UNIVERSITY OF KERALA

SCHEME AND SYLLABUS

(OUTCOME BASED)

FIRST DEGREE PROGRAMME IN POLYMER CHEMISTRY

(B.Sc.)

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM

Core Courses, Foundation Course II, Open and Elective Courses

2021 ADMISSION ONWARDS

UNIVERSITY OF KERALA

SCHEME AND SYLLABUS

FIRST DEGREE PROGRAMME (B.Sc.) IN POLYMER CHEMISTRY

2021 ADMISSION ONWARDS

The BSc Degree programme in Polymer Chemistry covers three academic years of six semesters and aims to provide the students with an in-depth understanding and training in chemical sciences. The syllabus has been designed to stimulate the interest of the students in polymer chemistry and prepared in order to equip the students with a potential to contribute to the academic and industrial Requirements of the society. The new, updated syllabus is in accordance with the **OUTCOME BASED EDUCATION (OBE)** which aim at acquiring advanced knowledge in Polymer Chemistry as a discipline, in an interdisciplinary way. Based on the new guidelines of OBE, **Programme Outcome (PO)** ***for the First degree Programme is defined by University of Kerala***. **Programme Specific Outcome (PSO)** relating to B.Sc. Polymer Chemistry and **Course Outcome (CO)** relating to each course are also specified. [CO is of the Remember level (R) understand level (U) and apply level (A) based on Blooms Taxonomy]

Polymer Chemistry being an experimental science, due importance is given to the development of laboratory and instrumentation skills. The student is acquainted with the method of science, research methodology and the use of Computational software and Cheminformatics thus developing basic skills and knowledge of computing and data based decision making. At the same time, emphasis is given to critically analyse the impact of Polymer Chemistry in the present scenario of emerging human friendly and eco-friendly green approach in various facets of life and to become cautious against the random usage of dangerous chemicals.

It also provides a detailed knowledge of the terms, concepts, methods, principles and experimental techniques of chemistry, in order to get a comprehensive knowledge in leading a better life in harmony with nature.

PROGRAMME SPECIFIC OUTCOME (PSO) FOR FDP IN POLYMER CHEMISTRY

Sl. No.	Upon completion of B.Sc. Degree programme in Polymer Chemistry, students	PSO No.
1	Develop scientific outlook scientific attitude and scientific temper	PSO1
2	Develop skill in experimenting, analyzing and interpreting data	PSO2
3	Develop research attitude and adopt scientific method of identifying, analyzing and solving research problems in an innovative way	PSO3
4	Apply physical and mathematical theories and principles in the context of chemical science	PSO4
5	Use chemistry related soft wares for drawing structure and plotting graphs	PSO5
6	Use instruments- potentiometer, conductometer, pH meter and colorimeter.	PSO6
7	Acquire skill in safe handling of chemicals including hazardous materials.	PSO7
8	Identify the ingredients in household chemicals, use them in a critical way	PSO8

9	Predict analytical procedures, compare experimental, theoretical and graphical methods of analysis	PSO9
10	Predict reaction mechanism in organic reactions	PSO10
11	Understand the terms, concepts, methods, principles and experimental techniques of physical, organic, inorganic and analytical chemistry	PSO11
12	Develop critical thinking and adopt healthier attitudes towards individual, community and culture through the course of Chemistry	PSO12
13	Become cautious about environmental aspects and impact of chemicals in soil, water and air and adopt eco-friendly approach in all frontiers of life	PSO13
14	Become responsible in consumption of natural resources and adopt measures for sustainable development.	PSO14
15	Visit Chemical factories and industries with scientific curiosity	PSO15
16	Develop writing skills and presentation skills using audio visual aids	PSO16
17	Compare and share knowledge in an interdisciplinary manner	PSO17
18	Inculcate spirit of originality, novelty, and necessity in scientific research	PSO18
19	Contribute to the academic and industrial requirements of the society	PSO19
20	Adopt safer life skills in a human friendly and eco-friendly way	PSO20
21	Understand the basic concepts, preparation methods and processing techniques of polymers and its importance in the present society.	PSO21
22	Employ critical thinking and the scientific method to design, carry out, record and analyze the production of polymers.	PSO22
23	Use chemical techniques relevant to academia and industry, generic skills and global competencies, including knowledge and skills that enable students to undertake further studies in the field of polymer chemistry or a related field, and work in the chemical and non-chemical industry sectors.	PSO23
24	Undertake hands on lab work and practical activities which develop problem solving abilities required for successful career in pharmaceuticals, chemical industry, teaching, research, environmental monitoring, product quality, consumer goods industry, food products, cosmetics industry, etc.	PSO24
25	Understand safety of chemicals, transfer and measurement of chemical, preparation of solutions, and find out the green route for polymer synthesis for sustainable development.	PSO25
26	Create an awareness of the impact of polymers on the environment, society, and development outside the scientific community.	PSO26

COURSE STRUCTURE

The First Degree programme in Polymer Chemistry comprises of fourteen core courses, one project course, two choice based courses (an Open course in Vth semester and an Elective course in VIth semester), one core specific foundation course (IInd semester) in addition to one area-specific foundation course, the complementary courses and language courses. The open course offered in the fifth semester is open to students from other Majors. The details of the Course Structure are given in **Table I to IV**.

A Computer Skill Development Programme is included as part of the Core Course PO1221 (Foundation Course II in Semester II), for computational skill development with no End Semester Evaluation (ESE).

FIRST DEGREE PROGRAMME IN POLYMER CHEMISTRY

Table I: Course structure, Scheme of Instruction and Evaluation

SEMESTER I								
Course Code	Study component	Instructional hrs/Week		Credit	Duration of Uty. Exam	Evaluation marks		Total Credit
		T	P			CE	ESE	18
EN1111.1	English I	5		4	3hrs	20	80	
1111.1	Additional Language I	4		3	3hrs	20	80	
EN1121	Foundation Course I	4		2	3hrs	20	80	
MM1131.2	Complementary Course I	4		3	3hrs	20	80	
PY1131.2	Complementary Course II	2		2	3hrs	20	80	
	Complementary Course Lab of PY1131.2		2	-	-	-	-	
PO1141	Core Course I	2		4	3hrs	20	80	
	Core Course Lab I of PO1141		2	-	-	-	-	
SEMESTER II								
EN1211.1	English II	5		3	3hrs	20	80	18
EN1212.1	English III	4		4	3hrs	20	80	
1211.1	Additional Language II	4		3	3hrs	20	80	
PO1221	Foundation Course II	2	2	3	3hrs	20	80	
MM1231.2	Complementary Course III	4		3	3hrs	20	80	
PY1231.2	Complementary Course IV	2		2	3hrs	20	80	
	Complementary Course Lab of PY1231.2		2	-	-	-	-	

SEMESTER III								
EN1311.1	English IV	5		4	3hrs	20	80	18
1311.1	Additional Language III	5		4	3hrs	20	80	
MM1331.2	Complementary Course V	5		4	3hrs	20	80	
PY1331.2	Complementary Course VI	3		3	3hrs	20	80	
	Complementary Course Lab of PY1331.2		2	-	-	-	-	
PO1341	Core Course II	3		3	3hrs	20	80	
	Core Course Lab II of PO1341		2	-	-	-	-	
SEMESTER IV								
EN1411	English V	5		4	3hrs	20	80	24
1411	Additional	5		4	3hrs	20	80	
	Language IV							
MM1431.2	Complementary	5		4	3hrs	20	80	
	Course VII							
PY1431.2	Complementary Course VIII	3		3	3hrs	20	80	
PY1432.2	Complementary Course Lab of PY1131.2 PY1231.2 PY1331.2 & PY1331.2		2	4	3hrs	20	80	
PO1441	Core Course III	3		3	3hrs	20	80	
PO1442	Core Course IV- Lab I & II of PO1141,PO1341,PO1441		2	2	6 hrs	20	80	
SEMESTER V								
PO1541	Core Course V	3		3	3hrs	20	80	18
PO1542	Core Course VI	4		4	3hrs	20	80	
PO1543	Core Course VII	4		4	3hrs	20	80	
PO1544	Core Course VIII Lab III		6	3	3hrs	20	80	
PO 1545	Core Course IX - Lab III & IV		3	2	3hrs	20	80	
1551	Open Course	3		2	3hrs	20	80	
	Project		2	-	-	-	-	
SEMESTER VI								
PO1641	Core Course X	3		3	3hrs	20	80	24
PO1642	Core Course XI	4		4	3hrs	20	80	
PO1643	Core Course XII	4		4	3hrs	20	80	
PO1644	Core Course XIII Lab V		2	3	3hrs	20	80	

PO1645	Core Course XIV Lab VI		6	4	3hrs	20	80	
PO1661	Elective Course	3		2	3hrs	20	80	
PO1646	Project and Factory Visit		3	4	Viva voce	-	100	

Table I A. Total number of Courses offered in B.Sc. programme

Sl No.	Courses	No. of courses	Credits semester wise
1	Language Courses	9	7+10+8+8=33
2	Foundation Courses	2	2+3=5
3	Complementary Courses	9	5+5+7+11=28
4	Core Courses	14	4+3+5+16+18=46
5	Open Course	1	2
6	Elective Course	1	2
7	Project	1	4
Total number of Courses		37	
Total number of credits in all six semesters		18+18+18+24+18+24=120.	120

Table II. Scheme of instruction of Core Courses, Foundation Course II, Open Course and Elective Course

