactions - consecutive reactions, opposing reactions, parallel reactions, Chain reactions. Steady state approximation.	5	3
	2.2	Catalysis: Homogeneous catalysis, enzyme catalysis – Heterogeneous catalysis – Surface catalysis, Elementary idea about Autocatalysis.	2	4
	ELECTROCHEMISTRY AND ELECTROMOTIVE FORCE			

3	3.1	Ionic mobility: - relation with ionic conductance (with derivation), influence of temperature on ionic conductance, ionic conductance and viscosity –	5	5

		Walden's rule. Abnormal ionic conductance of H^+ and OH^-.		
	3.2	Debye-Hückel theory of strong electrolytes – the concept of ionic atmosphere, asymmetry and electrophoretic effect, Debye- Hückel-Onsager equation (no derivation). Activity, mean ionic activity coefficient, ionic strength, Debye-Hückel limiting law (no derivation).	5	5
	3.3	Applications of conductance measurements – determinations of degree of dissociation of weak electrolytes, determination of solubility and solubility products of sparingly soluble salts, conductometric titrations involving strong acid- strong base, weak acid- strong base, strong acid- weak base, mixture of a strong acid and weak acid against strong base and precipitation titrations.	5	6
	3.4	Reversible cells - Daniel cell. Reference electrodes – Standard Hydrogen Electrode, Calomel electrode. Electrode potential – Electrochemical series. Representation of cells (IUPAC), Electrode reactions and cell reactions.	4	7
	3.5	Derivation of Nernst equation for electrode potential and cell potential, Calculation of equilibrium constant from EMF data. Applications of emf measurements – determination of pH using glass electrode. Potentiometric titrations- acid-base and redox reaction.	4	7
Physical chemistry – 3 Practicals				

4		Viscosity – Determination of viscosity of sucrose/glycerol. Determination of composition of binary liquid mixture using viscometry (toluene-nitrobenzene) Determination of molecular weight of a polymer using viscometry (polystyrene in toluene) Viscometry: Verification of Kendalls equation-full experiment 5. Conductometry • Determination of equivalent conductance of an electrolyte • Determination of dissociation constant and degree of dissociation of a weak acid • Verification of Onsager equation 6. Adsorption:	30	8
		• Verification of Freundlich and Langmuir adsorption isotherm - Charcoal Acetic acid or Charcoal-Oxalic acid system. • Determination of concentration of given acid using the isotherm		
5	**Teacher-Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture sessions, (chalk & board,powerpoint presentation) ● Interactive sessions and simulations, ● Visual aids like videos and models to enhance understanding. ● Peer discussions. ● Laboratory experiments and hands-on training

Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Theory :** **25 marks** Pop quiz Assignments Test for each unit (MCQ/written) **Practical : 15 marks** Lab involvement and skill Report of lab works done
	Semester end examination **Theory: Written examination (50 Marks)- 1.5 hrs** i. MCQ 10 questions : 10 X 1 = 10 ii. Short answer 4 questions (out of 6): 4 X 3 =12 iii. Short essay 2 questions (out of 3): 2 X 7 = 14 iv. Essay 1 question (out of 2): 1 X 14 = 14 **Practical: (35 Marks)-1 hr.** Viva voce: 10 marks
	Writing procedure: 15 marks Certified lab report: 10 marks

References

1. S. Glasstone, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd. 2006.
2. G. Raj, *Advanced Physical Chemistry*, Goel publishing house, 2016.
3. Glasstone and Lewis, Elements of Physical Chemistry, Macmillan, 1967.
4. S. H. Marron and J. B. Lando, *Fundamentals of Physical Chemistry*, Macmillan Ltd, 1974.
5. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd, 1996.
6. Puri, Sharma and Pathania, *Principles of Physical Chemistry*, 48th Edition, Vishal Publishing Company, 2020.

7. G. W. Castellan, *Physical Chemistry*, 4th Edn. Narosa Publishing House 2018.
8. K. L. Kapoor, *A Textbook of Physical chemistry*, Volume 5, 4th edition, Macmillan India Ltd., 2018.

Suggested Readings

1. R P W Atkins, Physical Chemistry, Oxford University Press (12th Edition), 2020.
2. G. M. Barrow, *Physical Chemistry*, Tata McGraw-Hill (2007).
3. D. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd., 2019.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**				
Course Name	**Organic Chemistry-4**				
Type of Course	DSE				
Course Code	SJC6DSECHE300				
Course Level	**300-399**				
Course Summary	This course examines the structure and biological importance of polypeptides, amino acids, proteins, nucleic acids, carbohydrates, natural products, lipids, vitamins, steroids, and hormones. Practical part of the course comprises extraction of natural products.				
Semester	VI	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Predict the synthetic pathway of polypeptides and amino acids	A	1,2
2	Identify the structure and biological importance of proteins and nucleic acids	A	1,2,3
3	Examine the structure, properties, and industrial applications of carbohydrates	An	1,2
4	Predict the interconversion of carbohydrates	A	1,2

5	Identify the structure and properties of natural products and lipids	A	1,2
6	Describe the classification structure and biological significance of vitamins, steroids, and hormones	U	1,2,3
7	Make use of theory to synthesis and extract various components of oils and tea leaves	A,S	1,2,3,4,10
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	**Units**	**Course description**	**Hrs**	**CO No.**
1		**Amino Acids, Peptides, Proteins and Nucleic Acids**		
	1.1	Amino Acids-Classification. Synthesis- Gabriel phthalimides synthesis, Strecker synthesis, Ionic properties and Ninhydrin reaction. Zwitterion structure and Isoelectric point.	4	1
	1.2	Polypeptides- Synthesis -DCC method. Merrifield's solid phase peptide synthesis.	3	1
	1.3	Primary, secondary, tertiary and quaternary structure of proteins: α-helix and β-pleated sheets. Denaturation of proteins.	4	2
	1.4	Nucleicacids: Components of nucleic acids, nucleosides and nucleotides. Structure of DNA, Watson, and Crick model. Differences between DNA and RNA. Protein biosynthesis, Replication of DNA	4	2
		Carbohydrates		

2	2.1	Classification of carbohydrates.	1	3
	2.2	Fischer and Haworth projections of glucose and fructose. Cyclic structure of glucose. Reactions of	4	3

		glucose and fructose - osazone formation, Tollen's reagent.		
	2.3	Epimers, mutarotation and anomers.	3	3
	2.4	Chain lengthening and chain shortening of aldoses - Kiliani-Fischer synthesis and Wohl degradation. Interconversion of aldoses and ketoses.	3	4
	2.5	Sucrose-Structure, reactions and uses of sucrose	1	3
	2.6	Structure and properties of starch and cellulose (elementary idea). Industrial applications of cellulose.	3	3
3		**Natural products, Lipids ,Vitamins, Steroids and Hormones**		
	3.1	Natural products. Terpenoids: Classification, isoprene rule. Essential oils - citral and geraniol –chemical properties and uses. Alkaloids: Classification based on source, isolation, general properties, physiological effects of coniine and nicotine.	4	5
	3.2	Lipids. Oils and fats: Biological functions. Trans fat and their effect. Hydrogenation, Rancidity. Acid value, Saponification value, Iodine value and RM value. Soaps - Types and cleansing action. Synthetic detergents - Comparison between soaps and detergents.	5	5

	3.3	**Vitamins**. Classification, structure, biological functions and deficiency diseases of vitamins A, B_{12} and C	2	6
	3.4	**Steroids** Diels' hydrocarbon. Structure and functions of cholesterol. Elementary idea of HDL and LDL.	2	6

	3.5	**Hormones** Biological functions of steroid hormone - Estrogen, peptide hormone-Insulin and amine hormone–Thyroxine. (Structure not required). Artificial hormone –Birth control pill.	2	6
		Organic Chemistry IV Practical		
4	4.1	1. Extraction of caffeine from tea leaves/tea dust powder 2. Extraction of volatile oils by Clevenger's method (Hydro distillation method). 3. Solvent extraction -isolation of lycopene from tomato 4. Determination of saponification value of the fat and oils by taking any real sample 5. Determination of acid value of the fat and oils by taking any real sample	30	7
5	**Teacher-Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** • Lecture (chalk & board, powerpoint presentation) Group discussion • Peer teaching • Demonstration of experiments • Hands-on training

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory: 25 marks** Quiz /Assignment /Class test **Practical : 15 marks** Lab involvement and skill Report of lab works done

	B. Semester end examination **Theory: Written examination (50 Marks)-1.5 hrs.** i. MCQ 10 questions : 10 X 1 = 10 ii. Short answer 4 questions (out of 6): 4 X 3 =12 iii. Short essay 2 questions (out of 3): 2 X 7 = 14 iv. Essay 1 question (out of 2): 1 X 14 = 14 **Practical: (35 Marks)-1 hr.** Viva voce: 10 marks Writing procedure: 15 marks Certified lab report: 10 marks

References

1. Clayden, J; Greeves, N; Warren, S. *Organic chemistry*; Oxford University Press, 2012.
2. Finar, I. L. *Organic Chemistry*; Vol. 1& 2; Dorling Kindersley (India) Pvt. Ltd (Pearson Education).
3. McMurry, J. *Organic Chemistry*; 7th Edn. Cengage Learning, 2013.
4. Morrison, R.T.; Boyd, R.N.; Bhattacharjee, S.K. *Organic Chemistry*; 7th Edn.; Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
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9. Norman, R. O. C.; Coxon, J. M. *Principles of Organic Synthesis*; Routledge, 2017.
10. Pine, S. H. *Organic Chemistry*; Tata McGraw-Hill, 2014.
11. Furniss, B. S.; Hannaford, A. J.; Rogers, V.; Smith, P. W. G.; Tatchell, A. R. *Vogel's Textbook of Practical Organic Chemistry*; 5th Edn.; Pearson Education, 2005.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Rubber Technology**					
Type of Course	DSE					
Course Code	SJC6DSECHE301					
Course Level	**300-399**					
Course Summary	This course explores the basic aspects of rubber its modifications and Applications					
Semester	VI	Credits				Total Hours
Course Details	Learning Approach					
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the basics of rubber and latex chemistry	U	1,2,3
2	Apply knowledge on different aspect of Vulcanization and Compounding in rubber	A	1,2,3
3	Understand the different application of rubber in different sectors	U	1,2,3
4	Analyse physical and chemical properties of latex and dry rubber	An, S	1,2,3,10
Remeber (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), e Intpreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		Natural rubber and latex		
1	1.1	Origin – Natural Rubber Latex, tapping, processing, properties and applications – Conversion of Latex into dry rubber – Properties of dry rubber – Classification based on technical specifications Natural rubber, isoprene rubber, butyl rubber, nitrile rubber, chloroprene rubber and styrene-butadiene rubber	8	1
	1.2	Definition of latex, classification, latex particle size and distribution, stability and destabilization of lattices, comparison between lattices and polymer solution Natural rubber latex –origin, tapping, bulking and preservation, composition of field latex, properties, preservation, methods of concentrating latex - creaming, centrifuging, & evaporation,– Specification and testing- (national and ISO) for latex grades (ASTM D 1076)	7	1
2		**Vulcanization and Compounding**		
	2.1	Theory and mechanism of sulphur and non-sulphur vulcanization (with and without accelerators), rheo-curve of compounded rubber, properties of vulcanized rubber - Vulcanizing ingredients & their sequence of mixing: Activators and accelerators: mechanisms of action. Other cure systems based on metal oxides, peroxides, etc. retarders, inhibitors anti-reversion agents.	4	2

	2.2	Fillers: Carbon black-Its preparation, structure, properties and their effect on rubber properties. Silica fillers & coupling agents. Other fillers: Clay, calcium carbonate, titania etc. Nano-fillers: Reinforcement by filler: Reinforcement, factors influencing elastomers reinforcement, fillers characteristics, main effects of fillers on vulcanizate properties, influence of fillers characteristics on the cross linking process, filler incorporation, the role of bound rubber, reinforcement and crosslink density.	6	2
	2.3	Processing aids, plasticizers, process additives, release agents, Other additives like colourants, blowing agents, factice, fire retardants, antistatic agents, deodorants and reodorants, biocides and fungicides etc. Anti-degradants: Introduction, autoxidation of hydrocarbon polymers, amine & phenolic antioxidants & other types, anti-zonants, Prevention of ozone attack with the use of waxes & saturated polymer for ozone protection.	5	2
3	**Application of Rubber in Different Sectors**			
	3.1	Functions of tyres– Role of rubber and unique properties of rubbers for the applications. Tyre constructions – generic design features and materials. Tubeless tyres – comparison. Mechanics of rubber – Cord composites. Inflation pressure – Contact area, tyre deflections – Design factors and principles. Classifications of tyres – Essential design criteria. Rolling resistance, friction, mechanical loss on tyre behaviour. Tyre endurance and life related properties	8	3

	3.2	Overview of rubber's use in various industrial and consumer products such as hoses, belts, gaskets, and seals, as well as in footwear, sports equipment, and household items. Medical Devices: Examination of rubber's critical role in healthcare, including in the manufacture of gloves, catheters, contraceptives, and various medical devices where flexibility and biocompatibility are essential. Aerospace Industry: Discussion on the use of rubber in the aerospace industry, such as in seals, gaskets, and fuel tank linings, highlighting rubber's resistance to extreme temperatures and conditions.	7	3
4	**Rubber Technology Practicals**			
	4.1	I. Latex Analysis 1. Determination of total solid content of latex 2. Determination of alkalinity of latex 3. Determination of dry rubber content of latex . Determination of volatile fatty acid number of latex 5. Determination of viscosity of latex 6. Determination of KOH number 7. Determination of coagulum 8. Determination of sludge . Determination of mechanical stability time (MST) 10. Determination of density II. Dry Rubber Analysis 1. Determination of dirt 2. Determination of Po and PRI 3. Determination of ash 4. Determination of nitrogen 5. Determination of volatile matter III. Mixing behaviour of NR on two roll mill	30	4
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures (Chalk & Board, Multimedia presentations) Group Discussions Case studies Quizzes
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Theory : 25 marks** Quiz Assignment Problem based test - Open book Written exam **Practical : 15 marks** Lab involvement and skill Report of lab works done
	B. Semester End examination **Theory: Written examination (50 Marks)- 1.5 hrs.** i. MCQ 10 questions : 10 X 1 = 10 ii. Short answer 4 questions (out of 6): 4 X 3 =12 iii. Short essay 2 questions (out of 3): 2 X 7 = 14 iv. Essay 1 question (out of 2): 1 X 14 = 14 **Practical: (35 Marks)-1 hr.** Viva voce: 10 marks Writing procedure: 15 marks Certified lab report: 10 marks

References

1. J.A. Brydson, *Rubber Chemistry*, Allied science Publishers, London, 1978.
2. M. Morton, *Rubber Technology*, Chapman Hall, 1995.
3. R.C. Klingender, *Handbook of speciality elastomers*, CRC Press, 2008.
4. J.K. Setright, *Automobile Tyre*, Chapman and Hall, 1972.
5. S. Blow, *Hand Book of Rubber Technology*, Hanser Gardner, 2000.

6. J. M. Martin and W.K. Smith, *Handbook of Rubber Technology*, CBS Publisher 2007

7. J. E. Mark, B. Erman, M. Roland, *The Science and Technology of Rubber*, Academic Press, 2013

8. J. Urbanski, W. Czerwinski, K. Janicka, *Handbook for analysis of synthetic polymer and plastics,* Ellis Harwood Ltd. 1977

9. W.C. Wake, *Analysis of Rubbers and Rubber like Polymers*, 2nd Edn, Wiley Interscience, 1969.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Industrial Inorganic Chemistry and Nuclear Chemistry**
Type of Course	DSE
Course Code	SJC6DSECHE302
Course Level	**300-399**
Course Summary	This course is designed to provide students with a comprehensive understanding of the industrial processes involved in the production of inorganic compounds and the principles governing nuclear reactions.