Course No. Course code	Course Title	Sem I		Sem II		Sem III		Sem IV		SemV		Sem VI		Total	
		Hrs L/P	C	Hrs L/P	C	Hrs L/P	C	Hrs L/P	C	Hrs L/P	C	Hrs L/P	C	Hrs	**C**
C.C.I PO1141	Inorganic Chemistry I	2/2	4											2	**4**
F.C.II PO1221	Methodology and Informatics			2/2	3									4	**3**
C.C.II PO1341	Physical Chemistry I					3/--	3							3	**3**
C.C.III PO1441	Organic Chemistry I							3/--	3					3	**3**
C.C.IV PO1442	Lab I & II of PO1141,PO1341&PO1441 (Inorganic Qualitative & Volumetric Analysis)					--/2		--/2	2					6	**2**
C.C.V PO1541	Organic Chemistry II									3/--	3			3	**3**
C.C.VI PO1542	Physical Chemistry II									4/--	4			4	**4**
C.C.VII PO1543	Polymer Chemistry I									4/--	4			4	**4**

C.C.VIII PO1544	Lab III of PO1541, (Organic Analysis)									--/6	3			6	**3**
C.C.IX PO1545	Lab IV of PO 1543 (Polymer Chemistry Experiments)									--/3	2			3	**2**
O.C PO1511	Open to other majors									3/--	2			3	**2**
C.C.X PO1641	Inorganic Chemistry II											3/--	3	3	**3**
C.CXI PO1642	Physical Chemistry III											4/--	4	4	**4**
C.CXII PO1643	Polymer Chemistry II											4/--	4	4	**4**
C.C.XIII PO1644	Lab Course V (Gravimetry Experiments)											--/2	3	2	**3**
C.C.XIV PO1645	LabCourseVI (Physical Chemistry Experiments)											--/6	4	6	**4**
E.C PO1661	Any one of the options											3/--	2	3	**2**
C.C.XV PO1646	Project									--/2		--/3	4	5	**4**
	Factory visit														
Credits/Semester		**4**		**3**		**3**		**5**		**18**		**24**			**57**

C.C-Core Course, F.C-Foundation Course, O.C-Open Course, E.C-Elective Course L-Theory, P-Practical, C-Credit

B.Sc. Degree Programme in Polymer Chemistry

Table III. Open Course offered to students of other disciplines

Semester V

Semester	No. of Hours / Week		Credits	Course Code	Title of the Course	Instructional Hours
	L	P				
V	3	-	2	PO1551.1	Chemistry in Everyday Life	54
				PO1551.2	Chemistry and its Applications	
				PO1551.3	Fundamentals of Chemistry & Its Application to Everyday Life	
				PO1551.4	Environmental Chemistry	

B.Sc. Degree Programme in Polymer Chemistry

Table IV. Elective Course offered in Semester VI

Semester	No. of Hours / Week		Credits	Course Code	Title of the Course	Instructional Hours
	L	P				
VI	3	-	2	PO1661	Advanced Polymer Chemistry	54

GENERAL ASPECTS OF EVALUATION
MODE OF EVALUATION - COMMON TO CORE, ELECTIVE AND FOUNDATION COURSES

Evaluation of each course shall involve Continuous Evaluation (CE) of 20 marks and End Semester Evaluation (ESE) of 80 marks.

1. CONTINUOUS EVALUATION FOR LECTURE COURSES

The Continuous evaluation will have 20 marks and will be done continuously during the semester.

CE components are

1) Attendance for lecture and laboratory sessions (to be noted separately where both lecture and laboratory hours have been specified within a course);
2) Assignment /seminar and
3) Test

The distribution of marks is shown below. There will be two class tests for which, the better of the two marks obtained will form part of CE. Seminar for each course to be organized by the course teacher and assessed along with a group of teachers in the Department. The topic selection by the student for assignments/seminar will be with the approval of the course teacher.

No	Component	Marks
1	Attendance	5
2	Assignment / Seminar	5
3	Tests	10
Total		**20**

1.1 EVALUATION OF THE ASSIGNMENTS AND SEMINAR

The topic selection by the student for assignments/seminar will be with the approval of the course teacher.

The assignment can be

1. A report of about 4-6 pages in A4 size paper

2. The topic can be presented either as oral or as power point for 10 minutes duration using audio-visual aids if available. The seminar is to be conducted within the contact hour allotted for the course.
3. Preparing Charts on assigned topic
4. Making static or working models.

The submitted report /chart /models should be evaluated for assignment marks.

Mode of Assignments / Seminar Evaluation		
No	**Main Component**	**Marks**
1	Adherence to overall structure & submission deadline	All four main components present & satisfactory : 5 Only three : 4 Only two : 3 Only one : 2
2	Content & grasp of the topic	
3	Lucidity / Clarity of presentation	
4	References / Interaction/Overall effort	

QUESTION PAPER PATTERN FOR CONTINUOUS EVALUATION TESTS

- The theory examination has a duration of 1.5 hours and a maximum mark of 40
- Questions should be 20% hard, 60% medium and 20% easy.

1. Each question paper has three sections: A, B & C
2. Section A has ten compulsory- one word/one sentence questions carrying 1 mark each.
3. Section B contains twelve short questions of which 7 questions have to be answered. Each question carries 2 marks.
4. Section C contains nine questions of which 4 has to be answered. Each question carries 4 marks. The answer must contain at least 8 points (Short Essay type).
5. 30% of the questions in physical chemistry papers should be problem based.

Question Paper Pattern for CE Test		
Question No	Type of Question	Marks
Section A: 1-10	All / one word/one sentence	1×10 = 10
Section B: 11-22	7out of 12; Short Answer	7 × 2 = 14
Section C: 23-31	4 out of 9; Short Essay	4 × 4 = 16

DETAILS OF ESE FOR LAB COURSES					
Lab Course	Course name	ESE	Time	Total Marks 100	
				CE	ESE
Lab course I & II	Inorganic Qualitative and Volumetric analysis	IV Semester	6Hrs	20	80
Lab course III	Organic Chemistry Experiments	V Semester	3Hrs	20	80
Lab course IV	Polymer Chemistry Experiments	V Semester	3Hrs	20	80
Lab course V	Gravimetric Experiments	VI Semester	3Hrs	20	80
Lab course VI	Physical Chemistry experiments	VI Semester	3Hrs	20	80

CONTINUOUS EVALUATION FOR LABORATORY COURSES

The Continuous evaluation will have 20 marks. The ESE of Inorganic Qualitative Analysis and Volumetric analysis will be done only in the IV semester and similarly the ESE of Organic chemistry and Polymer chemistry experiments will be done only in the V semester. The ESE of Physical and Gravimetric experiments will be done at the end of VI semester. But the corresponding CE are calculated from all the semesters in which there is attendance for laboratory sessions.

No	Component	Marks
1	Attendance	5
2	Lab test	5
3	Record	5
4	Punctuality	5
Total		**20**

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EVALUATION OF THE RECORD

On completion of each experiment, a report should be presented to the course teacher as soon as the experiment is over. It should be recorded in a bound note-book. The experimental description should include aim, principle, materials/ apparatus required/ used, method/ procedures, and tables of data collected, equations, calculations, graphs, and other diagrams and the final results.

CE for Lab report &Laboratory Record *		
No	**Sub Component**	**Marks**
1	Punctual submission and Neat presentation	All four sub-components present & satisfactory : 5
2	Record of more than 90% experiments in the syllabus	Any three : 4 marks
3	Calculations and absence of errors/mistakes	Only two 3
4	Accuracy of the result	Only one 2

***The LAB RECORD of experiments, certified by the tutor and HOD is compulsory for the ESE**

2. GUIDELINES FOR QUESTION PAPER SETTERS FOR ESE

- The theory examination has a duration of 3 hours
- The maximum marks is 80 for each theory paper.
- Question paper should contain 20% Remember (R), 60% Understanding (U) and 20% Application (A) Level questions.
- Questions should be as per the syllabus from the standard text books mentioned in syllabus
- Question paper setter should submit a detailed scheme of evaluation along with question paper.

QUESTION PAPER PATTERN (ESE)

1. Each question paper has four Sections: A, B , C and D
2. Section A has ten compulsory- one word/one sentence questions carrying **1** mark each
3. Section B contains twelve short questions of which eight questions have to be answered. Each question carries **2** marks with four points (Short Answer type).
4. Section C contains nine questions of which six has to be answered. Each question carries **4** marks. The answer must contain at least 8 points (Short Essay type).
5. Section D contains four questions of which the candidate has to answer two. Each question should have three subdivisions with a total of **15** marks.
6. Section D contains four questions of which the candidate has to answer two. Each question should have three subdivisions with a total of **15** marks.

Question Paper Pattern for ESE		
Question No	Type of Question	Marks
Section A: 1-10	10 one word/one sentence	1 × 10 =10
Section B: 11-22	8 out of 12; Short Answer	2 × 8 =16
Section C: 23-31	6 out of 9; Short Essay	4 × 6 = 24
Section D: 32-35	2 out of 4	15 × 2 = 30
Total	**80 marks**	

UNIVERSITY OF KERALA

SYLLABUS FOR BSc POLYMER CHEMISTRY

First degree programme

2021 admission onwards

Semester	I
Course	Core course -I
Course name	**INORGANIC CHEMISTRY -I**
Course code	PO1141
Credit	4
Hours	36 hours
Lecture –Tutorial- Lab	2-0-2

CO No.	**COURSE OUTCOME** Upon completion of this course, the students	Cognitive Level	PSO No.
1	Differentiate particle nature & wave nature of matter and associate wave concept with microscopic matter	U	10
2.	Discuss the rules for the filling of electrons in atomic orbitals,	A	10
3.	Correlate stability of atom with electronic configuration	U	10
4.	Understand the relevance of periodic classification of elements	U	10
5.	Define various scales of electronegativity and their applications	U	4
6.	Discuss the occurrence and isolation of elements	U	4
7.	Predict the stability of atoms and nature of bonding between them.	U, A	4
8.	Discuss different types of secondary bond forces.	U	4
9.	Explain the significance of hydrogen bonding	U	4
10.	Define dipole moment and discuss its applications	U, A	4
11.	Understand various theories of chemical bonding and their limitations.	U	4
12.	Predict geometry of molecules from the type of hybridisation	A	4
13.	Discuss theories of metallic bonding	U	4
14.	Discuss the structure of nucleus and comprehend the meaning of stability of nucleus.	U	11
15.	Discuss various types of nuclear reactions and nuclear reactors.	U	11
16.	Discuss applications of radioactivity in various fields.	A	3
17	Point out the major sources of air, water & soil pollution and its environmental impact. Take steps for sustainable development.	U, A	12

	COURSE DESCRIPTION	Hrs	CO No.
Module 1	**Modern Theory of Atomic Structure**	**6**	
1.1	Introduction to wave mechanics: Dual nature of electron, Heisenberg's uncertainty principle and its significance.	1	1
1.2	Schrodinger wave equation for a particle in one dimensional box and its solution (no derivation), Radial and angular function	1	1
1.3	significance of orbital concept, shapes of orbitals, Pauli's exclusion principle, Aufbau principle and Hund's rule	2	2
1.4	Electronic configuration if atoms, extra stability of filled and half-filled orbital, classification of elements into s, p, d and f blocks	2	3
Module 2	**Periodic Properties, Occurrence and Isolation of Elements**	**6**	
2.1	Periodic Properties: Size of atoms & ions, ionization energies, electron affinity, Fajan's rule, electronegativity	1	4
2.2	Pauling, Mulliken, Allred & Rochow scale, horizontal vertical and diagonal relationship in the periodic table	2	5
2.3	Occurrence & isolation of elements (brief idea)-mechanical separation of elements that exist in the native form, thermal decomposition methods, displacement of one element by another, high temperature chemical reduction method, electrolytic reduction, factors influencing the choice of extraction process	3	6
Module 3	**Chemical Bonding, I**	**6**	
3.1	Types of bonds, General properties of ionically and covalent bonded compounds. Ionic bond- Lattice energy of ionic compounds-Born Haber Cycle	2	7
3.2	Partial covalent character of ionic bond-Fagan's rule	1	7
3.3	Secondary bond forces- Vander Waals forces: ion-dipole, dipole-dipole, ion-induced dipole & dipole-induced dipole interactions	1	8
3.4	Hydrogen bond & their consequences	1	9
3.5	Dipole moment & its applications	1	10
Module 4	**Chemical Bonding, II**	**6**	
4.1	Covalent bond - Lewis theory, Sidgwick - Powell theory, VSEPR theory	1	11
4.2	V.B. theory (qualitative idea taking hydrogen as example)	1	11
4.3	Hybridisation (explanation of structures of molecules such as SF_4, ClF_3, IF_7, XeF_4 & XeF_6).	1	12
4.4	Sigma & pi bonds, the extent of d orbital participation in molecular bonding, M. O. Method - s – p, p– p, p-d, d-d, and non–bonding combinations of orbitals	1	11

4.5	Rules of LCAO, M.O. Configuration of H_2^+, He_2^+, Li^{2+}, C_2, N_2, O_2, O_2^-, F_2, NO bond order. M.O. treatment involving delocalized π bonding resonance.	1	11
4.6	Metallic bonding - general properties, qualitative idea of theories of bonding in metals - free electron theory, V.B. theory, and band theory.	1	13
Module 5	**Nuclear Chemistry**	**6**	
5.1	Structure of nucleus - liquid drop model, shell model, forces in the nucleus, stability, ratio of neutrons to protons	1	14
5.2	Modes of decay, gamma radiation, half-life period, binding energy Nuclear stability –alpha decay, radioactive decay series,	1	14
5.3	Induced nuclear reactions –nuclear fission &nuclear fusion, atomic bomb, moderators	1	15
5.4	Types of reactor (general idea) HTR, water cooled thermal reactor, fast breeder reactors	1	15
5.5	Application of radioactive isotopes-radio carbon dating, rock dating, neutron activation analysis, solubility of sparingly soluble salt	2	16
Module 6	**Environmental Chemistry (Air, Water and Soil Pollution)**	**6**	
6.1	Air pollution - ozone layer depletion, ozone hole, protection of ozone umbrella –Air pollution caused by fireworks, harmful effects of fireworks, acid rain, greenhouse effect, smog –Classic and photochemical Smog, management of air pollution.	2	17
6.2	Water pollution: Causes- Heat, industrial waste, sewage water, detergents, agricultural pollutants treatment of industrial waste water-Activated charcoal, Synthetic resin, reverse osmosis and electro dialysis, Quality of drinking water - Indian standard and W H O standard - Dissolved oxygen - BOD, COD.	3	17
6.3	Soil pollution - Pesticides, Fertilizers, Industrial waste, plastics - Control of pollution	1	17

Text Books

1. B. R. Puri, L. R, Sharma, K.C. Kalia, Principles of Inorganic Chemistry, Milestone Publishers New Delhi, 2010
2. F. A. Cotton, G. Wilkinson, Advanced Inorganic Chemistry, Wiley, India (P) Ltd, 6th Edn, 1999.
3. J. D. Lee, Concise Inorganic Chemistry, 5thEdn. Wiley, India (P) Ltd, 2008.
4. A. K. De, Environmental Chemistry, New Age International (P) Ltd. New Delhi, 8th Edn, 2016.
5. A. K. Ahluwalia, Environmental Chemistry, Ane Books, India, New Delhi, 2008.

For Further Reading

1. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, 2nd Edn., Reinhold Book Corp. 2008
2. S. Prakash, G. D. Tuli, S.K Basu, R. D. Madan, Advanced Inorganic Chemistry, Vol. 1.,S Chand
3. J. E. Huheey, E. A. Keiter, R. L. Keiter, O. K. Medhi. Inorganic Chemistry, 4th Edn. Pearson, 2006
4. S. S. Dara, A Textbook of Environmental Chemistry and Pollution Control, 8th Edn. S Chand& Sons, New Delhi, 2004.
5. M. N. Greenwood, A .Earnshaw, Chemistry of the Elements, 2nd Edn 1997.

Weightage of marks

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 Admission onwards
SEMESTER -I
Core Course - I Course Code - PO1141 Credit-4
INORGANIC CHEMISTRY - I

Time: 3 Hours Maximum Marks: 80

SECTION A

(Answer **all** questions in one word/one sentence. Each question carries **1** mark)

1. Mention about the flame colouration of II group elements.
2. Write an example of classic smog.
3. State Heisenberg's uncertainty principle.
4. What are matter waves?
5. Which is the conjugate base of HF.
6. Define covalent radius.
7. Write the reason for eutrophication.
8. In the stratosphere, fluorine from the CFC's change to which compound.
9. Name the radio isotope of hydrogen?
10. Mention any one use of alkali metals. **(10 × 1 = 10 Marks)**

SECTION B

(Answer any **8** questions. Each question carries **2** Marks)

11. Calculate the wavelength of electron moving with a velocity of 10^6 ms^{-1}.
12. A cricket ball weighing 100g is to be located within 0.1Å. What is the uncertainty in its velocity?
13. What are Eigen values and Eigen functions?
14. How first element differs from other elements in a group?
15. What is COD?
16. What are ortho and para hydrogens.

17. Write SHAB principle?
18. Comment about the hydration of alkali metals?
19. State and illustrate Pauli's Exclusion Principle.
20. Distinguish between levelling solvents and differentiating solvents.
21. Write a note on greenhouse effect.
22. What is acid rain? **(8 × 2 = 16 Marks)**

SECTION C

(Answer any **6** questions. Each question carries **4** Marks)

23. Discuss the following reactions in liquid SO_2. (i) Solvation (ii) acid- base reaction
24. Discuss hydrogen and water gas as fuels.
25. Describe reverse osmosis for water purification.
26. Briefly explain about the Davisson and Germer's experimental verification of wave nature of electron.
27. What is smog? What are the different types of smog?
28. How ozone layer is depleted?
29. What is the trend of Ionization enthalpy and electron gain enthalpy in the periodic table?
30. What are hydrides? Explain.
31. Discuss about the redox property of alkali metals

(6 × 4 = 24 marks)

SECTION D

(Answer any **2** questions. Each question carries **15** Marks)

32. (a) What is effective nuclear charge? Explain with example.
    (b) Write a note on various electronegativity scales
    (c) Explain about the various rules for filling up of electrons in orbitals. (5+5+5 Marks)
33. (a) Write a note on allotropes of carbon.
    (b) Discuss on the topic 'hydrogen as next generation fuel'
    (c) Give an account of Cesium in photo voltaic cell and Lithium battery (5+5+5 Marks)
34. (a) What are the common characteristics of solvents?
    (b) Liquid ammonia is a better solvent for organic compounds. Why?
    (c) Write a note on various concepts of acids and bases. (5+5+5 Marks)
35. (a) Briefly discuss about the various air pollutants
    (b) Fertilizers and pesticides pollute soil. Justify.
    (c) Explain about the various water quality parameters (5+5+5 Marks)

(2 × 15 = 30 Marks)

UNIVERSITY OF KERALA
SYLLABUS FOR B.Sc. POLYMER CHEMISTRY
First degree programme
2021 admission onwards