Semester	VI	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse different industrially important inorganic materials.	An	1,2, 6
2	Evaluate the important processes involved in metallurgy	E	1,2 ,6
3	Explain the catalytic properties of inorganic materials	E	1,2,6
4	Illustrate the basics of chemical explosives and rocket propellants	U	1,2,6,10
5	Analyse different aspects of nuclear chemistry, its applications and associated problems.	An	1,2,6,10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Glass, Ceramic and Cements			
1	1.1	**Glass-**Glassy state and its properties, classification (silicate and non-silicate glasses). Manufacture and processing of glass. Composition and properties of: Soda lime glass, lead glass, armoured glass, safety glass, borosilicate glass, fluorosilicate glass, coloured glass and photosensitive glass.	5	1
	1.2	**Ceramics -**Important clays and feldspar, ceramic, their types and manufacture. High technology ceramics and their applications. Bioceramics.	5	1
	1.3	**Cement-**Classification of cement, ingredients and their role, manufacture of cement and the setting process, quick setting cements. Biocement- Living building materials	5	1
2		**Metallurgy**		
	2.1	Minerals in India, mineral processing, chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agents.	5	2
	2.2	Electrolytic reduction, hydrometallurgy with reference to cyanide process for silver and gold. Methods of purification of metals: electrolytic process, Van Arkel-de Boer process and Mond's process, Zone refining.	7	2
	2.3	Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.	3	2
	Introduction to Chemical Explosives, rocket propellants and catalysis			

3	3.1	General principles and properties of catalysts, homogenous catalysis, and heterogenous catalysis (catalytic steps and examples), their industrial applications, deactivation, or regeneration of catalysts. Phase transfer catalysts, application of zeolites and metal organic frameworks as catalysts.	7	3
	3.2	Origin of explosive properties in inorganic compounds. Categorisation of explosives (low explosives – high explosives – primary, secondary, intermediary, tertiary). Explosive properties of Gun powder, lead azide, TNT, PETN, cyclonite (RDX).	6	4
	3.3	A Brief History and introduction of chemical rocket propellants. Liquid propellants, ecofriendly propellants and solid propellants	2	4
	Nuclear Chemistry			
4	4.1	Nucleus and its classification, nuclear forces, nuclear stability, binding energy, nuclear models. Radioactive decay, radioactive elements, general characteristics of radioactive decay, decay kinetics - decay constant, half- life, mean life period, units of radioactivity.	5	5
	4.2	Measurement of radioactivity, Geiger-Muller detector, scintillation detectors, nuclear reactor: classification of reactors, uranium reactor, breeder reactor. Nuclear reactors in India (Brief Idea). Nuclear fusion and stellar energy. Units of radiation energy (Rad, Gray, Rontgen)	5	5
	4.3	Nuclear pollution and radiological safety: interaction of radiation with matter, radiolysis of water, radiation dosimetry. Radioactive isotopes and their applications, isotopic dilution analysis, neutron activation analysis, disposal of nuclear waste, nuclear disaster (nuclear accidents–case study).	5	5
5	**Teacher-Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture (chalk & board, powerpoint presentation) Group discussion Peer teaching Industrial Visit/ visit to a nuclear Reactor (IGCAR/KNPP etc.)
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks**

	Quiz Class test for each unit (MCQ/written)
	B. Semester end examination **Theory: Written examination (70 Marks) -2 hrs.** i) Short answer 5 questions (out of 6): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. Stocchi, *Industrial Chemistry*, Vol-I , Ellis Horwood Ltd. UK, 1990
2. R. M. Felder and R. W. Rousseau, *Elementary Principles of Chemical Processes*, Wiley Publishers,
3. New Delhi, 2004
4. J. A. Kent, *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi, 1997.
5. W. D. Kingery, H. K. Bowen and D. R. Uhlmann, *Introduction to Ceramics*, Wiley Publishers, New Delhi, 2012.
6. P. C. Jain and M. Jain, Engineering Chemistry, Dhanpat Rai & Sons, Delhi, 2015.
7. R. Gopalan, D. Venkappayya, S. Nagarajan, *Engineering Chemistry*, 4th Edn.Vikas Publications, New Delhi.
8. K. Sharma, *Engineering Chemistry*, Goel Publishing House, Meerut, 2000.
9. S.F. Sarner, *Propellant Chemistry*, Reinhold Publishing Co., 1966
10. T. Urbanski, *Chemistry and Technology of Explosives* Vol.I to IV, Pergamon Press, 1984
11. Harvey, B. G. *Introduction to Nuclear Physics & Chemistry*, Prentice – Hall, 2012.

12. Overman R. T, *Basic concept of Nuclear Chemistry*, Chapman & Hall, 1963.
13. N. Nesmeyanov, *Radiochemistry*, MIR Publication, Moscow.
14. J. W. T. Spinks, R.J. Woods R. J. *An Introduction to Radiation Chemistry*, 3rd Edn. Wiley–Blackwell, 1990.
15. H.J. Arnikar, *Essentials of Nuclear Chemistry*, 4th Edn. New Age International Private Limited, 2011.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Spectroscopic Methods of Chemical Analysis**					
Type of Course	**DSE**					
Course Code	SJC6DSECHE303					
Course Level	**300-399**					
Course Summary	This course covers various spectroscopic methods, including principles, instrumentation and applications.					
Semester	VI	Credits				Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4		0		60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Discuss instrumentation in IR, NMR and electronic spectroscopic techniques.	U	1,2
2	Describe the fundamental principles of Raman, EPR, NQR, Mossbauer, Fluorescence and X-ray spectroscopic techniques in chemical analysis.	U	1,2
3	Evaluate the advantages and limitations of Raman spectroscopy, EPR spectroscopy and NQR spectroscopy in different scientific and industrial applications.	E	1,2,10
4	Assess the utility of Mössbauer spectroscopy, Fluorescence spectroscopy and X-ray spectroscopy in various fields.	E	1,2
5	Describe the fundamental principles of AAS, AES and FES.	U	1,2
6	Compare and contrast the advantages and limitations of AAS, AES, and FES in elemental analysis.	U	1,2

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Instrumentation in Electronic, IR and NMR Spectroscopic Techniques			
1	1.1	Instrumentation in UV/ Visible Spectroscopy: Light sources, wavelength dispersion (gratings, prisms, interference filters, lasers).Sample holders, detection of signals (photocells, photo multipliers, and diode arrays), Sensitivity and S/N ratio. Single and double beam instruments.	5	1
	1.2	Instrumentation in IR Spectroscopy: Light sources, infrared detectors, sample preparation techniques; liquids, solids. Dispersive I R spectrometer. (FTIR- basic idea only)	5	1
	1.3	Instrumentation in NMR Spectroscopy: Magnet: Types of magnets used in NMR (permanent, resistive, superconducting), Probes and RF coils. Sample handling and temperature control.	5	1
	Raman and EPR Spectroscopic Techniques			
2	2.1	Raman Spectroscopy: Scattering of light, polarizability and classical theory of Raman spectrum, rotational and vibrational Raman spectrum, Stokes and anti-Stokes lines: their intensity difference, complementarities of Raman and IR spectra, mutual exclusion principle, applications of Raman spectroscopy.	8	2,3
	2.2	EPR Spectroscopy: Electron spin in molecules, interaction with magnetic field, g factor, factors affecting g values, fine structure and hyperfine structure, Kramers' degeneracy, applications of ESR spectroscopy.	7	2,3
3	**NQR, Mossbauer and Fluorescence Spectroscopic techniques**			
	3.1	Theory and important applications of NQR Spectroscopy.	3	2,3
	3.2	Mossbauer Spectroscopy: Principle, Doppler effect, recording of spectrum, chemical shift, factors determining chemical shift, application to complexes of iron.	6	2,4

	3.3	Fluorescence Spectroscopy. Instrumentation: light source, monochromator, optical filters, photomultiplier tube, polarizers, application- fluorescence sensing.	6	2,4
4		**Atomic Spectroscopic Techniques**		
	4.1	Atomic absorption spectroscopy (AAS), principle of AAS, absorption of radiant energy by atoms, measurement of atomic absorption, instrumentation: Radiation Sources, Atomizers, Detectors. Analytical Applications of AAS.	5	5,6
	4.2	Atomic emission spectroscopy (AES), advantages and disadvantages of AES, origin of spectra, principle and instrumentation, applications.	5	5,6
	4.3	Flame emission spectroscopy (FES), flames and flame temperature, spectra of metals in flame, instrumentation, applications.	5	5,6
5		**Teacher Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture sessions, interactive sessions including discussions and demonstrations, to engage students actively and visual aids like presentations and videos to enhance understanding. Utilize case studies from various scientific fields (like environmental science, pharmaceuticals, forensics) to illustrate how spectroscopy is applied practically. Form study groups to discuss concepts, compare approaches, and explain concepts to one another.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Total marks: 30** Assignment MCQ Class test Viva
	B. **Semester end examination (70 marks)- 2 hrs.** i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 **iii)** Essay 1 question (out of 2): 1 X 15 = 15

References

1. J W. Robinson, E M S Frame, and G M. Frame II, *Instrumental Analytical Chemistry*, CRC Press, 2021.
2. F A Settle, *Handbook of Instrumental Techniques for Analytical Chemistry*, Prentice Hall, 1997.
3. J W. Robinson, E M S Frame and G M. Frame II, *Undergraduate Instrumental Analysis*, 7^{th} Edn. CRC Press, 2014.
4. D A. Skoog, D M. West, F. J Holler and S R. Crouch, *Fundamentals of Analytical Chemistry*, 9^{th} Edn. Brooks/Cole, 2014.
5. C N Banwell, E M McCash, *Fundamentals of Molecular Spectroscopy*, 4^{th} Edn. McGraw-Hill Publishing Company, 2017.
6. Aruldhas, *Molecular Structure and Spectroscopy*, 2^{nd} Edn. Prentice Hall India, 2007.
7. D A. Skoog, F. J Holler and S R. Crouch, *Principles of Instrumental Analysis*, 7^{th} Edn. Brooks/Cole, 2020.
8. P. Gupta, S. S. Das and N. B. Singh, *Spectroscopy*, Jenny Stanford Publishing, 2023.

St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Fundamentals of Biochemistry</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC6DSECHE304</td></tr>
<tr><td>Course Level</td><td colspan="6">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course covers structure and biological functions of amino acids, proteins, enzymes, carbohydrates, nucleic acids and lipids and general features of metabolism.</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td></td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain fundamental features of biochemistry such as functions of subcellular organelles, membranes and membrane transport,	U	1,2
2	Analyse the classification, properties and functions of amino acids, proteins, enzymes, lipids and carbohydrates.	An	1,2
3	Describe the catalytic activity of enzymes and enzyme inhibition	U	1,2
4	Examine the functions of DNA and RNA	E	1,2
5	Analyse various metabolic pathways and phases.	An	1,2

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Foundations of Biochemistry**		
	1.1	Introduction to biochemistry: scope of biochemistry, historical development and significance	2	1
	1.2	Subcellular organelles: nucleus, endoplasmic reticulum, golgi apparatus, lysosomes, peroxisomes and mitochondria. Marker enzymes.	5	1
	1.3	Plasma membrane and membrane proteins.	2	1
	1.4	Membrane transport: active and passive transports and pumps. Ion channels, ligand-gated channels, voltage-gated channels, ionophores. Sodium pump and calcium pump.	6	1
		Amino acids and Proteins		
2	2.1	Amino acids Classification-based on structure, side chain, metabolism and nutritional requirements. Physical properties of amino acids, isoelectric point, optical activity and peptide bond formation. Colour reactions of amino acids and proteins- ninhydrin, biuret and xanthoproteic tests.	6	2
	2.2	Peptides and proteins. Primary structure and numbering of amino acids in proteins. Secondary structure- alpha helix and beta pleated sheets. Tertiary structure- relationship between structure and function of proteins. Quaternary structure of proteins.	5	2
	2.3	Classification of Proteins based on function, composition, shape and nutritional value.	2	2
	2.4	Physical properties and precipitation reactions of proteins. Quantitative estimation of proteins by Kjeldahl's method.	2	2
3		**Enzymes**		
	3.1	Enzymes; Characteristics, six major classes of enzymes, IUMB system of classification of enzymes-explanation with one example.	6	2

		Coenzymes- Classification, nicotinamide adenine dinucleotide (NAD^+) and coenzyme A. Cofactors. Metallo-enzymes.		
	3.2	Catalytic power and specificity of enzymes. Mode of action of enzymes- active site, substrate binding, lock and key principle, induced-fit model, entropy effect and stabilisation of transition state. Coupled reactions.	7	3
	3.3	Enzyme inhibition- types.	2	3
4	**Carbohydrates, Nucleic acids, Lipids and Metabolism**			
	4.1	Carbohydrates- Biological functions of mono, di and polysaccharides. Regulation of Blood Glucose; insulin and diabetes mellitus.	4	2
	4.2	Nucleotides and nucleic acids, DNA and RNA, functions of DNA and RNA.	4	4
	4.3	Lipids- classification of lipids and fatty acids and functions of lipids.	3	2
	4.4	Metabolism: types of metabolic pathways, phases of metabolism, metabolic profile of brain, skeletal muscles and liver.	4	5
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture sessions, interactive sessions including discussions and demonstrations, to engage students actively and visual aids like presentations and videos to enhance understanding.
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA) Total marks : 30** Assignments MCQ Class test Viva
	B. Semester end examination (70 marks) -2hrs. i) Short answer 5 questions (out of 6): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35

	iii)	Essay 1 question (out of 2): 1 X 15 = 15

References

1. D M Vasudevan, S Sreekumari, *Textbook of Biochemistry for Medical Students*, Jaypee Brothers Medical Publishers, 2023.
2. Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Biochemistry*, 7th Edn. W. H. Freeman., 2021.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L. *Biochemistry*. 9th Edn. W.H. Freeman and Co., 2019.
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6. R Singh, R Goyal, *Lippincott's Illustrated Reviews – Biochemistry*, 2020.
7. P Naik, *Biochemistry*, Jaypee Brothers Medical Publishers, 2022.
8. H. P. Gajera, S. V. Patel, B. A. Golakiya, *Fundamentals of Biochemistry*, IBDC, 2000.

SUGGESTED READINGS

1. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. *Harper's Illustrated Biochemistry*. XXVIII edition. Lange Medical Books/ McGraw-Hill, 2009.

St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Data Analysis using Python and Soft skills</td></tr>
<tr><td>Type of Course</td><td colspan="6">SEC</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC6SECCHE300</td></tr>
<tr><td>Course Level</td><td colspan="6">300- 399</td></tr>
<tr><td>Course Summary</td><td colspan="6">This interdisciplinary course provides a comprehensive exploration of scientific investigation, statistical analysis, and python programming in the context of chemistry.</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td></td><td></td><td></td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Apply scientific methods for designing experiments systematically	A	1,2,3
2	Interpret data using various statistical tools.	U	1,2,3
3	Understand the basics of Python	U	1,2,3
4	Utilize Python in data visualization and analysis	A	1,2,3
5	Develop ideas in chemistry that can be grown into startups	C	4,5,9,10
6	Develop comprehensive scientific communication skills	C	4,10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transactions (Units)

Module	Units	Course description	Hrs	CO No.
1		**Data Analysis**		
	1.1	**The Investigative Approach**: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.	3	1
	1.2	**Analysis and Presentation of Data**: Descriptive statistics. Choosing and using statistical tests.	4	1,2
	1.3	**Chemometrics**. Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r, and its abuse. Basic aspects of multiple linear regression analysis.	8	2
2		**Introduction to Python**		
	2.1	Introduction to Python Programming Defining numbers, Variables, Strings, Lists and Loops, Comparisons of flow control, functions, data structures, file input/output, Basic Numppy	9	3
	2.2	Data Visualization with Python Matplotlib, drawing line plots with a single line, line plots with multiple line, adding legend, drawing bar plots, scatter plots, plot title and axis labels. Saving plots,	6	4
3		**Soft skills for chemists**		
	3.1	● Presentation on a hypothetical start-up idea incorporating chemistry background. ● Review of recent research articles (writing) ● Poster design and presentation skills ● Plotting of data using different software (excel, origin etc.) ● Fitting of data	15	5,6
4		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)**

	Lectures, demonstrations, discussions, hands-on training, seminars, presentations and assignments.
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Total marks: 25 marks** Presentation writing skills Data analysis skill Examination
	Semester end examination Total marks:50 marks-1.5 hrs Short answer questions – 20 marks (2 marks each – 10 out of 12 nos) Long answer questions – 30 marks (5 marks each – 6 out of 8 nos)

References

1. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
2. D. Topping, J. (1984) *Errors of observation and their treatment*. Fourth Ed., Chapman Hall, London.
3. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
4. *Python Crash Course- A Hands-on, Project Based Introduction to Programming*, Eric Matthes, no starch Press, 2016 edition
5. Open access Python tutorials
6. Christian Hill. (2020). *Python for Chemists*. Cambridge University Press
7. Bindner, Donald & Erickson, Martin. (2011). *A Student's Guide to the Study, Practice, and Tools of Modern Mathematics.* CRC Press, Taylor & Francis Group, LLC.
8. Lamport, Leslie (1994). LaTeX: A Document Preparation System, User's Guide and Reference Manual (2nd ed.). Pearson Education. Indian Reprint.