Semester	II
Course	Foundation course II
Course name	**METHODOLOGY AND INFORMATICS**
Course Code	PO 1221
Credit	3
Hours	36 hours
Lecture-Tutorial-Lab	2-0-2

CO no.	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive level	PSO
1	Appreciate the development of scientific theories through years with specific examples	U	1
2	Develop curiosity and scientific attitude towards the application of chemistry in daily life	A	1
3	Outline a procedure for experimentation	A	2
4	Appraise the current development in Chemistry	A	1
5	Get an idea about concepts of IPR	U	8
6	Adopt safety measures in handling chemicals	A	7
7	Explain the theory of qualitative chemical analysis	U,A	11
8	Draw titration curves and explain theory of volumetric titrations	U, A	2 & 3
9	Select suitable indicators for acid base titration knowing the theories of acid base titration and indicators	U, A	11
10	Explain the theory of gravimetric analysis	U,A	11
11	Explain the theory of Colorimetric analysis	U, A	3
12	Get an idea about emerging areas like Nano chemistry and Green chemistry	U	11 & 14
13	Develop computational and statistical skills	A	5

R-Remember, U-Understand, A-Apply

	Course Description	Hrs	CO No.
Module 1	**Science and its Methods**	**6**	
1.1	Theories and laws of science - Basis for scientific laws and factual truths	1	1
1.2	Science and technology, Scientific temper and empiricism	1	2
1.3	The vocabulary of science,- Hypothesis, observations and proofs	1	2
1.4	Formulation of hypothesis - Its verification (proving), corroboration and falsification (disproving),	1	2
1.5	Revision of scientific theories and laws	1	2
1.6	Importance of models, simulations and virtual testing	1	3
Module 2	**Experimentation and Data Handling in Science**	**6**	
2.1	Design of an experiment - observation, data collection, interpretation and deduction	2	3
2.2	Repeatability and replication, Documentation of experiments	1	3
2.3	Planning of experiments-Design, selection of controls, choice and selection of instruments	1	3
2.4	Data interpretation - significance of statistical tools in data interpretation, errors and in accuracies, Accuracy and precision	1	11
2.5	Data presentation- Graphics, tables, histograms and pi diagrams	1	11
Module 3	**Evolution of Chemistry as a Discipline of Science**	**6**	
3.1	Ancient speculations on the nature of matter, Alchemy- early form of chemistry	1	1
3.2	Robert Boyle and the origins of modern chemistry, Antoine Lavoisier and the revolution in chemistry, Chemical atomism- John Dalton, Atom models of J.J. Thomson, Ruther Ford and Bohr.	1	1
3.3	Major contributions of Friedrich Wohler, Dmitri Mendeleev, Michael Faraday and Marie Sklodowska- Curie.	1	1
3.4	Structure of chemical science: scope of chemical science, branches of chemistry.	1	1
3.5	Evolution of nanoscience and its basic aspects, Carbon nanotubes and fullerenes, Applications– in electronics, robotics, sensors, medicine.	1	4,12
3.6	Introduction to green chemistry - basic aspects of atom economy calculations (simple reactions).	1	4,12
Module 4	**Over view of Information Technology**	**6**	
4.1	Personal computer and its peripherals, computer networks & internet, wireless technology, introduction to mobile phone technology, overview of operating systems & major application software.	2	11

4.2	Data, information and knowledge, Knowledge management, Internet access methods, internet as a knowledge repository, Academic search techniques, Internet-based information mining in chemistry and chemistry related websites.	2	10
4.3	IT in teaching and learning - educational software- academic services-INFLIBNET, NICNET, BRNET, Virtual labs	1	11
4.4	Basic concepts of IPR, copyrights and patents, plagiarism..	1	5
Module 5	**Introduction to Cheminformatics**	**6**	
5.1	Basics of cheminformatics, applications of cheminformatics, storage & retrieval	1	13
5.2	File formats- MOL, SDF, CML, PDB formats	1	13
5.3	SYBYL Line Notation, SMILES of simple molecules like methane, ethyl alcohol, benzene, cyclohexane etc.	2	13
5.4	Molecular visualization tools, Chemical Data bases	1	13
5.5	Chemical safety- Toxicology information- Material safety data sheets.	1	6
Module 6	**Analytical Principles**	**6**	
6.1	Qualitative analysis - Principles involved in the precipitation of compounds of cations	2	7
6.2	Volumetric analysis- Principles of acid–base, redox, precipitation & complexometric titrations	2	8,9
6.3	Gravimetric analysis - factors affecting the solubility of precipitates	1	10
6.4	Colorimetric methods - theory & applications	1	11

Text Books

1. Newton R. G. The Truth of Science: New Delhi, 2nd edition, 2010.
2. Collins and Pinch, The Golem: What everyone should know about science, Cambridge University, 1993.
3. Soti Sivendra Chandra, Contemporary Science Teaching, Surjeet Publications, 2002
4. N.C. Datta, The Story of Chemistry, University Press, 2005.
5. Alexis Leon & Mathews Leon, Computers Today, Leon Vikas, 2009.
6. Alexis & Mathews Leon, Fundamentals and Information Technology, Vijay Nicole, 2009
7. Ramesh Bangia, 'Learning Computer Fundamentals, Khanna Book Publishers, 2005.
8. Barbara Wilson, Information Technology, the Basics, Thomas Learning, 1996.
9. R C Mishra, Teaching of information Technology, APH, 2005.
10. Kolasani Sunil Kumar, K Ramakrishna and D.B. Rao, Methods of Teaching Chemistry
11. V. Rajaraman, Introduction to Information Technology, Prentice Hall, 2003.
12. Andrew. R. Leach & V. J. Gillet, An Introduction to Cheminformatics, Springer Netherlands, 2007.
13. M. A. Shah, Tokeer Ahmed, Principles of Nano science and Nanotechnology, Alpha Science International Ltd, 2010.

14. T. Pradeep, “NANO: The Essentials”, McGraw-Hill Education, 2007.
15. Anastas. P.T; Warner, J.C, “Green Chemistry; Theory and Practice”, Oxford University Press; Oxford, U.K., 1998.
16. Lancaster. M. Green Chemistry; An introductory text, Royal society of chemistry, Cambridge, UK, 2003.
17. Vogel, Text book of Quantitative Inorganic Analysis, 1989.
18. Day & Underwood, Quantitative analysis: Laboratory manual, Prentice Hall, 1991.
19. A.H Ahluwalia, Renu Aggarwal, Comprehensive Practical Organic Chemistry, Universities Press, 2000.

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme Polymer Chemistry
2021 Admission onwards
SEMESTER – II
Foundation course II Course Code - PO 1221 Credit 3
METHODOLOGY AND INFORMATICS

Time: 3 Hours Maximum Marks: 80

Section A

(Answer **all** questions. Each question carries **1** marks)

1. A well tested scientific hypothesis is called a ……...
2. A tentative supposition made in science to account for a phenomenon is termed as a ….
3. The basis of laws in science generally is …..

   (a) Observation (b) Experimentation (c) That these can be disproved (d) Observation, experimentation and disprovability.
4. Sketch the pH titration curve of weak base with strong acid.
5. The working of science consists of …….

   (a) Deduction (b) Induction (c) Experimentation (d) Deduction, induction and experimentation
6. Who is known as the father of modern chemistry?
7. Size of nano gold particle will be between……..to…..…….nm
8. The SMILES of benzene is.
9. Plagiarism is……..
10. INFLIBNET is used in……..

(10 × 1 = 10 Marks)

Section B

(Answer any **8** questions. Each question carries **2** marks)

11. Explain empiricism in science.
12. Describe the accuracy and precision of the results of a scientific experiment.
13. What are the features of a modern personal computer?
14. Describe what DOS is and how it was later replaced.
15. State the theory of acid -base indicators.
16. What is co-precipitation?
17. Comment on the role of INFLIBNET in science education and research in India.
18. Explain intellectual property right and its significance.
19. What are the major contributions of Marie Sklodowska -Curie?
20. Which are the factors affecting solubility of precipitates.
21. Explain plagiarism. Why is it undesirable?
22. What is the basis of molecular modelling using computers?

(8 × 2 = 16 Marks)

Section C

(Answer any **six** questions. Each question carries **4** marks)

23. Discuss the relation between research in basic science and the advancement of technology.
24. Explain the steps involved in the conducting scientific experiments.
25. What is co-precipitation and post precipitation in gravimetric analysis?
26. With an example, illustrate how science advances with revision of scientific theories.
27. Explain the precautions necessary in order to safe guard a discovery so that a patent on it can be filed.
28. Write short note on adsorption indicators.
29. Exemplify the use of a π -diagram in presenting the results of a typical experiment.
30. Write a note on applications of nanotechnology.
31. How can atom economy be calculated?