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Intellectual Property Rights</td></tr>
<tr><td>Type of Course</td><td colspan="6">VAC</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC6VACCHE300</td></tr>
<tr><td>Course Level</td><td colspan="6">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course covers various aspects of intellectual property law, including patents, trademarks, and copyrights.</td></tr>
<tr><td>Semester</td><td>VI</td><td colspan="3">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td></td><td></td><td></td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Analyse the fundamental principles of intellectual property rights, distinguishing between patents, copyrights, and trademarks.	An	1,2
2	Interpret the ethical and legal implications of intellectual property infringement in diverse contexts.	U	1,2
3	Evaluate the criteria for patentability, including novelty, non-obviousness, and utility.	E	1,2
4	Identify the fundamental concepts and legal framework surrounding trademarks.	U	1,2
5	Analyse and interpret the fundamental principles and theories underlying copyright law.	An	1,2

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**INTRODUCTION TO IPR**		
	1.1	Meaning of property, origin, nature, meaning of intellectual property rights	4	1
	1.2	Kinds of Intellectual property rights—copy right, patent, trade mark, trade secret and trade dress, design, layout design, geographical indication, plant varieties and traditional knowledge.	7	1,2,4
	1.3	Significance of IPR and their protection	3	1,2
2		**INTERNATIONAL ORGANIZATIONS & TREATIES**		
	2.1	Paris Convention for the Protection of Industrial Property, Patent Cooperation Treaty (PCT), World Trade Organization (WTO)	5	1,2,3
	2.2	Trade Related Aspects of Intellectual Property TRIPS, TRIMS, WIPO	5	1,2,3
	2.3	Budapest treaty on the international recognition of the deposit of microorganisms for the purpose of patent procedure, international convention for the protection of new varieties of plants (UPOV)	5	1,2,3
3		**PATENT RIGHTS AND COPYRIGHTS**		
	3.1	Types of patents, inventions which are not patentable, the patent's act 1970- patentable invention, registration procedure, rights and duties of patentee, assignment and licence, restoration of lapsed patents, surrender and revocation of patents, infringement, remedies & penalties.	10	1,2,3
	3.2	Types of copyright, registration procedure, assignment & licence, terms of copyright, piracy, infringement, remedies, copy rights with special reference to software	5	1,2,5
4		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, discussions, group activities and presentations by students.

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Total marks: 25** Assignments Examination Viva Classroom participation (participation in class activities)
	B. Semester end examination **Total marks: 50-1.5 hrs.** i) MCQ 9 questions : 9 X 1 = 9 ii) Short answer 5 questions (out of 7): 5 X 4 =20 iii) Short essay 3 questions (out of 5): 3 X 7 = 21

References

1. G.B. Reddy, *Intellectual Property Rights and the Law*, Gogia Law Agency, 2017.
2. B.L.Wadehra, *Law relating to Intellectual Property*, Universal Law Publishing Co, 2017.
3. P. Narayanan, *Intellectual Property Law*, Eastern Law House, 3rd Edn. 2023.
4. S.R. Myneni, *Law of Intellectual Property*, Asian Law House, 2019.
5. R K Singh. A Banerjee, *Intellectual Property Rights*, Gogia Law Agency, 2022.
6. V K Ahuja, *Law Relating To Intellectual Property Rights*, LexisNexis, 2017.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Research Methodology for Chemistry**
Type of Course	VAC
Course Code	SJC6VACCHE301
Course Level	**300-399**
Course Summary	This course covers a wide range of topics aimed at preparing students to conduct a scientific project in chemistry. The aim is to equip students with the skills and knowledge necessary to design, conduct, analyse, and communicate scientific research effectively in the field of chemistry.

Semester	VI	Credits			3	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3				45
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply the tools for literature survey in chemistry in doing and reporting a chemistry project.	A	1,2
2	Describe the methodology of scientific research.	U	1,2
3	Apply the knowledge of scientific writing in preparing a project report.	A	1,2
4	Discuss the ethical aspects of chemistry research.	U	1,2
5	Apply the basic principles of research methodology in the conducting, reporting and presenting a chemistry project.	A	1,2

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Literature Survey**		
	1.1	Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples	6	1
	1.2	Digital: Web resources, E-journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki- Databases, ChemSpider, Science Direct, Beilstein, SciFinder, Scopus. Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.	9	1
2		**Methods of Scientific Research and Writing Scientific Papers**		
	2.1	Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation.	5	2,3
	2.2	Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work.	5	2,3
	2.3	Ethical challenges in chemistry research, Responsible conduct of research, Writing Ethics, Avoiding plagiarism.	5	4
3		**Training on writing a project report**		
	3.1	❖ Project selection ❖ Literature Survey ❖ Conducting the project ❖ Preparing a report ❖ Preparing and displaying a poster ❖ ICT enabled oral presentation	15	1,2,3,4,5
4		**Teacher-Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, discussions, group activities and presentations by students.
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Total marks : 25** Poster presentation Oral presentation Project report Classroom participation (participation in class activities)
	B. Semester end examination Total marks : 50-1.5 hrs. i) MCQ 9 questions : 9 X 1 = 9 ii) Short answer 5 questions (out of 7): 5 X 4 =20 iii) Short essay 3 questions (out of 5): 3 X 7 = 21

References

1. A T Tyowua, *A Practical Guide to Scientific Writing in Chemistry: Scientific Papers, Research Grants and Book Proposals*, CRC Press. 2023.
2. F. H. Jardine, *How to do your Student Project in Chemistry*, Springer, 1994.
3. A M. Coghill and L R Garson, *The ACS Style Guide: Effective Communication of Scientific Information*, Oxford University Press, 2006.
4. V Bairagi, M V. Munot, *Research Methodology: A Practical and Scientific Approach*, CRC Press, 2019.
5. H G Deal, *Science Research Writing for Native and Non-Native Speakers of English*. World Scientific Publishing Europe Ltd, 2020.
6. D Angelo, G John, *Ethics in Science: Ethical Misconduct in Scientific Research*, Chapman and Hall/CRC, 2018.
7. https://www-library.ch.cam.ac.uk/list-useful-databases
8. https://fordham.libguides.com/Chemistry/Databases

SEMESTER 7

St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Coordination and Organometallic Chemistry</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCC</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC7DCCCHE400</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course provides a comprehensive understanding of the structure, bonding, and reactivity of coordination complexes, electronic spectral properties, synthesis, and catalytic applications of organometallic compounds.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td></td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Inorganic Chemistry-2</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Compare the stability of metal complexes.	E	1,2
2	Examine the structure and bonding in coordination and organometallic compounds using the concepts of crystal field theory and molecular orbital theory.	An	1,2
3	Construct correlation diagrams and explain the spectral properties of metal complexes.	A	1,2
4	Analyse the reactions of organometallic compounds.	An	1,2
5	Examine the catalytic properties of various organometallic compounds and their applications.	An	1,2,10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Structure and Bonding in Coordination Complexes**		
	1.1	Classification of complexes based on coordination numbers and possible geometries, σ and π bonding ligands such as CO, NO, CN^-, R_3P, and Ar_3P.	2	1
	1.2	Stability of complexes, kinetic and thermodynamic aspects of complex formation - Irving William order of stability.	2	1
	1.3	Splitting of *d* orbitals in octahedral, tetrahedral, square planar, square pyramidal and triagonal bipyramidal fields.	2	1
	1.4	Crystal Field Stabilization Energy (CFSE) and Dq values, Jahn Teller (JT) distortion (d^1 – d^{10} systems), static and dynamic JT distortion, consequences of JT distortion, theoretical failure of crystal field theory, Ligand Field Stabilization Energy (LFSE) and evidence of covalency in the metal-ligand bond.	4	1
	1.5	Ligand field theory and molecular orbital theory - diagrams for octahedral and tetrahedral complexes without and with π-bonding, experimental evidences for π -bonding.	5	2
2		**Electronic Spectral Properties of Metal Complexes**		
	2.1	Electronic spectra of complexes: term symbols and microstates of d^n systems, Racah parameters, splitting of terms in weak and strong octahedral and tetrahedral fields, selection rules for electronic transitions - effect of spin-orbit coupling and vibronic coupling.	5	3
	2.2	Correlation diagrams: Orgel and Tanabe – Sugano diagrams.	3	3
	2.3	Electronic spectra of metal complexes and their interpretation. Charge transfer spectra, luminescence spectra.	5	3
	2.6	Electronic spectra of lanthanide and actinide complexes.	2	3
3		**Organometallic Compounds-Synthesis, Structure and Bonding**		
	3.1	Ligands and their bonding with metals: CO, CN, NO, N_2, H_2, alkene, alkyne, PR_3, arenes, dienes, allyl, carbenes – carbynes (Fischer and Schrock) and alkyl.	5	1

	3.2	Preparation of metal nitrosyl, dinitrogen, alkyl, aryl, alkene, alkyne, carbenes - carbynes (Fischer & Schrock), arene and phosphine complexes.	3	1
	3.3	18 electron rule.	1	1
	3.4	Bridging and non-bridging (polynuclear) metal carbonyls, IR spectra of metal carbonyls, carbonyl clusters, Wade-Mingos rules.	3	1
	3.5	Isolobal analogy.	1	1
	3.6	Cyclopentadienyl complexes - fluxionality.	1	1
	3.7	Ferrocene: structure and bonding.	1	1
4	**Reactions of Organometallic Compounds and Catalysis**			
	4.1	Unique reactions in organometallic chemistry: oxidative addition (concerted and stepwise, C_{aryl}-H activation – orthometallation), reductive elimination, migratory insertion (1,1 and 1,2), β-hydride abstraction/elimination. Agostic interactions, σ-bond metathesis (Zr(IV) and Lu(III)).	6	4
	4.2	Homogeneous/heterogeneous catalysis: Tolman catalytic loops, hydrogenation by Wilkinson catalyst, olefin isomerization, Wacker process, hydroformylation (Co & Rh), Monsanto & Cativa acetic acid process, Ziegler-Natta polymerization including metallocene based Zr catalyst, water gas shift reaction and the Fischer-Tropsch reaction (synthesis of gasoline).	7	5
	4.3	Grubbs (I generation & II Generation) and Schrock catalysts – preparation and characteristics, olefin metathesis, ROMP.	2	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Peer teaching
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Marks: 30** Quiz **Assignment** Class Test (MCQ/written)
	B. Semester end examination **Theory:** Written examination **(70 Marks)- 2hrs.** **i) Short answer 5 questions (out of 6): 5 X 4 =20** **ii) Short essay 5 questions (out of 7): 5 X 7 = 35** **iii) Essay 1 question (out of 2): 1 X 15 = 15**

References

1. F.A. Cotton, G. Wilkinson, *Advanced Inorganic Chemistry: A Comprehensive Text*, 3rd Edn. Interscience, 1972.
2. J.E. Huheey, E.A. Keiter, *Inorganic Chemistry Principles of Structure and Reactivity*, 4th Edn. Pearson Education India, 2006.
3. K.F. Purcell, J.C. Kotz, *Inorganic Chemistry*, Cengage, 2010.
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5. B.E. Douglas, D.H. McDaniel, J.J. Alexander, *Concepts and Models of Inorganic Chemistry*, 3rd Edn. Wiley-India, 2007.
6. R.S. Drago, *Physical Methods in Chemistry*, Saunders College, 1992.
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8. J.D. Lee, *Concise Inorganic Chemistry*, 4th Edn. Wiley-India, 2008
9. R. G. Wilkins, *Kinetics and Mechanisms of Reactions of Transition Metal Complexes*, Wiley VCH, 2002.
10. G. A. Lawrance, *Introduction to Coordination Chemistry*, John Wiley & Sons Ltd, 2010.
11. C. E. Housecroft, A. G. Sharpe, *Inorganic Chemistry*, Pearson, 5th Edn. 2018.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Organic Chemistry-5**					
Type of Course	DCC					
Course Code	SJC7DCCCHE401					
Course Level	**400-499**					
Course Summary	This course delves into the concepts of organic chemistry, focusing on reactive intermediates and the underlying physical principles governing their behaviour. It also investigates concerted reactions and advanced stereochemical aspects of organic reactions.					
Semester	VII	Credits			4	Total Hours
Course Details	Learning approach	Lecture	Tutorial	Practical	Others	
		3		**1**		**75**
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Predict the reaction mechanism and rationalize the outcome of various organic reactions and obtain practical experience.	A	1, 2, 4, 10
2	Illustrate and practice the transformations and rearrangements of reactive intermediates.	An	1, 2, 4, 10
3	Correlate the reactivity of organic molecules to HSAB concept and various kinetic and thermodynamic conditions and obtain hands-on experience in this area.	An	1, 2, 4, 10
4	Distinguish and predict the stereoselectivity, regioselectivity, and feasibility of pericyclic reactions and their applications.	E	1, 2, 3, 4, 10
5	Master in determining and differentiating chirality, topicity of organic molecules and explore the chemical consequences and applications of conformational equilibria.	C	1, 2, 4, 9, 10
6	Perform raw mechanisms and schemes using chemistry software.	A	1, 2, 4, 10
***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Organic Reactivity and Mechanistic Insights: Exploring Reactive Intermediates and Physical Principles**		
	1.1	Mechanical aspects of S_N1, S_N2, S_NAr, $S_{RN}1$, S_Ni, S_E1, S_E2, effect of substrate, reagent, leaving group, solvent and neighbouring group on nucleophilic substitution (S_N2 and S_N1).	5	1
	1.2	Reactive Intermediates: non-classical carbocations. Structure, generation and reactions of carbenes and nitrenes: insertion reaction of carbene. Simmons-Smith reaction, Lossen reaction, Curtius reaction, Wolff rearrangement and Hoffmann rearrangement.	5	2
	1.3	Physical organic chemistry: kinetic versus thermodynamic control of product formation Hammond postulate, Hammet equation, hard and soft acids and bases – HSAB principle and its applications (organic reactions only).	5	3
2		**Symmetry and Molecular Transformations: Insights into Concerted Reactions**		
	2.1	Classification: electrocyclic, sigmatropic, cycloaddition, chelotropic, ene and dyotropic reactions. Woodward -Hoffmann rules - frontier orbital and orbital symmetry correlation approaches - PMO method (for electrocyclic and cycloaddition reactions only).	5	4
	2.2	Pericyclic reactions in organic synthesis such as Claisen, Cope, Wittig, and Mislow-Evans rearrangements. Diels-Alder and ene reactions (with stereochemical aspects), dipolar cycloaddition (introductory).	5	4
	2.3	Unimolecular pyrolytic elimination reactions of acetates, xanthates and tertiary amine oxides, cheletropic elimination.	5	4

3	**Advanced Stereochemistry & Conformational Stability and Reactivity**			
	3.1	Axial, planar and helical chirality with examples, stereochemistry and absolute configuration of allenes, biphenyls and binaphthyls, ansa and cyclophanic compounds, spiranes, exo-cyclic alkylidenecycloalkanes.	5	5
	3.2	Topicity and prostereoisomerism, topicity of ligands and faces as well as their nomenclature, NMR distinction of enantiotopic /diastereotopic ligands.	5	5
	3.3	Conformation and reactivity of cyclohexane systems: dehalogenation, dehydrohalogenation, semipinacolic deamination and pyrolytic eliminations, Grob fragmentation. Chemical consequence of conformational equilibrium - Curtin Hammett principle.	5	5
	Organic Chemistry-5 Practical			
4		) Practice Chemdraw (Use ChemDraw / other software to draw and manipulate different organic chemistry structures and reactions) (ii) Virtual Synthesis of aspirin (enable students to undertake an aspirin synthesis, perform recrystallization, Thin Layer Chromatography and calculation of yield using a digital resource). iii) Synthesis of aspirin) Experiment on Hammett equation (Experimentally determine the acid dissociation constant (K_a) of a series of substituted benzoic acids, correlate the K_a values with known substituent constants (σ_x) and use the correlation generated above to calculate the substituent constants for 'unknown' substituted benzoic acid compounds.		6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture using powerpoint presenatation ● Google classroom ● Group learning ● Laboratory work
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory** : 25 marks Pop quizzes Problem based assignments Written/MCQ Tests **Practical :** -15 Marks Quiz Lab involvement
	B. Semester end examination Theory (50 Marks): Written examination - 50 Marks- 1.5 hrs. i) Short answer 7 questions (out of 9): 7 X 3 =21 ii) Short essay 2 questions (out of 3): 2 X 7 = 14 i) Essay 1 question (out of 2): 1 X 15 = 15 Practical (35 Marks):Viva voce-10 Marks-1 hr. Written test of practical procedures-15 Marks Certified report of lab works done -10Marks

References

1. R.T.Morrison, R, N, Boyd, S. K. Bhattacharjee, *Organic Chemistry*; 7th Edn. Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2011.
2. T.W. G. Solomon, C. B. Fryhle, S. A. Snyder, *Organic Chemistry*; Wiley, 2014.
3. J. McMurry, *Organic Chemistry*; 7th Edn. Cengage Learning, 2013.
4. J. Clayden, N. Greeves, S. Warren, *Organic chemistry*; Oxford University Press, 2012.

5. I. L. Finar, *Organic Chemistry*; Vol. 1& 2; Dorling Kindersley (India) Pvt. Ltd (Pearson Education), 2002.
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8. F. A. Carey, R. J. Sundberg, *Advanced Organic Chemistry: Part A: Structure and Mechanisms*; Springer Science & Business Media, 2007.
9. R. O. C. Norman, J. M. Coxon, *Principles of Organic Synthesis*; Routledge, 2017.
10. S. H. Pine, *Organic Chemistry*; Tata McGraw-Hill, 2014.
11. B. S. Furniss, A. J. Hannaford, V. Rogers, P. W. G. Smith,.A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*; 5th Edn., Pearson Education, 2005.
12. V. K. Ahluwalia, S. Dhingra, *Comprehensive Practical Organic Chemistry- Qualitative Analysis*; University Press, 2000.
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St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Molecular Spectroscopy</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC7DCCCHE402</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course deals with structure elucidation of organic compounds by means of combined spectral techniques such as IR, UV, NMR and mass spectrometry.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td></td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Outline the theoretical aspects of various spectroscopic techniques.	U	1,2
2	Illustrate the basic concepts of infrared spectroscopy.	U	1,2
3	Apply the principles of electronic spectroscopy to organic compounds.	A	1,2
4	Demonstrate the underlying principles of NMR spectroscopy.	U	1,2
5	Explain the concepts of mass spectrometry.	U	1,2
6	Deduce the structure of organic compounds by means of combined spectral techniques such as IR, UV, NMR and mass spectrometry.	E	1,2,4,10

***_Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)_**

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Infrared and Electronic Spectroscopic Techniques**		
	1.1	Hooke's law, bond properties and absorption trends, fundamental vibrations, characteristic regions of the spectrum (fingerprint and functional group regions), influence of substituent, ring size, hydrogen bonding & solvent effect.	3	1,2
	1.2	IR spectra of O-H bonds (alcohols and carboxylic acids), C=C bonds (olefins and arenes), C=O bonds (acids, aldehydes, ketones, and esters) and C-H bonds (alkanes, alkenes and alkynes). Spectral interpretation and problems.	4	1.2
	1.2	Nature of electronic transitions, chromophore, auxochrome, representation of electronic spectra, bathochromic shift, hypsochromic shift, hyperchromic shift and hypochromic shift.	2	1,3
	1.3	Influence of substituents, solvent effect, conjugation, ring size and strain on spectral characteristics.	2	1,3
	1.4	Calculations of λ_{max} of enones, aromatic hydrocarbons and conjugated polyenes based on Woodward-Fieser and Fieser-Kuhn rules. Spectral interpretation and problems.	4	1,3
		Nuclear Magnetic Resonance Spectroscopy		
2	2.1	NMR phenomena based on ^1H & ^{13}C nuclei, ^1H & ^{13}C NMR spectra, relaxation processes.	3	1,4
	2.2	Chemical shift, magnetic anisotropy and shielding/deshielding, chemical equivalence and number of NMR signals. Population densities of nuclear spin states- intensity of the signal.	3	1,4
	2.3	Spin-spin splitting, coupling constant, geminal coupling, Karplus curve, Pople notation - AX, AX_2, A_2X_3, AB, AB_2 type coupling,	4	1,4

		first order and non-first order spectra, homotopic, enantiotopic and diastereotopic protons.		
	2.4	Simplification of non-first order spectra to first order spectra: spin decoupling and double resonance, off resonance decoupling, NOE and cross polarization and DEPT. Spectral interpretation and problems.	5	1,4
3		**Mass Spectrometry**		
	3.1	Basic principles. Ionization methods: Gas phase ionization methods– electron impact ionization (EI) and chemical ionization (CI); desorption ionization methods – SIMS, FAB and MALDI. Electrospray ionisation (ESI). Comparison between EI and CI. Mass analysers - time of flight analyser and quadrupole analyzer. Nitrogen and ring rules. Determination of molecular weight and molecular formula. HRMS. Tandem mass spectrometry (MS-MS) (concept only).	7	1,5
	3.2	Fragmentation and structural analysis: types of peaks involved (molecular ion, quasi molecular ion, isotopic peak, base peak, parent ion, daughter ion, fragment ion, metastable ion). Fundamental fragmentation processes – Stevenson's rule, α cleavage, two-bond cleavage, retro Diels- Alder cleavage and McLafferty rearrangements. Fragmentation pattern of hydrocarbons, alcohols, phenols, ethers, carbonyl compounds and amines. Mass spectral analysis and problem solving.	8	1,5
4		**Structure Elucidation of Organic Compounds**		
	4.1	Identification of structures of organic compounds based on the data from mass spectrometry, UV-Vis, IR, ^{1}H NMR and ^{13}C NMR spectroscopy. Interpretation of the given UV-Vis, IR and NMR spectra.	15	6
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture (chalk & board, powerpoint presentation, flipped classroom) Group discussion – thought problems; mind mapping Peer interaction Demonstration using simulations / models
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Total** **Marks: 30** Quiz Assignment Problem based test - Open book Test
	B. Semester End examination Total **Marks: 70 - 2 hrs.** MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

References

1. D.L. Pavia, G.M. Lampman, G.S. Kriz, *Introduction to Spectroscopy*, 3rd Edn. Brooks Cole, 2000.
2. A.U. Rahman, M.I. Choudhary, *Solving Problems with NMR Specroscopy*, Academic Press, 1996.
3. L. D. Field, S. Sternhell, J. R. Kalman, *Organic Structures from Spectra*, 4th Edn., John Wiley & sons, 2007.
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<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Drug Therapy and Drug Design</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC7DCECHE400</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course explores the fundamental concepts of drug therapy, drug discovery and design, drug delivery systems and computer aided drug design.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td></td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain the principles of drug therapy.	U	1,2,3
2	Analyse the concepts of drug design, leads, analogues, prodrugs and combinatorial synthesis.	An	1,2,3
3	Develop the concepts of enzymes and receptors as targets of drug design.	A	1,2,3,10
4	List the importance of various drug delivery systems.	U	1,2,3
5	Discuss the principles of computer aided drug design.	U	1,2,3,10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Principles of Drug Therapy**		
	1.1	Introduction to drugs. General Principles of drug therapy. Relationship between chemical structure, lipid solubility and biological activity of drugs. Stereochemistry and biological activity. The importance of water solubility.	6	1
	1.2	Drug action: the pharmacokinetic phase- ADME of the drug. The pharmacodynamic phase.	2	1
	1.3	Drug metabolism: sites of drug metabolism and phase I and phase II reactions. Prodrugs.	4	1
	1.4	Classification of drugs: based on chemical structure, pharmacological action and physiological classification.	3	1
2		**Drug discovery and design**		
	2.1	Historical outline, rational drug design. The general stages in modern-day drug discovery and design.	2	2
	2.2	Leads and analogues: bioavailability, solubility, structure and stability.	2	2
	2.3	Sources of leads and drugs. Approaches to lead optimisation.	4	2
	2.4	Prodrug design and applications: prodrug forms of various functional groups, prodrugs and intellectual property rights.	4	2
	2.5	Combinatorial Chemistry: introduction, solid-phase and solution phase strategies.	3	2
3		**Enzymes, Receptors and Drug Delivery Systems**		
	3.1	Enzymes as targets of drug design: enzyme inhibition and activation, approaches to the rational design of enzyme inhibitors.	3	3
	3.2	Receptors as targets of drug design: receptor theory, receptor complexes and allosteric modulators, molecular biology of receptors, receptor models and nomenclature, receptor binding assays, lead compound discovery of receptor agonists and antagonists.	7	3

	3.3	Drug delivery systems: general consideration, macromolecular drug carrier systems, bioprecursor prodrugs, oxidative activation and reductive activation.	5	4
4		**Computer-Aided Drug Design**		
	4.1	Basic concepts of CADD, molecular modelling: energy minimization, geometry optimization, conformational analysis, global conformational minima determination; approaches and problems; bioactive vs. global minimum conformations. Automated methods of conformational search.	5	5
	4.2	Molecular docking and dynamics: rigid docking, flexible docking, manual docking; advantages and disadvantages of flex-X, flex-S, autodock and dock softwares with suitable examples; Monte Carlo simulations and molecular dynamics in performing conformational search and docking.	5	5
	4.3	QSAR: changing size and shape and introduction of new substituents, lipophilicity, electronic and steric effects, Hansch analysis. Structure activity relationships and pharmacological activity. CoMFA analysis, 3D-QSAR.	5	5
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture Sessions, interactive sessions including discussions
Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA) Total marks : 30** Assignments MCQ Class test Viva
	B. Semester end examination **Total Marks : 70- 2 hrs.** i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

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St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Industrial Chemistry**					
Type of Course	DCE					
Course Code	SJC7DCECHE401					
Course Level	**400-499**					
Course Summary	This course covers the manufacture and applications of inorganic and organic chemicals, petroleum refining, industrial safety and pollution prevention.					
Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the manufacture and uses of common inorganic and organic chemicals.	U	1,2
2	Describe various processes involved in petroleum refining.	U	1,2
3	Discuss safety aspects of the chemical industry.	U	1,2
4	Analyse various aspects of industrial pollution prevention.	An	1,2
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Inorganic Chemicals**		
	1.1	Manufacture and applications of sulphuric acid, phosphoric acid, lime, soda ash, titanium dioxide and sodium chloride.	7	
	1.2	Manufacture and uses of syn gas, nitrogen, oxygen, hydrogen and ammonia.	4	
	1.3	Production of potable water: break-point chlorination and ozonization, flocculation and sedimentation, filtration, removal of dissolved inorganic impurities, activated charcoal treatment. Production of deionized water. Production of freshwater from seawater and brackish water.	4	
2		**Petroleum Refining**		
	2.1	Primary raw materials for petrochemicals- natural gas, crude oil (composition, properties and classification), coal, oil shale, tar sand and gas hydrates.	5	
	2.2	Introduction to petroleum refining, desalting, distillation, hydrotreating or hydroprocessing, cracking or hydrocracking, coking, visbreaking, steam cracking, alkylation, catalytic reformers, removal of the natural gas fraction, sulfur recovery.	7	
	2.3	Hydrocarbon intermediates and liquid petroleum fractions, chemicals based on methane.	3	
3		**Organic Chemicals**		
	3.1	Manufacture and uses of methanol, formaldehyde, formic acid and hydrocyanic acid.	5	
	3.2	Manufacture and uses of ethylene, propene and acetylene.	3	
	3.3	Hydroformylation of olefins, industrial hydroformylation.	2	
	3.4	Manufacture and uses of ethanol, acetaldehyde and acetic acid.	3	
	3.5	Chemicals based on benzene, toluene and xylenes.	2	
4		**Safety Considerations and Industrial Pollution Prevention**		
	4.1	OSHA (Occupational Safety and Health Administration) and PSM (Process Safety Management).	2	

	4.2	Types of hazards in industries: heat and temperature, pressure, electrical, and mechanical hazards, toxic materials, fire and explosion, radiation, noise and vibrations. risk management plan	6	

	4.3	Types of industrial wastes, public concern over pollution, legislation to waste management, industrial pollution prevention. Waste management: recycling, waste treatment and disposal.	7	
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Lecture Sessions, interactive sessions including discussions
Assessment Types	**MODE OF ASSESSMENT** **C. Continuous Comprehensive Assessment (CCA) Total marks : 30** Assignments MCQ Class test Viva
	D. Semester end examination Total marks: **70- 2 hrs.** iv) Short answer 5 questions (out of 7): 5 X 4 =20 v) Short essay 5 questions (out of 7): 5 X 7 = 35 vi) Essay 1 question (out of 2): 1 X 15 = 15

References

1. J. A. Tyrell, *Fundamentals of Industrial Chemistry*, John Wiley & Sons, 2014.
2. K. Weissermel, H. J. Arpe, *Industrial Organic Chemistry*, Wiley VCH, 1997.
3. M. A. Benvenuto, *Industrial Organic Chemistry*, De Gruyter Graduate, 2017.
4. M. F. Ali, B. M. Ali, J. G. *Speight, Handbook of Industrial Chemistry*, McGraw-Hill, 2005.
5. K. H. Buchel, H. H. Moretto, P. Woditsch, *Industrial Inorganic Chemistry*, Wiley VCH, 2003.
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7. S. Matar, L.F. Hatch, *Chemistry of Petrochemical Processes*, Gulf Professional Publishing, 2001.
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9. B. K. Sharma, *Industrial Chemistry Part 1 & 2*, Krishna Prakashan, 2023

	St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**				
Course Name	**Advanced Chemistry of Main Group Elements**				
Type of Course	DCE				
Course Code	SJC7DCECHE402				
Course Level	**400-499**				
Course Summary	This course explores the advanced aspects of properties and chemistry of main group elements.				
Semester	VII	Credits		4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Describe the advanced chemistry of main group elements.	U	1,2
2	Analyse the coordination and aqueous chemistry of group 1 and 2 metals.	An	1,2
3	Analyse the compounds and coordination complexes of group 13 and 14 elements.	An	1,2
4	Analyse the properties and chemistry of group 15 and 16 elements.	An	1,2
5	Compare the chemistry of halogens, and noble gases.	An	1, 2

***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Group 1 and Group 2 Metals**		
	1.1	Aqueous solution chemistry of group 1 metal compounds, complex formation of group 1 metals with crown ethers, sandwich complexes with crown ethers, cryptates of group 1 metal ions, sodide ion in cryptates, alkalide ions of higher alkali metals, uses of alkali metal cryptands.	5	1,2
	1.2	Non-aqueous coordination chemistry of alkali metals. Zintl phases containing alkali metals. Compound formation with aromatic compounds, sodium and potassium alkyls.	4	1,2
	1.3	Complex ions of group 2 metals in aqueous solution, complexes of group 2 metal ions with EDTA, $[P_3O_{10}]^{5-}$, crown ethers and cryptands. Complexes of group 2 metal ions with amido and alkoxy ligands.	6	1,2
2		**Group 13 and 14 Elements**		
	2.1	Biological aspects of boron, toxicity of aluminium, aqua ions of Al, Ga, In and Tl, coordination complexes of M^{3+} ions of Al, Ga and In. Metal borides- synthesis, structure and applications.	4	1, 3
		Zintl phases of group 13 elements. Spinels and tricalcium aluminate. Chalcogenides of Al, Ga, In and Tl.	4	1, 3
	2.2	Complexes containing a naked carbon atom, complexes containing naked dicarbon ligands. Carbides, silicides, germides, stannides and plumbides. Zintl ions containing Si, Ge, Sn and Pb. Polyatomic anions of Ge, Sn, and Pb. Sila- and germa-aromatic compounds.	7	1,3
3		**Group 15 and 16 Elements**		
	3.1	Hydrogen azide and azide salts. Nitrides, phosphides, arsenides, antimonides and bismuthides. Organometallic compounds of arsenic, antimony, and bismuth. π- Coordination complexes of phosphorus–carbon compounds.	7	1,4
	3.2	Polyanions and polycations of sulfur, selenium, and tellurium. Polysulfides, polyselenides and polytellurides. Compounds of sulfur and selenium with nitrogen.	4	1,4
	3.3	Allotropes of selenium and tellurium. Polyatomic cations and anions of selenium and tellurium. Biological aspects of oxygen, sulphur and selenium.	4	1,4
4		**Group 17 and 18 Elements**		
	4.1	Industrial extraction of fluorine, fluoridation of water. Polyhalogen cations, polyhalide anions, oxofluorides of chlorine, bromine and iodine.	4	1,5