(6 × 4 = 24 Marks)

Section D

(Answer any **two** questions. Each question carries **15** marks)

32. Explain what a hypothesis is. Illustrate with an example how one such hypothesis can be formulated, verified and corroborated.
33. a) Discuss the application of common ion effect and solubility product in qualitative analysis (10 Marks)

    b) Write a short note on method to avoid accidents in chemical laboratory. (5 Marks)
34. Explain the following in cheminformatics (i) file formats, (ii) data bases. Explain (i) Use of IT in teaching & learning, (ii) Revision of scientific theory

(2 × 15 = 30 Marks)

UNIVERSITY OF KERALA
SYLLABUS FOR B.Sc. POLYMER CHEMISTRY
First degree programme 2021 admission onwards

Semester	III
Course	Core course-II
Course name	**PHYSICAL CHEMISTRY I**
Course Code	PO 1341
Credit	3
Hours	54 hours
Lecture-Tutorial-Lab	3-0-2

CO No.	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive level	PSO
1.	Understand the basic concept of Thermodynamics, Chemical Kinetics, Ionic Equilibria and Binary Liquid Systems.	U	11
2.	Recall the basic concepts of Thermodynamics.	R	11
3.	Discussion on the Zeroth and First Law of Thermodynamics and its Applications.	U, A	1
4.	Apply the laws of Thermodynamics in Physical and Chemical Processes and in Real Systems.	A	1
5.	Understand the basic concepts of Thermochemistry and its Applications.	U, A	1
6.	Discuss the second law of thermodynamics and its applications.	U, A	3
7.	Detailed discussion on Entropy, Free Energy and Partial Molar Properties.	U, A	3
8.	Discuss basic Concepts of Statistical Thermodynamics.	U	11
9.	Solve numerical problems based on thermodynamics and thermochemistry.	A	2
10.	Understand the concept of Law of Mass Action, and Reaction Isotherm.	U	4
11.	Discussion of Solubility product, Common ion effect and their Applications.	U, A	10
12.	Discussion on various method for the determination of Order of a Reaction	U	4
13.	An in-depth knowledge of Kinetics of Complex Reactions. Discussion on various factors affecting the rate of reaction.	U	10

14.	Discuss the various theories of reaction rate and the concept of Steady State Approximation.	A	10
15.	Understand the concept of Raoult's Law, its applications.	U	4
16.	Discussion of Azeotropic Mixtures, critical solution temperature, distribution law and its applications.	A	9

	Course Description	**Hrs**	**CO No.**
Module 1	**Thermodynamics I**	**9**	
1.1.	System, Surroundings, Types of Systems. Extensive and Intensive Properties. State and Path Functions.	1	1, 2
1.2.	Types of Processes. Zeroth Law of Thermodynamics.	1	3
1.3.	First Law of Thermodynamics and its Mathematical Formulation.	1	3
1.4.	Definition of Internal Energy and Enthalpy. Heat Capacities at Constant Volume (C_v) and at Constant Pressure (C_p). Relationship between C_p and C_v.	1	4
1.5.	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. (numerical problems)	2	4,9
1.6.	The Joule-Thomson Effect. Derivation of the Expression for Joule-Thomson Coefficient. Sign and Magnitude of Joule- Thomson Coefficient, Inversion Temperature.	1	4
1.7.	Thermo Chemistry: Heat of Reaction at Constant Pressure (Q_p), at Constant Volume (Q_v) and their Relationship. Enthalpies of Formation, Combustion and Neutralization. Integral and Differential Enthalpies of Solution. Hess's Law and its Application. Kirchoff's Equation.	2	5,9
Module 2	**Thermodynamics II**	**9**	
2.1.	Second Law of Thermodynamics. Different Statements, Need for II^{nd} law of Thermodynamics.	1	6
2.2.	The Carnot Cycle and its Efficiency. Carnot's Theorem and its Proof.	1	6
2.3.	Concept of Entropy- Definition and Physical Significance. Entropy Changes in Reversible and Irreversible Processes and in Phase Changes. Dependence of Entropy on T, P and V.	2	7
2.4.	Free Energy: Gibbs and Helmholtz Free Energies and their Significances - Criteria of Thermodynamic Equilibrium and	2	7,9

	Spontaneity. Gibbs-Helmholtz Equation. Dependence of Gibbs Free Energy Changes on Temperature, Volume and Pressure. Significance of Gibbs-Helmholtz Equation.		
2.5.	Clausius – Clapeyron Equation and its Applications. Maxwell's relations.	1	7
2.6.	Partial Molar Quantities: Chemical Potential. Gibb's - Duhem Equation. Concept of Fugacity. Determination of Fugacity of a Gas by Graphical Method.	2	7,9
Module 3	**Thermodynamics III & Statistical Thermodynamics**	**9**	
3.1.	Nernst Heat Theorem, Proof and its Consequences. Statement of IIIrd law-Plank's Statement, Lewis Randall Statement. Concept of Perfect Crystal, Determination of Absolute Entropies of Solid, Liquid and Gas. Exception to IIIrd Law with reference to Examples- CO, NO, N_2O and H_2O	3	8
3.2.	Statistical Thermodynamics: Phase Space, Assembly and Ensemble, Types of Ensembles. Thermodynamic Probability. Boltzmann Distribution Law (no derivation).	2	8
3.3.	Entropy and Probability. Partition Function and its Physical Significance.	2	8
3.4.	Thermodynamic Functions in terms of Partition Functions - Internal Energy, Enthalpy, Heat Capacity, Pressure, Work Function, Gibb's Free Energy and Chemical Potential.	2	8
Module 4	**Chemical and Ionic Equilibria**	**9**	
4.1.	Thermodynamic Derivation of law of Mass Action. Relation between Kp, Kc and Kx	1	1,10
4.2.	Vant Hoff Reaction Isotherm. Variation of Equilibrium Constant (Kp & Kc) with Temperature – The Vant Hoff Equation.	2	10
4.3.	Ionic Equilibrium: Ionic Product of Water, Effects of Solvents on Ionic Strength, Levelling Effect.	1	10
4.4.	Ionization of Weak Acids and Bases. pKa and pKb values. Solubility Product and Common Ion Effect and their Applications.	2	11
4.5.	pH and its Determination by Indicator Methods. Buffers and Calculation of their pH - Henderson's Equation.	1	11
4.6.	Hydrolysis of Salts of all types. Degree of Hydrolysis and Hydrolysis Constant. Relation between Hydrolysis Constant and Ionic Product of Water.	2	11

Module 5	**Chemical Kinetics**	**9**	
5.1.	Order and molecularity of Reaction, Derivation of Integrated Rate Equation of Zero, First, Second and n^{th} Order Reaction and Examples.	1	1
5.2.	Determination of Order of Reactions:- Graphical and Analytical Methods using Integrated Rate Equations, Fractional Life Method, Differential Rate Equation Method, Isolation Method.	2	12
5.3.	Kinetics of Complex Reactions: Derivation of Rate Equations of (a) Opposing Reactions when both Forward and Backward Reactions are of First Order. (b) First Order Consecutive Reactions. (c) Parallel Reactions Forming two Products with First Order Rate Process. Qualitative Idea of Chain Reactions.	2	13
5.4.	Influence of Temperature on Rate of Reaction: Arrhenius Equation, Determination of Arrhenius Parameter, Energy of Activation and its Significance.	1	13
5.5.	Collision Theory, Derivation of the Rate Equation for a Second Order Reaction based on Collision Theory.	1	14
5.6.	Collision Theory of Unimolecular Reactions. Lindeman Mechanism. Steady State Approximation. Theory of Absolute Reaction Rate.	2	14
Module 6	**Binary Liquid Systems**	**9**	
6.1	Liquid-Liquid system:- Completely Miscible, Ideal and Non-Ideal Mixtures.	1	1
6.2.	Raoult's Law, Vapour Pressure - Composition, Temperature-Composition Curves.	1	15
6.3.	Fractional Distillation, Deviation from Raoult's Law.	1	15
6.4.	Azeotropic Mixtures, Partially Miscible Liquid System, Critical Solution Temperature, Conjugate Layers, Example for Upper, Lower and Upper cum Lower CST.	2	16
6.5.	Immiscible Liquid Pairs. Theory of Steam Distillation.	1	16
6.6.	Distribution Law - Its Thermodynamic Derivation. Limitations of Distribution Law.	1	16
6.7.	Applications of Distribution Law to the Study of Association and Dissociation of Molecules. Solvent Extraction. Equilibrium Constant of $KI + I_2 \rightarrow KI_3$.	2	16

(At least 100 problems are to be worked out from all units together. 30% of the questions for Examination shall contain problems.)

Text Books

1. Samuel Glasstone, Thermodynamics for Chemists, East West Publishers, 2008.
2. S. Glasstone, and G. N. Lewis, Elementary Physical Chemistry, Longman.
3. N. Kundu and S. K. Jain, Physical Chemistry, S. Chand and Co. Ltd. New Delhi, 1996.
4. K. L. Kapoor, A Textbook of Physical Chemistry, Macmillan India Ltd, 2006.
5. Barrow, M. Gordon, Physical Chemistry, McGraw Hill, 1996.
6. R. J. Selby and R.A. Alberty, Physical Chemistry, John Wiley & Sons, 1985.
7. G. W. Castellan, Physical Chemistry, Narosa Publishing House, 2004.
8. P. W. Atkins, Physical Chemistry, Oxford University Press, 2018.
9. R.P. Rastogi and Rastogi and R.R. Misra, An Introduction to Chemical Thermodynamics, Vikas, 2018.
10. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., 2020.
11. Gurdeep Raj, Advanced Physical Chemistry, GOEL Publishing House, 2020.
12. Bahl, Arun Bahl and G D Tuli, Essentials of Physical Chemistry, S Chand Ltd, 2020.
13. S. C. Anand, A text book of Physical Chemistry, New Age International Publishers, 2007.
14. R. L. Madan, Physical Chemistry, Mc Graw Hill, 2015.
15. F. Daniels and R. A. Alberty, Physical Chemistry, Wiley Eastern, Fourth Edition, 2004.
16. E. A. Moelwyn Hughes, Physical Chemistry, Pergamon Press, 1961.
17. R. Stephen Berry, Stuart A. Rice, and John R. Ross, Physical Chemistry, 2nd Edition, Oxford University Press, Second Edition, 2000.