	4.2	Aqueous solution chemistry of chlorine, bromine and iodine. Biological aspects of fluorine, chlorine, bromine and iodine. Chemistry of astatine.	4	1,5
	4.3	Chemistry and uses of helium. Synthesis, structure and reactions of xenon insertion compounds, organoxenon compounds and compounds containing metal–xenon bonds.	4	1,5
	4.4	Compounds of argon, krypton and radon and coordination compounds of noble gases. Biological aspects of noble gases.	3	1,5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Lecture sessions, interactive sessions including discussions
Assessment Types	**MODE OF ASSESSMENT** **E. Continuous Comprehensive Assessment (CCA) Total marks : 30** Assignments MCQ Class test Viva
	F. Semester end examination **G. Total Marks ; 70- 2hrs.** i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. C. E. Housecroft, A. G. Sharpe, *Inorganic Chemistry*, 5th Edn., Pearson, 2018.
2. D. Shriver, M. Weller, T. Overton, J. Rourke, F. Amstrong, *Inorganic Chemistry*, 7th Edn., Oxford University Press, 2018.
3. G. R. Canham, T. Overton, *Descriptive Inorganic Chemistry*, W.H. Freeman & Company, 2014.
4. W. Li, G. Zhou, T. C. W. Mak, *Advanced Structural Inorganic Chemistry*, OUP, 2008.
5. W. Hendersen, *Main Group Chemistry*, RSC, 2000.
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St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Statistical Thermodynamics and Bioenergetics**					
Type of Course	DSE					
Course Code	SJC7DCECHE403					
Course Level	**400-499**					
Course Summary	This course covers the principles of statistical thermodynamics and applications of thermodynamics and statistical thermodynamics to various biological processes.					
Semester	VII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Describe the basic principles of statistical thermodynamics.	U	1,2,3
2	Apply the principles of statistical thermodynamics to biological processes.	A	1,2,3
3	Analyse the energy changes associated with various biological processes.	An	1,2,3
4	Apply the principles of thermodynamics to various biological processes.	An	1,2,3
**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Statistical Thermodynamics -1**		
	1.1	Probability, Stirling's approximation, macrostates and microstates, ensemble, types of ensembles.	3	1
	1.2	Boltzmann distribution law, partition function and its physical significance, relation between molecular partition function and molar partition function, distinguishable and indistinguishable particles, partition function and thermodynamic functions, separation of partition function-translational, rotational, vibrational, and electronic partition functions. The equipartition theorem.	7	1
	1.3	Thermodynamic properties: internal energy, heat capacity, entropy, enthalpy and Gibbs free energy. Statistical basis of chemical equilibrium.	5	1
2		**Statistical Thermodynamics -2**		
	2.1	Need for quantum statistics, bosons and fermions, Bose-Einstein statistics:, Bose-Einstein distribution law, Bose-Einstein condensation, first order and higher order phase transitions, liquid helium, Fermi- Dirac statistics:, Fermi- Dirac distribution law, application in electron gas, thermionic emission. Comparison of three statistics.	10	1
	2.2	Applications of statistical mechanics to biological processes: helix–coil Transitions, cooperative transitions, internal energy and heat capacity of biological macromolecules, protein heat capacity functions.	5	2
3		**Bioenergetics**		
	3.1	Bioenergetics, standard free changes in biochemical reactions, coupled reactions, ATP and its role in bioenergetics, high energy bond, free energy and entropy change in ATP hydrolysis.	8	3
	3.2	Thermodynamics of synthesis of ATP, thermodynamic aspects of metabolism and respiration, glycolysis, biological redox reactions and citric acid cycle.	7	3
4		**Thermodynamic Aspects of Biological Processes**		
	4.1	Thermodynamic aspects of photosynthesis, osmosis, dialysis, enzyme-substrate interactions, binding of oxygen to myoglobin and haemoglobin, cooperativity, allostery and proton binding by biomolecules.	8	4
	4.2	Thermodynamic aspects of transport of ions across biological membranes, biosynthesis of proteins, buffer action in blood, protein structure, mechanisms of protein folding and unfolding and DNA melting.	7	4
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** Lecture sessions, interactive sessions including discussions
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Total marks: 30** Assignments MCQ Class test Viva
	Semester end examination Total Marks: 70- **2hrs.** iv) Short answer 5 questions (out of 7): 5 X 4 =20 v) Short essay 5 questions (out of 7): 5 X 7 = 35 vi) Essay 1 question (out of 2): 1 X 15 = 15

References

1. P. Atkins, J. Paula, *Physical Chemistry for the Life Sciences*, Oxford University Press, 2006.
2. D. T. Haynie, *Biological Thermodynamics*, 2nd Edn. Cambridge University Press, 2008.
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8. G. G. Hammes, S. H. Schiffer, *Physical Chemistry for the Biological Sciences*, Wiley, 2015.
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St. Joseph’s College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Novel Inorganic Solids</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC7DCECHE404</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course covers the synthetic route to novel inorganic solids, properties and applications of inorganic nanomaterials, engineering materials, composite materials and speciality polymers.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td></td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Describe different types of novel solids.	U	1,2
2	Discuss synthetic methods of inorganic solids.	U	1,2
3	Explain the synthesis, properties and applications of novel inorganic nanomaterials.	U	1,2
4	Analyse various inorganic engineering materials and composite materials.	An	1,2
5	Describe the synthesis, properties and applications of inorganic polymers.	U	1, 2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		Types of Novel Inorganic Solids and Synthetic Methods		
1	1.1	Solid electrolytes – cationic, anionic and mixed. Inorganic pigments – coloured solids. Molecular material and fullerides, one- dimensional metals, molecular magnets, inorganic liquid crystals.	7	1
	1.2	Synthetic methods: conventional heat and beat methods, co-precipitation, sol-gel, chemical vapour deposition, ceramic, alloying, hydrothermal, electrochemical and intercalation methods. Microwave synthesis.	8	2
2		**Nanomaterials**		
	2.1	Metal oxide nanostructures: synthesis-sol-gel and electrochemical deposition, applications in photovoltaics, lithium ion batteries, catalysis, gas sensing and biomedical applications.	4	3
	2.2	Magnetic nanomaterials for energy storage: synthesis- co-precipitation and chemical oxidation, applications of Fe_2O_3 and Fe_3O_4 nanomaterials for energy storage.	4	3
	2.3	Transition metal dichalcogenide nanomaterials: Synthesis- chemical vapour deposition, doping, applications in electronics, photonics and gas sensing.	3	3
	2.4	Inorganic nanotubes: general synthetic methods- sol-gel and hydrothermal methods, applications.	2	3
	2.5	Inorganic nanowires: synthesis-vapour phase growth, properties and applications.	2	3
3		**Engineering Materials for Mechanical Construction and Composite Materials**		
	3.1	Composition, mechanical and fabricating characteristics and applications of various types of cast irons, plain carbon and alloy steels, copper, aluminum and their alloys like duralumin, brasses and bronzes, cutting tool materials, super alloys, thermoplastics, thermosets and composite materials.	7	4
	3.2	Introduction, limitations of conventional engineering materials, role of matrix in composites, classification, matrix materials, reinforcements, metal-matrix composites, polymer-matrix composites, fibre-reinforced composites, environmental effects on composites, applications of composites.	8	4
4		**Speciality Polymers**		
	4.1	Preceramic inorganic polymers: carbon Fiber, silicon carbide (SiC), silicon nitride (Si_3N_4), boron nitride (BN), boron carbide (B_4C), aluminum nitride (AlN), phosphorus nitride. Poly(ferrocenylsilanes) as ceramic precursors.	8	5

	4.2	Sulfur-based inorganic polymers: polythiazyl and polythiol.	3	5
	4.3	Ferrocene based polymers: synthetic methods, Fc-based polypyrrole and cyclodextrin- synthesis and applications.	4	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture sessions, interactive sessions including discussions
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Total marks: 30** Assignments MCQ Class test Viva
	Semester end examination Total Marks : 70- 2 hrs. vii) Short answer 5 questions (out of 7): 5 X 4 =20 viii) Short essay 5 questions (out of 7): 5 X 7 = 35 ix) Essay 1 question (out of 2): 1 X 15 = 15

References

1. P. W. Alkins, T. Overton, J. Rourke, M. Weller, F. Armstrong, *Inorganic Chemistry*, 5th Edn. Oxford University Press, 2012.
2. D. M. Adam, *Inorganic Solids: An introduction to concepts in solid-state structural chemistry*, Wiley–Blackwell, 1974.
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5. S. Rajendran, M. Naushad, *Inorganic Materials for Energy, Medicine and Environmental Remediation*, Springer, 2022.

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13. W. D. Callister Jr., *Fundamentals of Materials Science and Engineering*, Wiley, 2001.

14. B. Sharma, C. K. Sarkar, *Advanced Nanomaterials and Their Applications*, CRC Press, 2024.

15. M. A. Benvenuto, Metals and Alloys, de Gruyter, 2016.

St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Analytical Chemistry</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC7DSECHE400</td></tr>
<tr><td>Course Level</td><td colspan="6">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course covers the fundamentals of analytical chemistry and discusses topics such as precision, accuracy and errors. Additionally, it encompasses qualitative analysis techniques, safety protocols, titrimetric analysis, and the principles and applications of chromatography.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td>0</td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain fundamental measurement concepts, and errors in analytical chemistry.	U	1, 2,3,10
2	Develop safe laboratory methods of chemical analysis.	An	1,2,3
3	Develop a comprehensive knowledge of titrimetric analysis including redox titrations, complexometric titrations, conductometric titrations and potentiometric titrations.	A	1, 2,3
4	Apply the principles of gravimetric analysis.	A	1, 2,3
5	Analyse various separation and purification techniques of compounds.	An	1, 2,3
6	Distinguish between different chromatographic methods based on their principle and mechanism.	An	1, 2,3,10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO
1		**Introduction**		
	1.1	The role of analytical chemistry, qualitative and quantitative analysis, general features of a typical quantitative analysis-choosing a method, acquiring the sample, processing the sample, eliminating interferences, calibration and measurement, calculation and evaluation of results. Case study illustrating the use of analytical chemistry to solve a problem.	6	1
	1.2	Calculations used in analytical chemistry: units of measurement-mass and weight, the mole, concentrations of solutions, p-functions, density and specific gravity. Chemical stoichiometry and stoichiometric calculations.	5	1
	1.3	Errors in chemical analysis: mean and median, precision and accuracy, absolute error and relative error. Random, systematic and gross errors. Sources and effects of systematic errors. Minimising systematic errors.	4	1
2		**Chemicals apparatus and unit operations of analytical chemistry**		
	2.1	Selecting and handling reagents and other chemicals.	2	2
	2.2	Cleaning and marking of laboratory ware.	2	2
	2.3	Evaporating liquids, measuring mass, equipment and manipulations associated with weighing, measuring volume, calibrating volumetric glassware.	3	2
	2.4	The laboratory notebook.	1	2
	2.5	Sampling, standardization, and calibration.	4	2
	2.6	Safety in the laboratory- the four principles of safety, personal protective equipment: eye protection, lab coat, shoes and long pants, gloves, respiratory protection and masks, hair, lead apron and shields.	3	2

3	**Titrimetric and Gravimetric Analysis**			
	3.1	Titrimetric analysis – basic concepts of redox reactions, redox titrations involving $KMnO_4$, and $K_2Cr_2O_7$, titration curves, redox indicators.	4	3
	3.2	Complexometric titrations – direct, indirect, back and replacement titrations, EDTA titrations. Precipitation titrations - methods of argentometric titration-indicators.	6	3
	3.3	Conductometric and potentiometric titrations – principle, examples and graphical representation.	2	3
	3.4	Gravimetric analysis: unit operations in gravimetric analysis - illustrations using iron and barium estimation.	3	4
4	**Separation and Purification of compounds**			
	4.1	Separation and purification techniques: filtration, recrystallization, precipitation, distillation, fractional distillation, solvent extraction and sublimation.	4	5
	4.2	Chromatography- principle and classification. Chromatographic techniques: paper chromatography, thin layer chromatography, R_f-values.	3	6
	4.3	Principle and applications of column chromatography, high-performance liquid chromatography (HPLC), gas chromatography, gel permeation chromatography (GPC), ion exchange chromatography, and reverse phase chromatography.	8	6
5	**Teacher Specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Peer teaching ● Demonstration of experiments ● Hands-on training

Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Total marks: 30** Assignments MCQ Class test Viva
	Semester end examination Total Marks : 70- 2 hrs. i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. A. Skoog, D. M. West, and S. R. Crouch, *Fundamentals of Analytical Chemistry* 9th Edn. Cengage Learning, 2013.
2. Vogel's *Textbook of Quantitative Chemical Analysis*, 6th Edn. Pearson Education Ltd., 2009.
3. G. D. Christian, *Analytical Chemistry*, JohnWiley and Sons, 2020.
4. R. Puri, L. R. Sharma, Kalia, *Principles of Inorganic Chemistry*, Milestone Publishers, New Delhi, 2020.
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6. A. Gupta, *Analytical Chemistry*, Pragati Prakashan, 2020.
7. R. Gopalan, *Inorganic Chemistry for Undergraduates,* Universities Press, Hyderabad, 2009.
8. Satya Prakash, *Advanced Inorganic Chemistry, Volume 1,* 5th Edition, S. Chand and Sons, New Delhi, 2012.
9. R. Shobha, M. Banani, *Essentials of Analytical Chemistry*, Pearson Education, 2017.

St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Biophysical Chemistry</td></tr>
<tr><td>Type of Course</td><td colspan="6">DSE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC7DSECHE401</td></tr>
<tr><td>Course Level</td><td colspan="6">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course explores how the principles of thermodynamics, chemical equilibrium, chemical kinetics and quantum mechanics are applied to biological processes.</td></tr>
<tr><td>Semester</td><td>VII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>4</td><td></td><td></td><td></td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
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COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Apply the principles of thermodynamics to life processes.	A	1,2
2	Analyse biological equilibrium processes.	An	1,2
3	Examine kinetic aspects of biological processes.	An	1,2
4	Apply the principles of quantum mechanics to simple chemical and biological systems.	A	1,2

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Thermodynamics**			
	1.1	Work, heat, internal energy, enthalpy, heat capacity. The first law of thermodynamics. The enthalpy of phase transition- case study- thermal denaturation of a protein.	5	1
	1.2	The second law of thermodynamics, entropy and entropy change. Entropy change and life. The Third Law of thermodynamics.	4	1
	1.3	Spontaneity and Gibbs free energy. Free energy as maximum work. Proteins- primary, secondary, tertiary and quaternary structures. Gibbs energy change of protein assembly. Basic idea of metabolism and free energy changes of metabolic cycles.	6	1
2	**Equilibrium**			
	2.1	Molar free energy of reaction. Reactions at equilibrium and Gibbs free energy change. Relationship between the Gibbs energy and equilibrium constant. Acid–base equilibria. Catalysts and equilibrium	6	2
	2.2	Temperature and equilibrium, coupled reactions. Active transport. Binding of oxygen to myoglobin and haemoglobin-thermodynamic aspects, cooperativity and allosteric effect. Standard Gibbs energy of formation and calculation of standard reaction Gibbs energy.	9	2
3	**Chemical Kinetics**			
	3.1	Rate of reaction, rate laws and rate constants, order of a reaction, first order and second order reactions. The temperature dependence of reaction rates- the Arrhenius equation and Arrhenius parameters. Reaction rates near equilibrium.	7	3

	3.2	Enzymes as biological catalysts- substrate binding, active site and lock and key principle. Enzyme catalysis: the Michaelis–Menten mechanism. The catalytic efficiency of enzymes. Enzyme inhibition. Pharmacokinetics. Fast events in protein folding.	8	3
4	**Quantum Mechanics**			
	4.1	Basics of quantum mechanics, electromagnetic radiation, wave properties of matter, quantization of energy and fundamentals of spectroscopy. Types of spectroscopy. The uncertainty principle.	7	4
	4.2	The particle in a box- the electronic structure of β-carotene. Quantum mechanical tunnelling- Scanning probe microscopy (STM and AFM). Particle on a ring- the electronic structure of phenylalanine.	8	4
5		**Teacher Specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture sessions, interactive sessions including discussions
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Total marks: 30** Assignments MCQ Class test

	Semester end examination Total Marks : 70- 2 hrs. i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35
	iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. P. Atkins, J. Paula, *Physical Chemistry for the Life Sciences*, Oxford University Press, 2006.
2. D. T. Haynie, *Biological Thermodynamics*, 2nd Edn. Cambridge University Press, 2008.
3. P. S. Kalsi, N. Mahanta, *Biophysical Chemistry*, 2nd Edn. New Academic Science Limited, 2014.
4. J. L. Burgot, *Thermodynamics in Bioenergetics*, CRC Press, 2020.
5. A. Cooper, *Biophysical Chemistry*, RSC, 2004.
6. J. P. Allen, *Biophysical Chemistry*, Blackwell Publishing, 2008.
7. M. R. Roussel, A life Scientist's Guide to Physical Chemistry, Cambridge University Press, 2012.
8. G. G. Hammes, S. H. Schiffer, *Physical Chemistry for the Biological Sciences*, Wiley, 2015.
9. P. Nelson, *Biological Physics: Energy, Information, Life*, www.physics.upenn.edu/~pcn/, 2002.
10. G. G. Hammes, *Thermodynamics and kinetics for the biological sciences*, Wiley, 2000.
11. P. R. Bergethon, *The Physical Basis of Biochemistry*, 2nd Edn. Springer, 2010.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Nanochemistry and Technology**					
Type of Course	DSE					
Course Code	SJC7DSECHE402					
Course Level	**300-399**					
Course Summary	This course explores fundamental concepts of nanotechnology covering synthesis, characterisation, properties and applications of nanomaterials.					
Semester	VII	Credits				Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		3		1		75
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the fundamental concepts of nanomaterials.	U	1,2
2	Compare bottom-up and top-down approaches in nanomaterial synthesis.	C	1,2
3	Describe various characterisation techniques of nanomaterials.	An	1,2
4	Explain the properties of different types of nanomaterials.	U	1,2
5	Analyse the applications of nanomaterials in various fields.	An	1,2,3,10

***Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)**

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
		Introduction		
1	1.1	Feynman's hypothesis- scales of nanosystems- Moore's law.	2	1
	1.2	Different types of nanomaterials. Classification of nanomaterials based on dimensions and origin.	3	1
	1.3	Nano in nature: lotus-leaf effect, Gecko's feet, butterfly wings, and magneto-tactic bacteria.	2	1
	1.4	Bottom-up techniques for the synthesis of nanomaterials: chemical vapour deposition, reduction techniques, solvothermal, sonochemical, biomimetic, molecular self-assembly and sol-gel methods.	4	2
	1.5	Top-down techniques: mechano-chemical, laser ablation, arc-discharge, sputtering, etching, lithography and electrospinning methods.	4	2
		Characterisation of Nanomaterials		
2	2.1	Imaging through electron microscopy: interaction of electron beam with sample. Scanning electron microscope and transmission electron microscope- comparison, advantages, applications and basic instrumental features.	4	3
	2.2	Scanning probe microscopy: scanning tunneling microscope and atomic force microscope- comparison, applications and basic instrumental features.	4	3
	2.3	Characterisation through spectroscopy: UV-visible, IR, X-ray photoelectron and Auger electron spectroscopy. Secondary ion mass spectrometry. X-ray diffraction, dynamic light scattering and zeta potential analysis methods.	7	3

	Properties of Nanomaterials			
3	3.1	Size effects: quantum confinement, the density of states and high surface area.	2	4
	3.2	Thermal properties: surface energy, thermal conductivity and melting of nanomaterials.	3	4
	3.3	Electronic and electrical properties: one dimensional conduction-ballistic conduction, the Coulomb blockade effect, the electron density of states and superconductivity.	4	4
	3.4	Magnetic properties: giant magnetoresistance, finite-size effects and surface effects.	3	4
	3.5	Optical properties: colour of quantum dots, surface plasmon resonance and quantum fluorescence.	3	4
4	**Applications of Nanoparticles**			
	4.1	Medicine and healthcare: applications of nanomaterials in medical diagnosis, advanced drug delivery systems, targeted drug delivery and therapy.	4	5
	4.2	Applications of nanotechnology in integrated circuits, data storage and displays.	2	5
	4.3	Applications of nanotechnology in water purification and air pollution control.	2	5
	4.4	Piezoelectric nanomaterials, hydrogen generation and storage, batteries and solar energy harvesting.	2	5
	4.5	Chemical and biosensors using nanomaterials and defence applications of nanotechnology.	2	5
	4.6	Applications of grapheme, carbon nanotubes and fullerenes.	3	5

5	**Teacher Specific Content**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** · Interactive instruction (chalk & board method, multimedia presentation) · Group discussion · Peer teaching · Experimental demonstrations · Practical training
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (Total 30 marks) Total marks: 30** Assignments MCQ Class test Viva
	Semester end examination Total marks : 70- 2hrs. i) Short answer 5 questions (out of 7): 5 X 4 =20 ii) Short essay 5 questions (out of 7): 5 X 7 = 35 iii) Essay 1 question (out of 2): 1 X 15 = 15

References

1. N. Kumar, K. Sunita, *Essentials in Nanoscience and Nanotechnology*, Wiley, 2016.
2. T. Pradeep *NANO: The Essentials: Understanding Nanoscience and Nanotechnology*; 1st Edition ed.; McGraw-Hill Education: New York, 2007.
3. V. S. Muralidharan,; A. Subramania, *Nanoscience and Technology*; Ane Books for, 2009.
4. C. P Poole, F. J. Owens, *Introduction to Nanotechnology*; Wiley, 2003.

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8. M. Benelmekki, *Nanomaterials: The Original Product of Nanotechnology*; Morgan & Claypool Publishers, 2019.

9. C. N. R. Rao, A. Müller, A. K. Cheetham, *Nanomaterials – An Introduction. In The Chemistry of Nanomaterials*, 2004, (Chapter 1).

10. C. Ngô, M. Van de Voorde, *Nanotechnology in a Nutshell: From Simple to Complex Systems*; Atlantis Press, 2014.

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SEMESTER 8

	St. Joseph’s College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Advanced Coordination and Organometallic Chemistry**					
Type of Course	DCC					
Course Code	SJC8DCCCHE400					
Course Level	**400-499**					
Course Summary	This course offers a comprehensive exploration of advanced topics in inorganic chemistry, covering magnetic properties, substitution mechanisms, organometallic catalysis including asymmetric catalysis, practical gravimetric analysis, and the separation and identification of cation mixtures.					
Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2		2		90
Pre-requisites, if any	**Basic Knowledge in Coordination and Organometallic Chemistry**					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Analyse and explain the magnetic properties of coordination complexes.	An	1,2
2	Evaluate the kinetics and mechanism of ligand substitution reactions in coordination complexes.	E	1,2
3	Analyse the applications of organometallic compounds in organic synthesis and catalysis.	An	1,2
4	Explain the properties and utility of polyferrocenylsilanes.	U	1,2
5	Apply gravimetric analysis techniques in estimating metal ions, including nickel (II), copper, iron, and aluminum.	A	1,2
6	Apply qualitative analysis techniques to distinguish and confirm the presence of specific cations, showcasing a comprehensive understanding of cation separation.	A	1,2
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Magnetic Properties and Ligand Substitution Mechanisms in Coordination Complexes**			
	1.1	Magnetic properties of complexes - paramagnetic and diamagnetic complexes, molar susceptibility, Gouy method for the determination of magnetic moment of complexes, spin only magnetic moment.	3	1
	1.2	Temperature dependence of magnetism- Curie's law, Curie-Weiss law, temperature independent paramagnetism (TIP).	2	1
	1.3	inetics and mechanism of octahedral substitution- water exchange, dissociative, associative and interchange mechanisms, acid hydrolysis, base hydrolysis, SN_1cB mechanism.	4	2
	1.4	Electron transfer reactions: outer sphere mechanism – Marcus' theory, inner sphere mechanism- Taube mechanism, mixed outer and inner sphere reactions, two electron transfer and intramolecular electron transfer.	4	2
	1.5	Δ and Λ isomers, linkage isomerism: electronic and steric factors affecting linkage isomerism.	2	2
2	**Organometallic Homogeneous Catalysis & Asymmetric versions**			
	2.1	Organometallic reagents in organic synthesis –Petasis, Schwartz reagents for organic transformations. Reppe reaction, Dötz reaction	4	3
	2.2	Hydrogenation reactions- H_2 hydrogenation and isopropanol transfer hydrogenations catalyzed by Ru(II) complexes, ionic hydrogenation, hydrosilylation	3	3
	2.3	Asymmetric catalysis- chiral phosphine ligands (structure only) - P-chiral ligands, BINAP, DIOP, ferrocene based ligands - Josiphos, asymmetric hydrogenation, Noyori hydrogenations, Shvo catalyst, transfer hydrogenation of ketones and imines, metal-ligand bifunctional catalysis-cooperative effect.	5	3
	2.4	Preparation of L-DOPA drug, Matalachlor herbicide	1	3
	2.5	Organometallic polymers: synthesis, properties and applications of polyferrocenylsilanes.	2	4
Inorganic Practical -4				
3		**Part-1** **Gravimetric Analysis:**	30	5

		. Estimation of nickel (II) using dimethylglyoxime (DSJC). ii. Estimation of copper as CuSCN ii. Estimation of iron as Fe_2O_3 by precipitating iron as $Fe(OH)_3$. v. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminium oxinate).		
4		**Part-2** Separation and identification of a mixture of four cations (a mixture of two familiar ions such as Ag^+ , Hg^{2+}, Pb^{2+}, Cu^{2+}, Bi^{2+}, Cd^{2+}, As^{3+}, Sn^{2+}, Sb^{3+}, Fe^{2+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+} , Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, SJC^{2+}, Li^+ , Na^+ , K^+ and NH_4^+ and two less familiar metal ions such as Tl, W, Se, Mo, Ce, Th, Ti, Zr, V, U and Li). Minimum four mixtures to be given.	30	6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** ● Lecture (chalk &board, powerpoint presentation) ● Group discussion ● Peer teaching ● Demonstration of experiments ● Hands-on training
Assessment Types	**Mode of Assessment** **A. Continuous Comprehensive Assessment Theory:15 marks** Quiz Theory: Test for each unit (MCQ/Written) **Practical: 15 marks** Lab involvement/report /Lab test
	B. Semester-end Examination Theory: Written examination (35 Marks) – 1 hr. i) Short answer 5 questions (out of 7): 5 X 3 = 15 marks ii) Short Essay 2 questions (out of 3) : 2 X 10 = 20 marks

	Practical: Certified report + procedure + viva voce (10+15+10=35 Marks) - 1 hr.

References

1. J.E. Huheey, E.A. Keiter, R.L. Keiter, *Inorganic Chemistry Principles of Structure and Reactivity*, 4th Edn. HarperCollins College Publishers, 1993.
2. F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, *Advanced Inorganic Chemistry*, 6th edition, Wiley-Interscience, 1999.
3. K.F. Purcell, J.C. Kotz, *Inorganic Chemistry*, Holt-Saunders, 1977.
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6. Sumit Bhaduri, Doble Mukesh, *Homogeneous Catalysis: Mechanism and Industrial Applications*, Wiley Interscience, 2000.
7. B.D. Guptha, A.J Elias, *Basic Organometallic Chemistry*, Universities Press, 2010.
8. Astruc, D., *Organometallic Chemistry and Catalysis*, Springer Verlag, 2007.
9. Robert H. Crabtree, *The Organometallic Chemistry of the Transition Metals*, 4th Edn. Wiley Interscience, 2005.
10. J. G. de Vries, C. J. Elsevier, *Handbook of Homogeneous Hydrogenations*, 3 Volumes, Wiley-VCH, 2006.
11. Catherine E. Housecroft, Alan G. Sharpe C. E. Barnes, *Inorganic Chemistry* 4th Edn. Journal of Chemical Education, 2003.

	St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**
Course Name	**Physical Chemistry- 4**
Type of Course	**DCC**
Course Code	SJC8DCCCHE401
Course Level	**400-499**
Course Summary	This course covers advanced aspects of kinetic theory of gases, chemical kinetics, surface chemistry and physical chemistry practicals.

Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		2		2		90
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the molecular velocities of gases, mean free path, collision diameter and effusion.	U	1.2
2	Illustrate the theories of reaction rates and correlate the thermodynamically measurable parameters.	A	1.2
3	Compare the nature of reactions in the gas as well as in the solvent phase.	An	1.2
4	Assess the theories and applications of adsorption with the help of adsorption isotherms.	E	1.2
5	Explain different methods for the molar mass determination of macromolecules.	U	1.2
6	Experiment with three component systems, kinetics, polarimetry and refractometry practicals.	A,S	1,2,9,10
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	UNIT 1: KINETIC THEORY OF GASES (10 HRS)			
1	1.1	Derivation of Maxwell's law of distribution of velocities, graphical representation, experimental verification of the law, most probable velocity, derivation of average, RMS and most probable velocities.	5	1
	1.2	Collision diameter, collision frequency in a single gas and in a mixture of two gases, mean free path, frequency of collision, effusion, the rate of effusion, time dependence of pressure of an effusing gas, the law of corresponding states, transport properties of gases.	5	1
2	**UNIT 2: CHEMICAL KINETICS: (10 HRS)**			
	2.1	Theories of reaction rates: potential energy surfaces. Conventional transition state theory, comparison of the collision theory and conventional transition state theories.	4	2
	2.2	Thermodynamic formulation of the reaction rate- Eyring equation. Significance of $\Delta G^{\neq}$, $\Delta H^{\neq}$ and $\Delta S^{\neq}$, volume of activation. Effect of pressure and volume on velocity of gaseous reactions. Reactions in solution: Effect of solvent on reaction rate, cage effect. Effect of dielectric constant and ionic strength on reaction rate - Bronsted-Bjerrum equation.	6	2,3
3	**UNIT 3: SURFACE CHEMISTRY (10 HRS)**			
	3.1	Multilayer adsorption-BET theory, use of BET isotherms for surface area determination.	3	4
	3.2	Application of Langmuir adsorption isotherm in surface catalysed reactions, the Eley-Rideal mechanism and the Langmuir-Hinshelwood mechanism, flash desorption. Macromolecules: Different averages, methods of molecular mass determination - osmotic, viscosity, sedimentation and light scattering methods.	7	4,5
Physical Chemistry IV- Practicals				
4	1. Construction of phase diagram of three component system with one pair of partially miscible liquids.		60	6

	2. Kinetics of simple reactions e.g. acid hydrolysis of methyl /ethyl acetate.		6
	3. Kinetics of reaction between $K_2S_2O_8$ and KI.		6
	4. Data analysis of kinetic experiments using spreadsheet program (determination of rate constant).		6
	5. Polarimetry: ● Kinetics of the inversion of sucrose in presence of HCl. ● Determination of the concentration of a sugar solution. ● Determination of the concentration of HCl. ● Determination of the relative strength of acids.		6
	6. Refractometry: ● Identification of pure organic liquids and oils. ● Determination of molar refractions of pure liquids. ● Determination of concentration of solutions (KCl-water, glycerol—water). ● Determination of molar refraction of solids. ● Study of complex formation between potassium iodide and mercuric iodide system.		6
5	**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture sessions (chalk & board, powerpoint presentation) ● Interactive sessions and simulations ● Visual aids like videos and models to enhance understanding ● Peer discussions ● Laboratory experiments and hands-on training
Assessmen t Types	**Mode of Assessment** **A. Continuous Comprehensive Assessment Theory: 15 marks** Assignment /Quiz /Theory: Test for each unit (MCQ/Written) **Practical: 15 marks** Lab involvement/report /Lab test

	B. Semester-end examination **Theory: Written examination (35 Marks)- 1 hr.** Short answer 5 questions (out of 7): 5 X 3 = 15 marks Short Essay 2 questions (out of 3) : 2 X 10 = 20 marks **Practical: Certified report + procedure + viva voce (10+5+20=35 Marks)- 1 hr.**

References

1. K. J. Laidler, *Chemical kinetics*, 3rd Edn. Pearson education, 2004.
2. I.N. Levine, *Physical Chemistry*, Tata McGraw Hill, 2012.
3. R. P. Rastogi, R. R. Misra, *An Introduction to Chemical Thermodynamics*, 6th Edn. Vikas Pub. Pvt. Ltd., 2003.
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7. G. M. Barrow, *Physical Chemistry*, Tata McGraw-Hill, 2007.
8. G. W. Castellan, *Physical Chemistry*, 4th Ed. Narosa Publishing House, 2018.