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 Admission onwards
SEMESTER III
Core Course II COURSE CODE- PO1341 Credit 3
PHYSICAL CHEMISTRY – I

Time: 3 hours Maximum marks: 80

Section A

(Answer **all** questions. Each question carries **1** mark)

1. Write the mathematical statement of first law of thermodynamics
2. Define entropy
3. What is meant by Raoult's law
4. Give the expression for work done in an isothermal reversible expansion of an ideal gas
5. The equation connecting K_p and K_c is given by ----------

6. What is the principle of purification of common salt
7. Half-life of a first order reaction is equal to ----------
8. The relation between entropy and thermodynamic probability is ----------
9. Saponification of ester follows ---------- order kinetics
10. Give examples for system with upper and lower CST

(10 × 1 =10 Marks)

Section B

(Answer any **8** questions. Each question carries **2** marks)

11. State and explain Zeroth law of Thermodynamics.
12. Define integral and differential heat of solution
13. Why is the heat of neutralization of all strong acid by strong base is the same in aqueous solution
14. A first order reaction has a rate constant of 2.18×10^{-3} sec^{-1}. Calculate the half-life of the reaction
15. What are azeotropic mixtures? Explain with an example
16. What are consecutive and parallel reactions?
17. What is meant by order and molecularity of a reaction?
18. State and explain Nernst heat theorem.
19. Write a note on physical significance of entropy
20. What is meant by common ion effect? Give example
21. Distinguish between degree of hydrolysis and dissociation constant
22. What is meant by levelling effect?

(8 × 2 =16 Marks)

Section C

(Answer any **6** questions. Each question carries **4** marks)

23. Explain Hess's law and its application
24. Derive Gibbs Helmholts equation
25. Give an account of the different types of ensembles
26. Briefly discuss solvent extraction technique
27. Write a note on hydrolysis of salts. Explain any two of its categories
28. Explain any two methods used for the determination of order of a reaction?
29. Derive Van't Hoff equation for temperature dependence of equilibrium constant.
30. State and explain Nernst distribution law. What are the limitations of the law?
31. The rate constant of a second order reaction is 5.70×10^{-5} dm^3 mol^{-1} s^{-1} at 25^0C and $1.64 \times 10^{-4} dm^3$ mol^{-1} s^{-1} at 40^0C. Calculate the activation energy and the Arrhenius - pre exponential factor.

(6 × 4 =24 Marks)

Section D

(Answer any **2** questions. Each question carries **15** marks)

32. a) Derive the expression for Joule Thomson coefficient and discuss
    b) Describe Carnot's cycle for establishing the maximum convertibility of heat to work

33. a) Explain third law of thermodynamics and how is it useful in determining the absolute entropy of a solid at required temperature?

b) Obtain expressions for enthalpy, entropy and Gibbs free energy in terms of partition function

34. a) Write a brief note on the theory of absolute reaction rate

b) Derive equation for rate constant of a bimolecular reaction from collision theory

35. a) Explain the buffer action of a solution of weak base and its salt. Derive the relationship between pH of solution and the relative amount of base and salt present in it.

b) Define solubility product. Explain its any two applications in qualitative analysis

(2 × 15 = 30 Marks)

Note: At least 25% of the questions should contain numerical problems.

UNIVERSITY OF KERALA
SYLLABUS FOR B.Sc. POLYMER CHEMISTRY
FIRST DEGREE PROGRAMME
2021 Admission onwards

Semester	IV
Course	Core course-III
Course name	**ORGANIC CHEMISTRY – I**
Course Code	PO 1441
Credit	3
Hours	54 hours
Lecture-Tutorial-Lab	**3-0-2**

CO No.	**COURSE OUTCOME** *Upon completion of this course, the students*	**Cognitive Level**	**PSO No.**
1	Recall the fundamentals of organic chemistry.	R	1
2	Apply the electron displacement effects to compare acidity, basicity and stability of organic compounds/intermediates.	A	4
3	Judge the reaction mechanism of substitution and elimination on the basis of the structure of alkyl halides.	U	10
4	Summarise the chemistry of reaction intermediates.	U	10
5	Describe the preparation, reactivity and properties of hydrocarbons.	U	11
6	Discuss optical, geometrical, conformational and stereochemistry of simple organic compounds.	A	10

7	Use CIP rules to predict the configuration of organic compounds.	U	10
8	Describe the preparation, properties and applications of halogen compounds, alcohols, phenols, aldehydes, ketones and carboxylic acids.	U	10
9	Write reaction steps in ascending & descending of aliphatic acid series.	U	11
10	Predict the outcome and mechanism of simple organic reactions, using a basic understanding of the reactivity of functional groups.	A	10

R-Remember, U-Understand, A-Apply

	COURSE DESCRIPTION	**Hrs**	**CO No.**
Module 1	**Introduction to Reaction Mechanisms and Hydrocarbons**	**9**	
1.1	Electron displacement effect - inductive, electromeric, resonance, hyper conjugation and steric effects.	1	2
1.2	Homolytic and heterolytic fission of bonds.	1	1
1.3	Reactive intermediates – carbocations, carbanions, free radicals, carbenes, nitrenes and benzyne.	2	4
1.4	Hydrocarbons - Alkanes: Methods of preparation (Wurtz reaction, Kolbe reaction and Decarboxylation reaction) physical and chemical properties and commercial importance.	1	5
1.5	Alkenes –two methods of preparation (Decarboxylation and Dehalogenation) - Addition to conjugated dienes, 1, 4-addition and Diels-Alder reaction.	2	5
1.6	Arenes: Aromaticity. Huckel's rule; Non-benzenoid aromatic compounds. Polynuclear hydrocarbons –preparation of Naphthalene, anthracene and phenanthrene, its resonance structures – aromatic electrophilic substitution. Directive influence of substituent such as -OH, - NH_2, -NO_2, Alkyl groups and halogens.	2	5
Module 2	**Organic Reaction Mechanisms**	**9**	
2.1	Types of organic reaction – substitutions (in aliphatic and aromatic) SN_1, SN_2 and SNi reactions and mechanisms.	3	3
2.2	Addition reactions (electrophilic and nucleophilic) Mechanism of addition of hydrogen, hydrogen halide to alkenes and alkynes - free radical addition, Markownikoff's rule and Kharasch effect.	3	3
2.3	Elimination reactions - E_1 & E_2. Stereochemistry of the above reactions. Saytzeff's and Hofmann's rules. Competition between elimination and substitution.	3	3

Module 3	**Cycloalkanes and Conformations**	9	
3.1	Cycloalkanes: Nomenclature, methods of formation (from halides, Simmons-Smith reaction) and reactions.	2	6
3.2	Baeyer's strain theory and its limitations, ring strain in cyclopropane and cyclobutane. Theory of strainless rings, banana bonds in cyclopropane. Ring, angular and torsional strain, relative stabilities.	2	6
3.3	Conformations: Conformational analysis of ethane, n-butane, cyclohexane and mono substituted cyclohexanes. Fisher Newman, saw-horse and wedge projections.	3	6
3.4	Introduction to polycyclic alkanes: decalin, cubane, prismane and adamantane. Large ring compounds: Muscone and civetone.	2	6
Module 4	**Stereochemistry of Organic Compounds**	9	
4.1	Elements of symmetry, chirality, stereogenic centre, enantiomers, chiral and achiral molecules with two stereogenic centres, diastereoisomers, meso compounds, resolution, inversion and racemization.	3	6
4.2	Absolute and relative configuration, D-L, R-S systems of nomenclature, Priority and sequence rules.	3	7
4.3	Asymmetric synthesis. Geometrical isomerism: E-Z systems of nomenclature. Geometric isomerism of maleic and fumaric acid and butadiene.	3	7
Module 5	**Halogen Compounds, Alcohols, Phenols**	9	
5.1	Halogen compounds: methods of preparation (from alcohol and alkene) and properties, synthetic uses of vinylchloride, chloroform, carbon tetrachloride, chloroprene, Freon-12, DDT, and BHC.	2	8
5.2	Alcohols, phenols and ethers: Methods of preparation (hydroboration & hydration of alkene) Special emphasis to oxymercuration, demercuration, hydroboration, oxidation and anti-hydroboration, crown ethers.	2	8
5.3	Preparation, properties and industrial applications of ethylene glycol and glycerol.	1	8
5.4	Pinacol- pinacolone rearrangement. Mechanisms - Reimer-Tiemann reaction, Kolbe reaction. Fries and Claisen rearrangements and their mechanisms. Phthalein reaction.	2	10
5.5	Preparation and properties of catechol, resorcinol, quinol, and naphthols. Ziesel's method of estimation of alkoxy group.	2	8
Module 6	**Aldehydes, Ketones and Carboxylic Acids**	9	
6.1	Aldehydes and Ketones: - General methods of preparation: Grignard reaction; oxidation reaction. General chemical reactions.	2	8

	Reduction using LiAlH4, Sodium borohydride and Aluminium isopropoxide – comparative study.		
6.2	Mechanism of Wolff-Kishner reduction, Clemmenson reduction, Aldol condensation and Benzoin condensation.	2	10
6.3	Preparation and uses of crotonaldehyde, mesityl oxides, cinnamaldehyde, salicylaldehyde and vanillin.	2	8
6.4	Carboxylic acids and their derivatives: - Preparation and properties of aliphatic and aromatic carboxylic acids. Ascent and descent series in aliphatic carboxylic acids.	2	8 & 9
6.5	Mechanism of Cannizarro reaction and Beckmann rearrangement.	1	10

Text Books

1. K. S. Tewari, S.N. Mehrotra and N. K. Vishnoi, "A Text Book of Organic Chemistry", Vikas Publishing House (Pvt) Ltd., New Delhi, 1998.
2. I. L. Finar, "Organic Chemistry" Vol – 1 & 2, 5th Edition, Pearson Education, New Delhi, 2002.
3. P. S Kalsi, "Organic Reactions and Their Mechanisms", New Age International, 2020.
4. R. T. Morrison and R. T. Boyd, "Organic Chemistry", Prentice-Hall, Sixth Edition, 2001.
5. Francis A. Carey, "Organic Chemistry". McGraw Hill, Fourth Edition, 2000.
6. P. Y. Bruice, "Essential Organic Chemistry", Pearson Education, New Delhi, Third Edition, 2016.
7. P. Sykes, "Guide Book to Mechanism in Organic Chemistry", Orient Longman, 1985.
8. S. M. Mukherji and S. P. Singh, "Reaction Mechanisms of Organic Chemistry", Macmillan, 2014.
9. M. K. Jain, "A Text Book of Organic Chemistry", 2020.
10. A. Bahl and B.S. Bahl, "Advanced Organic Chemistry", S. Chand & Company, New Delhi, 2012.
11. P. S. Kalsi, "Stereochemistry and Mechanism through Solved Problems", New Age International, 2006.

Weightage of marks

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA

MODEL QUESTION PAPER

First Degree Programme in Polymer Chemistry

SEMESTER IV

Core Course III Course Code- PO1441 Credit 3

ORGANIC CHEMISTRY – I

Time: 3 hours Maximum Marks: 80

SECTION A

(Answer **all** questions. Each question carries **1** mark)

1. The reaction of a conjugated diene with an alkene to form a cyclic product is called
2. Which is aromatic – tropyllium anion or cyclopentadienyl anion?
3. Pyrole is —basic than pyridine
4. The Hybridisation of carbon atom in Benzyne is — and —
5. Haloalkanes react with aqueous alkali to form—
6. Schiff's bases are obtained by reaction of ketones with —
7. The reducing agent in Clemmensen reduction is —
8. Picric acid is —
9. Lucas reagent is —

(10 × 1 = 10 Marks)

SECTION B

(Answer any **8** questions. Each question carries **2** marks)

10. What are the conformations of cyclohexanes? Diagrammatically show and label the C-H bonds in these.
11. Depict the structure of muscone and civetone
12. What is the directive effect of a methyl group in aromatic electrophilic substitution?
13. How is diethyl ether prepared? Why is it more volatile than ethanol?
14. The peroxide effect is observed only in the addition of HBr and not HCl or HI. Why?
15. What is nitrene? Illustrate its formation in a reaction
16. State and explain Huckel's rule
17. Arrange in the increasing order of acid strength: propionic acid, formic acid, acetic acid. Give reason.
18. Tertiary alcohols are more reactive than primary and secondary alcohols towards Lucas reagent. Why?
19. What is aldol condensation?
20. How will you distinguish acetaldehyde and acetone?
21. Starting from phenol how 2-hydroxy benzaldehyde is prepared?

(8 × 2 = 16 Marks)

SECTION C

(Answer any **6** questions. Each question carries **4** marks)

22. How are 1- naphthol, 2-naphthol and BHC prepared?
23. How will you synthesise glycerol from propene?

24. Give an account of resolution
25. Give an account of non-benzenoid aromatics
26. Illustrate asymmetric synthesis
27. Discuss the reduction of carbonyl compounds with $LiAlH_4$ and $NaBH_4$
28. What is the mechanism of SNi reaction? Illustrate with an example
29. Write a note on the directive influence of OH and NO_2 groups

(6 × 4 = 24 Marks)

SECTION D

(Answer any **2** questions, each question carries **15** marks)

32. a) Illustrate the conformations of n-butane using projections
    b) Write the mechanism of Claisen rearrangement
33. a) Describe the E-Z nomenclature used to specify the configuration of Alkens
    b) Describe the structure of carbenes. Mention a reaction in which carbene is formed.
34. a) Discuss Cannizaro reaction and Beckmann rearrangement
    b) Write briefly on (i) Reimer-Teiman reaction and (ii) Simmons- Smith reaction
35. a) Discuss the mechanism of Saytzeff's and Hoffmann's elimination
    b) Write briefly on (i) hyper conjugation and (ii) Kharash effect

(2 × 15 = 30 marks)

UNIVERSITY OF KERALA
SYLLABUS FOR B.Sc. POLYMERCHEMISTRY
FIRST DEGREE PROGRAMME

Semester	V
Course	Core Course V
Course name	**ORGANIC CHEMISTRY II**
Course Code	PO 1541
Credit	3
Hours	54 hours
Lecture-Tutorial-Lab	3-0-0

CO no.	**COURSE OUTCOME** *Upon completion of this course, the students*	**Cognitive level**	**PSO**
1	Describe the preparation and Chemistry of Nitrogen and sulphur compounds	R	10
2	Distinguish primary, secondary & tertiary amines	U	10
3	Outline the chemistry of simple heterocyclic compounds	U	10

4	Outline the chemistry of simple organometallic compounds	U	10
5	Explain the structure of glucose, fructose, sucrose, starch and cellulose	U, A	11
6	Classify amino acids, proteins, nucleic acids, drugs, steroids, vitamins and lipids	R, U, A	10
7	Discuss the synthesis of amino acids, peptides and nucleic acids	U, A	9
8	Describe the isolation and structure of terpenes, alkaloids and dyes	R, U	10

R-Remember, U-Understand, A-Apply

	Course Description	**Hrs**	**CO No.**
Module1	**Nitrogen and Sulphur Compounds**	**9**	
1.1	Methods of preparation of aliphatic (reaction of alkyl halide or alcohol with ammonia) and aromatic (reduction, Hoffmann degradation) amines.	2	1
1.2	Methods of separation of amine mixtures - Hoffmann and Hinsberg methods.	1	2
1.3	Hoffman exhaustive methylation.	1	1
1.4	Preparation and uses of benzene diazonium salts.	1	1
1.5	Benzidine rearrangement and its mechanism.	1	1
1.6	Preparation, structure and properties of urea.	1	1
1.7	Methods of preparation of mercaptans, sulphoxides, sulphones, sulphonic acid, sulphanilic acid and sulphanilamide.	2	1
Module2	**Carbohydrates**	**9**	
2.1	Classification and nomenclature of monosaccharides	1	5
2.2	Configuration of monosaccharides Epimerization, mutarotation and anomers.	2	5
2.3	Elucidation of structures of glucose and fructose. Chair conformation of D-glucopyranose.	3	5
2.4	Occurrence and chemical properties of disaccharides.	1	5
2.5	Elucidation of structure of sucrose.	1	5
2.6	Starch and cellulose (brief study). Industrial application of cellulose.	1	5
Module 3	**Heterocyclic and Organometallic Compounds**	**9**	
3.1	Heterocyclic compounds: Introduction, classification and nomenclature. Aromaticity in heterocyclic compounds.	3	3

3.2	General methods of preparation and properties of furan, thiophene, pyrrole, indole, pyridine, quinoline and isoquinoline. Importance of heterocyclic compounds.	3	3
3.3	Organometallic compounds: Preparation, reactions and synthetic uses of Grignard reagent, organozinc and organolithium compounds. Reformatsky reaction.	3	4
Module4	**Alkaloids, Terpenes, Dyes**	**9**	
4.1	Alkaloids: Introduction, extraction and general properties.	1	8
4.2	Elucidation of structures of coniine and nicotine. Importance of alkaloids.	2	8
4.3	Terpenoids: Introduction - Isoprene and special isoprene rules. Isolation of terpenoids.	1	8
4.4	Structure of citral and geraniol (structure elucidation not required).Importance of menthol, alpha-pinene and camphor.	1	8
4.5	Dyes: Classification. Witt's theory.	2	8
4.6	Synthesis of the following dyes: Methyl orange, congo red, Bismarck brown, malachite green, rosaniline, indigotin and alizarin	2	8
Module 5	**Steroids, Vitamins and Drugs**	**9**	
5.1	Steroids: Introduction. Diel's hydrocarbon. General nature of steroids. General idea of structure of cholesterol (elucidation not required).	2	6
5.2	Sex hormones - examples and functions (Structure not expected).Importance of androgen, estrogen and cortisone.	1	6
5.3	Vitamins: Introduction, classification and general features. Physiological functions and deficiency symptoms of vitamin A, thiamin, riboflavin, nicotinic acid, vitamin B12,C, D, E and K.	2	6
5.4	Drugs: Classification of various types of drugs with examples.	2	6
5.5	Sulphonamides, antimalarials and chemotherapy	2	6
Module6	**Bioorganic Chemistry -Amino acids, Proteins and Nucleic Acids**	**9**	
6.1	Amino acids: - Classification, structure and stereochemistry of amino acids	2	6
6.2	Two methods of preparation and reactions of alpha-amino acids - essential and non-essential amino acids. Zwitter ion and isoelectric point.	2	7
6.3	Peptides: structure and synthesis (Carbobenzoxy method, Sheehan method only).	2	7
6.4	Proteins: Structure of proteins, denaturation and colour reactions.	1	7
6.5	Nucleicacids: Classification and structure of DNA and RNA. Replication of DNA, Genetic Codes.	2	7

Text Books

1. K. S. Tewari, S.N. Mehrotra and N.K. Vishnoi, "A Text Book of Organic Chemistry", Vikas Publications, 1998.
2. I. L. Finar, "Organic Chemistry" Vol 1 & 2, Longman, 1988.
3. R. T. Morrison and R.T. Boyd, "Organic Chemistry", Prentice-Hall, 2001.
4. T. W. Graham Solomons, "Organic Chemistry". John Wiley & Sons, 2016.
5. S. H. Pine, "Organic Chemistry", Prentice Hall, 1987
6. M. K. Jain, "A Text Book of Organic Chemistry", 2020.
7. Bahl and Bahl, "Advanced Organic Chemistry", 2012.