Suggested Readings

1. P W Atkins, Physical Chemistry, Oxford University Press, 12th Edition, 2022.
2. R J Silby and R. A. Alberty, M G Bawendi, *Physical Chemistry*, 4th Edition, John Wiley & Sons, 2021.
3. J. Rajaram, J. C. Kuriakose, *Chemical thermodynamics: classical, statistical and irreversible*, Dorling Kindersley (India), 2013.
4. S. Glasstone, D. Lewis, *Elements of Physical Chemistry*, Macmillan, 1963.

St. Joseph's College Moolamattom (Autonomous)

<table>
<tr><td>Programme</td><td colspan="6">BSc (Hons) CHEMISTRY</td></tr>
<tr><td>Course Name</td><td colspan="6">Organic Chemistry-6</td></tr>
<tr><td>Type of Course</td><td colspan="6">DCE</td></tr>
<tr><td>Course Code</td><td colspan="6">SJC8DCECHE400</td></tr>
<tr><td>Course Level</td><td colspan="6">400-499</td></tr>
<tr><td>Course Summary</td><td colspan="6">A comprehensive study of organic synthesis.</td></tr>
<tr><td>Semester</td><td>VIII</td><td colspan="3">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Tutorial</td><td>Practical</td><td>Others</td></tr>
<tr><td>3</td><td></td><td>1</td><td></td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6"></td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply the knowledge of synthetic reagents and reactions in organic transformations.	A	1,2,3
2	Summarize the stereoselective transformations in organic synthesis.	U	1,2,3
3	Analyse the structure and formulate a retrosynthetic scheme for the given organic molecule.	An	1,2,3
4	Develop a synthetic route for an organic molecule.	A	1,2,3,6
5	Synthesise biologically important molecules.	A, S	1, 2, 4

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom Transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Synthetic Reagents and Reactions**		
	1.1	Phosphorous based- triphenylphosphine- Mitsunobu reaction, Wittig reaction, Staudinger reaction; Sulphur based- sulphonium salts, sulfur ylides- Corey-Cheykovsky reaction; Si based reagents- -silyl ethers-TMS, TBDMS, TBDPS, TES, TIPS, Julia olefination, Peterson's olefination, - NBS, DDQ and DCC, Gilman reagent.	5	1,4
	1.2	Carbon-carbon bond formation through coupling reactions - Heck, Suzuki, Stille, Sonogoshira, Negishi, Kumada, Hiyama, Tsuji-Trost, olefin metathesis and McMurry reaction.	5	1,4
	1.3	Baylis-Hillman reaction, Kulinkovich reaction, Ritter reaction, Sakurai reaction, Tishchenko reaction, Tebbe olefination, multi component reactions- Passerini reaction and Biginelli reaction, Click reactions- Huisgen1,3-dipolar addition.	5	1,4
2		**Oxidation and Reduction**		
	2.1	Metal based and non-metal based oxidations of (a) Alcohols to carbonyls- Collins oxidation, Sarett oxidation, PCC; Oppeneur oxidation, Swern oxidation. (b) Alkenes to diols- Prevost reaction and Woodward modification.	3	1,4

	2.2	(c) Alkenes to alcohols/carbonyls without bond cleavage hydroboration-oxidation, Selenium/chromium based allylic oxidation.	3	1,4
		(d) Ketones to ester/lactones- Baeyer-Villiger oxidation.		
	2.3	Reduction : (a) Catalytic hydrogenation (heterogeneous: Pd, Pt, Rh and Ni; homogeneous: Wilkinson's catalyst) (b) Metal based reductions -Birch reduction, pinacol formation, acyloin formation (c) Hydride transfer reagents from group III and group IV in reductions - $NaBH_4$, $LiAlH_4$ and DIBAL-H	4	1,4
3	**Stereoselective and Total Syntheses**			
	3.1	Asymmetric induction- Felkin-Ahn model, Zimmerman-Traxler chair-like transition states.	2	2
	3.2	Noyori asymmetric hydrogenation, Sharpless epoxidation, CBS reduction, Brown allylation and crotylation reactions.	4	2
	3.3	Evans aldol reaction, proline based asymmetric aldol reaction, Jacobsen epoxidation, asymmetric Diels-Alder reaction.	4	2
	3.4	Retrosynthesis- basic concepts, Umpolung reactivity – formyl and acyl anion equivalents, protecting group chemistry- protection and deprotection of hydroxy, carboxyl, carbonyl, and amino groups.	4	3,4
	3.5	Retrosynthetic analysis and total synthesis of atropine, papaverine, longifolene and juvabione.	6	3,4
	Organic Chemistry-6 Practicals			

4		Synthesis of biologically important molecule I. Preparation of phenytoin: - i) Preparation of benzoin using coenzyme catalysed reaction. ii) Preparation of benzil from benzoin. iii) Preparation of phenytoin from benzoin. II. Preparation of benzocaine i) Preparation of *p*-aminobenzoic acid from *p*-nitrobenzoic acid. ii) Preparation of benzocaine from *p*-aminobenzoic acid. III. Preparation of fluorescein. IV. Preparation of 7-hydroxy- 4-methyl coumarin from resorcinol.	15	4
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (mode of transaction)** ● Lecture (chalk & board, powerpoint presentation) ● Group discussion ● Peer learning ● Demonstration of experiments ● Hands-on learning
Mode of	**A. Continuous Comprehensive Assessment (CCA)** Theory : **25 marks** Pop quiz Assignment Written tests **Practical: 15 marks**

assessment	Lab involvement/report /Lab test
	B. Semester-end examination Theory: Written examination - 50 marks- 1.5 hrs.

	i) Short answer 7 questions (out of 9): 7 X 3 =21 i) Short essay 2 questions (out of 3): 2 X 7 = 14 ii) Essay 1 question (out of 2): 1 X 15 = 15 Practical (35 Marks): 1 hr. Viva voce-10 marks Written test of practical procedures-15 marks Certified report of lab works done -10 marks

References

1. J. Clayden, N. Greeves, S. Warren, *Organic Chemistry;* Oxford University Press, USA, 2012.
2. F. A. Carey, R. J. Sundberg, *Advanced Organic Chemistry: Part A. Structure and Mechanisms*; 5th ed.; Springer: New York, 2007.
3. F. A. Carey, R. J. Sundberg, *Advanced Organic Chemistry: Part B. Reactions and Synthesis*; 5th ed.; Springer: New York, 2007.
4. R. O. C. Norman, J. M. Coxon, *Principles of Organic Synthesis*; 3rd Edn. CRC Press: 1993.
5. B. S. Furniss, A. J. Hannaford, V. Rogers, P. W. G. Smith, A. R. Tatchell, *Vogel's Textbook of Practical Organic Chemistry*; 5th Edn.; Pearson Education, 2005.
6. S. Warren, P. Wyatt, *Organic Synthesis: The Disconnection Approach*, 2nd Edn. Wiley, 2008.
7. K. N. Jayaveera, S, Subramanyam, K. Y. Reddy, *Practical Medicinal Chemistry*, S. Chand, 2014.

SUGGESTED READINGS

1. K. C. Nicolaou, E. J. Sorenson, *Classics in Total Synthesis*: *Targets, Strategies, Methods*; VCH: Weinheim, 1996.

	St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Group Theory and Quantum Chemistry**					
Type of Course	**DCE**					
Course Code	SJC8DCECHE401					
Course Level	**400-499**					
Course Summary	This course deals with the applications of quantum chemistry and group theory and fundamental concepts of computational chemistry.					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Summarize the quantum mechanical principles of translational, vibrational and rotational motion.	U	1,2
2	Identify the principles of spherical harmonics in solving hydrogen and hydrogen-like systems.	E	1,2
3	Evaluate the many-body problem, recognize the necessity of approximation methods in quantum mechanics and to outline the basics concepts of bonding in molecules.	A	1,2
4	Outline the basic concepts of different computational chemistry techniques such as Ab initio, semi empirical, density functional theory and molecular mechanics.	U	1,2
5	Construct the character tables for specific point group based on group theoretical principles	A	1,2
6	Utilise the group theoretical aspects to predict the vibrational modes and electronic transition modes.	A	1,2
Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)			

COURSE CONTENT

Content for Classroom transaction (Units)

<table>
<tr><th>Module</th><th>Units</th><th>Course description</th><th>Hrs</th><th>CO No.</th></tr>
<tr><td rowspan="4">1</td><td colspan="4">Application of Quantum Mechanics to solvable systems</td></tr>
<tr><td>1.1</td><td>Translational motion: free particle in one-dimension, penetration into and through barriers (a barrier with finite width-tunnelling), wave function in region I, II & III and their plots. Concept of transmittance and reflection.</td><td>4</td><td>1</td></tr>
<tr><td>1.2</td><td>Vibrational motion: one-dimensional harmonic oscillator (complete treatment), Hermite equation (solving by method of power series), Hermite polynomials, wave functions- their sketch, energies, harmonic oscillator model and molecular vibrations.</td><td>5</td><td>1</td></tr>
<tr><td>1.3</td><td>Quantization of angular momentum, quantum mechanical operators corresponding to angular momenta (L_x, L_y, L_z and L^2).</td><td>4</td><td>1</td></tr>
<tr><td rowspan="3">2</td><td colspan="4">Rotational Motion and Hydrogen Like Atoms</td></tr>
<tr><td>2.1</td><td>Rotational motion: the particle on a ring and its solution. Rigid rotor and its solution for energies and wave function, polar diagrams of spherical harmonics. Spherical harmonics as eigen functions of angular momentum operators L_z and L^2.</td><td>6</td><td>1</td></tr>
<tr><td>2.2</td><td>Quantum mechanics of hydrogen-like atoms: Potential energy of hydrogen-like systems. The wave equation in spherical polar coordinates: separation of variables-r, theta and phi equations and their solutions, wave functions and energies of hydrogen-like atoms. Orbitals: Radial functions, radial distribution functions, angular functions, and their plots.</td><td>6</td><td>2</td></tr>
</table>

3		**Many Body Systems and Computational Chemistry**		
	3.1	Many-body problem and the need of approximation methods. Born-Oppenheimer approximation. Variation method- illustration of variation theorem using the trial function x(a-x) for particle in a 1D-box and using the trial function e^{-ar} for the hydrogen atom.	5	3
	3.2	Perturbation method: time-independent perturbation method (non-degenerate case only), first order correction to energy and wave function, illustration by application to particle in a 1D-box with slanted bottom.	5	3
	3.3	Chemical bonding: Schrödinger equation for molecules, valence bond (VB) theory, VB theory of H_2 molecule (elementary idea only) Molecular Orbital (MO) theory, MO theory of H_2 molecule (elementary idea only). Comparison of MO and VB theories.	5	3
	3.4	Introduction to computational chemistry: scope, potential energy surfaces, global minimum, local minima, saddle points. Tools (methods) of computational chemistry: molecular mechanics, semi empirical methods, *Ab initio* methods, density functional theory – general introduction. Comparison of ab initio, semi empirical and DFT methods	5	4
4		**Group Theory and its Applications**		
	4.1	Reducible and irreducible representations, statement of great orthogonality theorem (GOT) and properties of irreducible representations.	3	5
	4.2	Character table and description of its layout, construction of character tables for C_{2v} and C_{3v}.	3	5
	4.3	*Application to vibrational spectroscopy*: Standard reduction formula, normal mode analysis of H_2O and NH_3 employing cartesian coordinate method and internal coordinate method. Prediction of IR and Raman activity, rule of mutual exclusion.	4	6

	4.4	*Application to electronic spectroscopy*: Transition moment integral, direct product, transitions between non-degenerate states – criteria for allowed transitions, prediction of electronic transitions in C_{2v} and C_{3v} using direct product terms. Electronic transitions due to the carbonyl chromophore in formaldehyde	5	6
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture (chalk & board, powerpoint presentation, flipped classroom) Group discussion – thought problems; mind mapping Peer interaction Demonstration using simulations / models
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Theory: 30 marks** Quiz Assignment Problem based test - Open book Examinations
	Semester end examination Theory: 70 marks- 2 hrs. MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

References

1. P.W. Atkins, R.S. Friedman, *Molecular Quantum Mechanics*, 4th Edn. Oxford University Press, 2005.
2. N. Levine, *Quantum Chemistry*, 7th Edn. Pearson Education Inc., 2016.
3. D.A. McQuarrie, *Quantum Chemistry*, University Science Books, 2008.
4. R.K. Prasad, *Quantum Chemistry*, New Age International, 2001.
5. T. Engel, *Quantum Chemistry and Spectroscopy*, Pearson Education, 2006.
6. E.G. Lewars, *Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics*, 2nd Edn. Springer, 2011.
7. J.H. Jensen, *Molecular Modeling Basics*, CRC Press, 2010.
8. F. Jensen, *Introduction to computational chemistry*, 2nd Edn. John Wiley & Sons, 2007.
9. A. Leach, *Molecular Modelling: Principles and Applications*, 2nd Edn. Longman, 2001.
10. C.J. Cramer, *Essentials of Computational Chemistry: Theories and Models*, 2nd Edn. John Wiley & Sons, 2004.
11. D.C. Young, *Computational Chemistry: A Practical Guide for Applying Techniques to Real World Problems*, John Wiley & Sons, 2001.
12. F.A. Cotton, *Chemical Applications of Group Theory*, 3rd Edn. Wiley Eastern, 1990.
13. S. Swarnalakshmi, T. Saroja, R.M. Ezhilarasi, *A Simple Approach to Group Theory in Chemistry*, Universities Press, 2008.
14. A.S. Kunju, G. Krishnan, *Group Theory and its Applications in Chemistry*, PHI Learning, 2010.
15. K.Veera Reddy, *Symmetry and Spectroscopy of molecules*, New Age International (P) Ltd., 1999.

St. Joseph’s College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Instrumental Methods of Chemical Analysis**					
Type of Course	**DCE**					
Course Code	SJC8DCECHE402					
Course Level	**400- 499**					
Course Summary	This course deals with the theory, instrumentation and applications of various chromatographic techniques, and surface and thermal analytical methods.					
Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				75
Pre-requisites, if any	Nil					

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Describe the basic principles and instrumentation of various chromatographic techniques.	U	1,2
2	Evaluate the efficiency and effectiveness of different chromatographic methods.	E	1,2
3	Analyse the basic principles, instrumentation, limitations and applications of various techniques for surface analysis	An	1,2
4	Analyse the basic principles, instrumentation and applications of various thermal analytical techniques.	An	1,2
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to chromatography**		
	1.1	Adsorption and partition column chromatography- methodology, advantages, limitations and applications.	3	1,2
	1.2	Thin-layer chromatography- introduction, principle, methodology, Rf values, advantages, limitations, and applications.	4	1,2
	1.3	Paper chromatography- Introduction, methodology, development techniques, advantages, limitations, and applications	4	1,2
	1.4	Electrophoresis–introduction, factors affecting electrophoretic mobility, techniques of paper, gel and capillary electrophoresis and its applications.	4	1,2
2		**GC, HPLC and Ion exchange chromatography**		
	2.1	Gas chromatography - introduction, theory, instrumentation, derivatization, temperature programming, advantages, limitations and applications, hyphenated GC techniques (GC-MS, GC-IR, GC-GC, or 2D GC).	6	1,2
	2.2	High-performance liquid chromatography (HPLC)- introduction, theory, instrumentation, advantages and applications, hyphenated techniques in HPLC.	5	1,2
	2.3	Ion exchange chromatography- introduction, classification, ion exchange resins, properties, mechanism of the ion exchange process, factors affecting ion exchange, methodology and applications.	4	1,2
3		**Surface Analysis**		
	3.1	X-Ray photoelectron spectroscopy- instrumentation and sample introduction, applications.	3	3
	3.2	Auger electron spectroscopy- instrumentation and applications.	3	3
	3.3	Secondary ion mass spectrometry- instrumentation, applications, ToF-SIMS.	3	3

	3.4	SEM- basic principles, instrumentation and applications.	2	3
	3.5	STM- basic principles, instrumentation, and applications.	2	3
	3.6	AFM- basic principles, instrumentation, and applications.	2	3
4	**Thermal Analysis**			
	4.1	Thermogravimetry (TGA)- instrumentation, analytical applications of thermogravimetry , derivative thermogravimetry	3	4
	4.2	Differential Thermal Analysis (DTA) - instrumentation and analytical applications.	3	4
	4.3	Differential Scanning Calorimetry (DSC) - instrumentation and applications.	3	4
	4.4	Hyphenated thermal methods.	1	4
	4.5	Thermometric titrimetry.	1	4
	4.6	Microcalorimetry- basic principles and applications of micro-DSC.	2	4
	4.7	Thermomechanical analysis and Dynamic mechanical analysis- applications of TMA and DMA.	2	4
5	**Teacher Specific Content**			

Teaching and Learning Approach	Lecture sessions/interactive sessions/ case studies/ from various scientific fields (like environmental science, pharmaceuticals, forensics) to illustrate how different techniques are applied practically.

Assessment Types	**MODE OF ASSESSMENT** **A. Continuous Comprehensive Assessment (CCA)** **Theory: 30 marks** Assignments MCQ Viva Class Test
	Semester end examination **Theory: 70 marks-2 hrs.** Short answer 5 questions (out of 6): 5 X 4 =20 Short essay 5 questions (out of 7): 5 X 7 = 35 Essay 1 question (out of 2): 1 X 15 = 15

References

1. J W. Robinson, E M. Skelly Frame, G M. Frame II, *Undergraduate Instrumental Analysis*, 7th Edition, Taylor & Francis, 2014.
2. M D Graef, M E. McHenry, *Introduction to TEM, SEM, and AFM: The Practical Approach to Materials Characterization*, 1st Edition, CRC Press, 2018.
3. J W. Robinson, E M S Frame, and G M. Frame II, *Instrumental Analytical Chemistry*, CRC Press, 2021.
4. F A Settle, *Handbook of Instrumental Techniques for Analytical Chemistry*, Prentice Hall, 1997.
5. D A. Skoog, F. J Holler, S R. Crouch, *Principles of Instrumental Analysis*, 7th Edn. Brooks/Cole, 2020.
6. D A. Skoog, D M. West, F. J Holler, S R. Crouch, *Fundamentals of Analytical Chemistry*, 9th Edn. Brooks/Cole, 2014.
7. P. J. Haines, *Principles of Thermal Analysis and Calorimetry*, Royal Society of Chemistry, 2002.
8. E Lundanes, *Chromatography: Basic Principles, Sample Preparations and Related Methods*, Wiley-VCH, 2013.
9. R Stafford, *Chromatography: Principles and Instrumentations*, Nyresearch Press, 2020.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Molecular Modelling**					
Type of Course	**DCE**					
Course Code	SJC8DCECHE403					
Course Level	**400-499**					
Course Summary	This course provides a comprehensive insight into molecular modelling covering Hartree Fock Method & Post Hartree Fock Methods, various computational chemistry methods and applications of computational chemistry softwares.					
Semester	**VIII**	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Demonstrate the need for the approximations to the Hamiltonian.	U	1,2
2	Classify different types of basis sets.	U	1,2
3	Compare and contrast different methods of computational chemistry.	An	1,2,3
4	Utilize GAMESS software to solve molecular systems.	A	1,2,4,9,10
5	Utilize Autodock software to predict protein-ligand interactions.	A	1,2,3,4,9, 10

****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Hartree Fock Method & Post Hartree Fock Methods			
1	1.1	Multi-electron atoms. Hartree method, spin multiplicity, Slater determinant, properties of Slater determinant, Hartree-Fock (HF) equations. Secular determinant, restricted and unrestricted HF models.	5	1
	1.2	The Fock matrix, Roothan Hall equations, elements of the Fock matrix (elementary ideas only), steps for HF calculation, Koopmann theorem.	5	1
	1.3	The need for post HF methods. electron correlation, post HF methods: configuration interaction and Møller Plesset perturbation theory (elementary ideas only)	3	1
	1.4	Roothan's concept of basis functions, Slater type orbitals (STO), Gaussian type orbitals (GTO), sketches of STO and GTO. Differences between STOs and GTOs.	3	2
	1.5	Classification of basis sets – minimal basis sets; Pople basis sets (with polarization and diffuse functions), correlation consistent basis sets; double zeta, triple zeta and quadrupole zeta basis sets, split valence basis set, Hartree Fock limit.	4	2
2	**Computational Methods**			
	2.1	Semiempirical methods: introduction, neglect of differential overlap method (NDO), complete neglect of differential overlap (CNDO), modified neglect of differential overlap (MNDO); Austin Model 1, parametric method 3 (PM3), zero differential overlap (ZDO) (concepts only). Comparison of semiempirical methods. Software used for semiempirical calculations.	5	3

	2.2	Ab Initio method: introduction, computation of correlation energy, computation of Slater determinant of excited states, Möller-Plesset perturbation and coupled cluster method.	4	3
	2.3	Density functional theory: introduction, electron density, development of DFT, The functional, Hohenberg and Kohn theorem, Kohn and Sham method, density functionals – exchange and correlation functionals with examples, DFT methods, applications of DFT, performance of DFT, advantages of DFT in biological chemistry.	6	3
	2.4	Molecular Mechanics (MM): introduction, basic theory- bond stretching, angle bending, torsional strain, non bonded interactions. Force fields – MM2, MM3, MM4, AMBER, CHARMM, merck molecular force field, consistent force field, parameterization.	4	3
	2.5	Comparison between semiempirical, Ab Initio, DFT and MM methods – merits and demerits.	1	3
	Computational Software			
3	3.1	Introduction to GAMESS. Setting up the input file with run type - geometry optimization, frequency calculation and single point energy calculations. $ groups, format for input file. Hands-on training using the software.	5	4
	3.2	Input for molecule – cartesian coordinates and Z-matrix. Z matrix- rules, z-matrix for linear molecules like diatomic molecules, acetylene, hydrogen cyanide and polyatomic molecules like water, ammonia, boron hydride and methane.	5	4
4	**Docking**			
	4.1	Introduction to docking (basic ideas only), protein ligand interactions; setting up the protein and ligand using babel and pymol; predicting ADMET of the molecule using PreADMET application; docking procedures using autodock software and result analysis with visualization of interactions using discovery studio. Hands-on training using the software.	10	5
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom procedure (mode of transaction)** Lecture (chalk & board, powerpoint presentation, flipped classroom) Group discussion – thought problems; mind mapping Peer interaction Demonstration using simulations / models
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Theory: 30 marks** Theory: Quiz Assignment Problem based test - Open book Examinations
	Semester end examination Theory: 70 marks- 2 hrs. MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

References

1. K. I. Ramachandran, G. Deepa, K. Namboori, *Computational Chemistry and Molecular Modeling Principles and Applications*, Springer, 2008
2. P.W. Atkins, R.S. Friedman, *Molecular Quantum Mechanics*, 4th Edn. Oxford University Press, 2005.
3. A. Szabo, N. S. Ostlund, *Modern Quantum Chemistry: Introduction to Advanced Electronic Structure Theory*, Dover Books on Chemistry, 1996.
4. A. Leach, *Molecular Modelling: Principles and Applications*, 2nd Edn. Longman, 2001.
5. E.G. Lewars, *Computational Chemistry: Introduction to the Theory and Applications of Molecular and Quantum Mechanics*, 2nd Edn. Springer, 2011.
6. J.H. Jensen, *Molecular Modeling Basics*, CRC Press, 2010.
7. F. Jensen, *Introduction to computational chemistry*, 2nd Edn. John Wiley & Sons, 2007.
8. C.J. Cramer, *Essentials of Computational Chemistry: Theories and Models*, 2nd Edn. John Wiley & Sons, 2004.
9. M. Tuckerman, *Statistical Mechanics: Theory and Molecular Simulation*, Oxford University Press, 2010.

St. Joseph's College Moolamattom (Autonomous)

Programme	**BSc (Hons) CHEMISTRY**					
Course Name	**Crystallography and Electrochemistry**					
Type of Course	DCE					
Course Code	SJC8DCECHE404					
Course Level	**400-499**					
Course Summary	This is an advanced physical chemistry course dealing with crystallography, electrochemistry and electro analytical techniques.					
Semester	VIII	Credits			4	Total Hours
Course Details	Learning Approach	Lecture	Tutorial	Practical	Others	
		4				60
Pre-requisites, if any						

COURSE OUTCOMES (CO)

CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Discuss the basic concepts of crystal systems like unit cell, lattice and deduce the crystal structure of NaCl and KCl from XRD patterns.	An	1,2,3
2	Distinguish different diffraction methods and correlate the structure factor with the peak intensity.	A	1,2,3
3	Describe the structure of ionic solution and interpret the laws governing ionic conductivity.	U	1,2
4	Explain the features of concentration cells and fuel cells.	U	1,2
5	Explain the causes of corrosion, prevention methods.	U	1,2
6	Learn the basic principles of voltammetry and describe voltammogram by analysing the peak current and peak potential.	U	1,2
7	Apply the theory behind electroanalytical techniques to quantitative and qualitative analysis.	A	1,2
****Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)***			

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	UNIT 1: CRYSTALLOGRAPHY (15 HRS)			
1	1.1	Symmetry in crystals: symmetry elements – proper rotation (order of axis – 1, 2, 3, 4 and 6 – derivation), mirror plane, rotary inversion axis. 32 crystallographic point groups (derivation not expected), Hermann-Mauguin notation and corresponding Schoenflies notations, translational symmetry elements - glide planes and screw axes, fourteen Bravais lattices, space groups (concept only). Space groups of triclinic and monoclinic systems.	5	1
	1.2	Miller indices, inter-planar spacing and method of determining lattice types, reciprocal lattices. X-ray diffractometer: single crystal and powder pattern methods (experimental part). Analysis of powder diffraction patterns of NaCl and KCl. Debye-Scherrer equation.	6	1
	1.3	Crystal growth techniques. Structure factor: atomic scattering factor, coordinate expression for structure factor.	4	2
	UNIT 2: ADVANCED ELECTROCHEMISTRY (30 HRS)			
2	2.1	Debye-Huckel theory, derivation of Debye-Huckel- Onsager equation, validity of DHO equation for aqueous and non-aqueous solutions, Debye-Huckel limiting law (no derivation) qualitative and quantitative tests of Debye-Huckel limiting law, deviations from DHLL.	10	3
	2.2	Concentration cells – with and without transference, liquid junction potential, electrode double layer, electrode-electrolyte interface, different models of double layer, theory of multilayer capacity, electro capillary, Lippmann equation, membrane potential. Fuel cells- theory and working of fuel cells- methanol fuel cell, H_2-O_2 fuel cell and solid oxide fuel cells.	10	4
	2.3	Corrosion and methods of prevention, Pourbaix diagram and Evans diagrams. Electrode polarization:- overvoltage: hydrogen and oxygen overvoltage, theories of overvoltage, Tafel equation and its significance.	10	5

	UNIT 3: ELECTRO ANALYTICAL TECHNIQUES (15 HRS)			
3	3.1	Electroanalytical techniques: classification – interfacial and bulk methods; idea of static and dynamic methods.	1	6
	3.2	Polarography- decomposition potential, residual current, migration current, supporting electrolyte, diffusion current, polarogram, half wave potential, limiting current density, polarograph, explanation of polarographic waves. The dropping mercury electrode, advantages and limitations of DME, quantitative analysis- pilot ion procedure, standard addition methods, qualitative analysis - determination of half wave potential of an ion, advantages of polarography.	8	6, 7
	3.3	Cyclic voltammetry – basic principles and fundamentals; cyclic voltammogram for a reversible and irreversible redox process, Scan rate. Amperometric titrations: General principles of amperometry, instrumentation, application of amperometry in the qualitative analysis of anions and cations in solution, merits and demerits of amperometric titrations.	6	7
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** ● Lecture sessions (chalk & board, powerpoint presentation) ● Interactive sessions and simulations ● Visual aids like videos and models to enhance understanding ● Peer discussions ● Laboratory experiments and hands-on training
Assessment Types	**MODE OF ASSESSMENT** **Continuous Comprehensive Assessment (CCA) Theory; 30 marks** Pop quiz Assignment Test for each unit (MCQ/written)

	Semester End examination **Theory: Written examination (70 Marks)- 2 hrs.** MCQ – 10 marks (1 mark each – 10 nos) Short answer questions – 24 marks (3 marks each – 8 out of 10 nos) Long answer questions – 21 marks (7 marks each – 3 out of 5 nos) Essay type question – 15 marks (1 out of 2 nos)

References

1. R P W Atkins, *Physical Chemistry*, 12th Edn. Oxford University Press, 2018.
2. N B Hannay, *Solid State Chemistry*, Prentice Hall. 1967.
3. A. McQuarrie, J. D. Simon, *Physical Chemistry – A molecular Approach*, Viva Books Pvt. Ltd., 2019.
4. Anthony R. West, *Solid State Chemistry and its Applications*, Wiley Eastern, 2018.
5. O. Simoska, S. D. Minteer, *Techniques in Electroanalytical Chemistry*, American Chemical Society, 2022.
6. S. Glasstone, *An Introduction to Electrochemistry*, East-West Press (Pvt.) Ltd. 2006.
7. G. Raj, *Advanced Physical Chemistry*, Goel publishing house, 2016.
8. R. J. Silby and R. A. Alberty, M G Bawendi, *Physical Chemistry*, 4th Edition, John Wiley & Sons, 2015.
9. A. J. Bard and L. R. Faulkner *Electrochemical methods: Fundamentals and Applications*, Second Edn., Wiley, 2022.

Suggested Readings

1. G. K. Vemulapalli, *Physical Chemistry*, Prentice-Hall of India Pvt. Ltd, 1996.
2. S. Glasstone, D.Lewis, *Elements of Physical Chemistry*, Macmillan, 1963.
3. I. N. Levine, *Physical Chemistry*, Tata McGraw Hill, 2011.
4. G. M. Barrow, *Physical Chemistry*, Tata McGraw-Hill, 2007.

Internship Evaluation

All students shall undergo summer internship or apprenticeship in a firm, industry or organization; or training in labs with faculty and researchers or other higher education institutions (HEIs) or research institutions after completion of the fourth semester.

Evaluation scheme (total 50 marks)

1) Internal Evaluation (15 marks)

(Internal marks may be obtained from the organisation/institution where the student is doing internship using the following format)

Mentor Signature: (Insert Mentor's Signature) :

2) Final Evaluation (35 marks)

Report (20 marks)

i)	Relevance	: 5 marks
ii)	Professionalism & ethical considerations	: 5 marks
iii)	Result Analysis	: 5 marks
iv)	Conclusions	: 5 marks

Viva voce (15 marks)

(Student's skills, work ethics, professionalism and contribution to the organisation may be evaluated through viva)

Chemistry Undergraduate Student Evaluation Form for Internship

Internship Details:

Student Name:

Date of Evaluation:

Duration of Internship:

Mentor Name:

Instructions: Please rate the student's performance based on their abilities, skills, and behaviour during the internship. Provide specific examples or comments where applicable to support your ratings.

1. Technical Skills and Problem Solving (Marks out of 3) :

2. Communication Skills and Collaboration (Marks out of 3) :

3. Professionalism (Marks out of 3) :

4. Adaptability (Marks out of 3) :

5. Overall Performance (Marks out of 3) :

Total (out of 15) :

Comments and Recommendations: (Provide specific comments on the student's strengths, areas for improvement, and any additional feedback or recommendations for their future

Project Evaluation- SJC8PRCHE400

I. Project with 12 credits (200 marks)

1) Internal Evaluation (60 marks)

i) Initiative and Independence	: 10 marks
ii) Technical Skills	: 10 marks
iii) Problem Solving	: 10 marks
iv) Communication Skills	: 10 marks
v) Professionalism	: 10 marks
vi) Overall Performance	: 10 marks

(If the student is doing project in any outside institution, internal marks may be obtained from there (from the project supervisor))

2) Final Evaluation (140 marks)

i) Novelty of the work	: 20 marks
ii) Experimental Section	: 10 marks
iii) Results and Discussion	: 20 marks
iv) Conclusion	: 10 marks
v) Literature Survey	: 10 marks
vi) Presentation of the work	: 30 marks
vii) Viva voce	: 40 marks

(If the student is doing project in any outside institution, internal marks may be obtained from there (from the project supervisor))