Weightage of marks

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 admission onwards
SEMESTER V
Core Course V COURSE CODE- PO1541Credit 3
ORGANIC CHEMISTRY – II

Time: 3 hours Maximum marks: 80

SECTION A

(Answer **all** questions. Each question carries **1** mark)

1. — is an example of an essential amino acid.
2. The fundamental unit of terpene is —
3. Sulpha drugs are used as —
4. Diazotisation is done at low temperature because —
5. An example for a mordant dye
6. The base present in RNA but not in DNA
7. The protein present in human hair is —
8. The main components of starch are —
9. Structure of D- glucose is —
10. Benzene diazonium chloride is converted to benzene by —

(10 × 1 = 10 Marks)

SECTION B

(Answer any **8** questions. Each question carries **2** marks)

11. Give the difference between chromophore and auxochrome with one example each
12. Give the structure of pyrole and indole
13. What is meant by reducing and non-reducing disaccharide?

14. How does glucose react with phenyl hydrazine?
15. In what respects vitamins differ from hormones?
16. List the difference between RNA and DNA
17. How is methyl orange prepared?
18. Pyridine is more basic than pyrole. Why?
19. What is Grignard reagent? Mention its use.
20. How is isoquinoline prepared?
21. How a primary amine is chemically distinguished from a tertiary amine?
22. What are zwitter ions? Write an example

(8 × 2 = 16 Marks)

SECTION C

(Answer any **6** questions. Each question carries **4** marks)

23. Name four fat soluble vitamins. Write the chemical name, source and a deficiency disease.
24. What is mutarotation? Why does glucose undergo mutarotation?
25. What are the industrial applications of cellulose?
26. What are Frankland reagents? How are they prepared?
27. Write a note on peptide synthesis
28. Write a note on (i) synthetic uses of ethyl acetoacetate and (ii) Witts theory
29. How is glucose converted into fructose?
30. Discuss the aromaticity of thiophene and pyrrole
31. Give the significance of isoelectric point.

(6 × 4 = 24 Marks)

SECTION D

(Answer any **2** questions. Each question carries **15** marks)

32. a) How will you separate a mixture of primary, secondary and tertiary amines (5 marks)

    b) Write brief notes on iodine value and saponification value (6 marks)

    c) Draw the structure of any four dyes (4 marks)

33. a) Explain the structure elucidation of glucose (7.5 marks)

    b) Write short note on Benzidine rearrangement and Reformatsky reaction (7.5 marks)

34 a) Explain the Hofmann exhaustive methylation and its application (5 marks)

    b) Write a note on synthetic detergents (5 marks)

    c) Give any two methods for the preparation of urea. Also write down any three reactions of it (5 marks)

35. a) Discuss briefly the structure of proteins (7.5 marks)

    b) Discuss the chemical steps in the determination of the structure of nicotine (7.5 marks)

(2 × 15 = 30 Marks)

UNIVERSITY OF KERALA

SYLLABUS FOR B.Sc. POLYMER CHEMISTRY

FIRST DEGREE PROGRAMME

2021 Admission onwards

Semester	V
Course	Core course-VI
Course name	**PHYSICAL CHEMISTRY II**
Course Code	PO 1542
Credit	4
Hours	72 hours
Lecture-Tutorial-Lab	4-0-0

CO No.	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive level	PSO
1.	Identify, compare and explain the properties and behavior of ideal and real gases. Understand Kinetic Theory of Gases and Molecular Velocities.	U	11
2.	Understand the concept of Boyle Temperature, Critical Phenomena and their determination. Determination of Molar Mass.	U, A	9
3.	Recalling the basic concepts of Liquids, Molality, Molarity, Normality and Mole Fraction.	R	9
4.	Discussion of Surface Tension, and Viscosity, Various Methods for its Determination and Factors Affecting it.	U, A	11
5.	Determination of Colligative Properties and Molecular Mass of Solute by various methods.	A	9
6.	Differentiate between Amorphous and Crystalline Solids, Understand Anisotropy, Symmetry and types of Crystals, X- ray Diffraction methods of study of Crystal Structure, identify the Imperfections in Crystals.	U, A	11
7.	Understand the Concept of Liquid Crystals, its Classifications and Applications.	U, A	11
8.	Discussion of Phase Rule and its Applications to various Systems	U, A	10
9.	Understand Congruent and Incongruent Melting Point with examples.	U	9
10.	Discussion on Solid–Gas System, Freezing Mixtures and its Applications.	U, A	9

11.	Understand the Arrhenius Theory, Debye- Huckel Theory, Debye–Falkenhagen Effect and Walden's rule.	U	2
12.	Understand the concept of Activity, Kohlrausch's Law and its Application	U, A	2
13.	Understand Ionic Mobilities and Applications of Conductivity Measurements	U, A	2
14.	Integrate the Theory into Practical Applications of Conductometric Titrations.		3
15.	Understand the Working Principle Electro-Chemical cells	U	3
16.	Nernst Equation and its Applications.	A	2
17.	Understand the Concentration Cells with and without Transference.	U	2
18.	Applications of Potential Measurements and Potentiometric Titrations.	A	2

	COURSE DESCRIPTION	**Hrs**	**CO No.**
Module1	**Gaseous State**	**12**	
1.1.	Kinetic Theory of Gases: Postulates, Types of Molecular Velocities (average, most probable and RMS), Formulas and their Inter Relations. Maxwell Boltzmann Distribution. Statement and Explanation (No derivation). Effect of Temperature. Derivation of R.M.S, Average and Most Probable Velocities from M B Equation.	3	1
1.2.	Collision Properties. Collision Diameter, Collision Number, Collision Frequency and Mean Free Path.	2	1
1.3.	Ideal Gas Equation. Behaviour of Real Gases. Deviation of Real Gases from Ideal Behaviour. Compressibility Factor.	2	1
1.4.	Boyle Temperature- Van der Waals' Equation of State- Derivation and Importance. Virial Equation of State. Determination of Molar Mass by Limiting Density Method.	2	2
1.5.	Critical Phenomena-Isotherms of CO_2.Continuity of State. Critical Constants and their Experimental Determination. Relation between Critical Constants and Van der Waals Constants. Reduced Equation of State. Liquefaction of Gases-Linde's and Claude's Process.	3	2
Module 2	**Liquid State and Dilute Solutions**	**12**	
2.1.	Properties of Liquids: Surface Tension- Measurement by Capillary Rise Method and Stalagmometer Method. Factors Affecting Surface Tension.	2	4

2.2.	Viscosity-Poisuelle Equation, Determination of Viscosity by Ostwald's Viscometer. Refractive Index and its Determination by Abbe's Refractometer.	2	4
2.3.	Dilute solutions: Molality, Molarity, Normality and Mole Fraction.	1	3
2.4.	Colligative Properties- Lowering of Vapour Pressure; Elevation of Boiling Point and Depression in Freezing Point; Molal Elevation Constant, Molal Depression Constant, Thermodynamic Derivation of ΔT. Osmosis and Osmotic Pressure, van't Hoff Equation.	4	5
2.5.	Determination of Molecular Mass of Solute by Beckmann Method. Rast Method and Cooling Curve Method. Abnormal Molecular Mass-Van't Hoff Factor. Determination of Degree of Dissociation and Association.	3	5
Module 3	**Solid state**	**12**	
3.1.	Isotropy and Anisotropy, Space Lattice and Unit Cell. Elements of Symmetry of Crystal.	2	6
3.2.	Crystal Systems, Bravais Lattices. Laws of Crystallography, Miller Indices, Representation of Lattice Planes of Cubic Crystals.	2	6
3.3.	Diffraction of X-rays by Crystals: Braggs' Equation-Derivation and Application. Identification of Type of Cubic Crystal. Rotating Crystal and Powder Method. Structure of NaCl, KCl and CsCl.	3	6
3.4.	Defects in Crystals - Schottky and Frenkel Defects.	2	6
3.5.	Liquid Crystals: Types of Liquid Crystals- Smectic, Nematic and Cholesteric. Molecular Arrangements in Various States of Liquid Crystals, Uses of Liquid Crystals.	3	7
Module 4	**Phase Equilibria**	**12**	
4.1.	Phase Equilibria:-Terminology, the Phase Rule, Thermodynamic Derivation of Phase Rule	2	8
4.2.	Application to (a) Water System (b) Sulphur System (c) Solid-Liquid Equilibria involving Simple Eutectic System such as Pb-Ag System, KI-Water System	3	8
4.3.	Thermal Analysis and Desilverisation of Lead. Freezing Mixtures.	2	10
4.4.	(d) Solid-Liquid Equilibria involving Compound Formation with Congruent and Incongruent Melting Point- $FeCl_3$-H_2O system and Na_2SO_4-H_2O system.	3	9
4.5.	(e) Solid–Gas System – Decomposition of $CaCO_3$ and dehydration of $CuSO_4$ -$5H_2O$. Efflorescence and Deliquescence.	2	10

Module 5	**Electrical Conductance**	**12**	
5.1.	Conductance: Arrhenius Theory. Variation of Conductance with Dilution of Strong and Weak Electrolyte.	2	11
5.2.	Debye- Huckel Theory of Inter Ionic Attraction. Debye–Huckel–Onsager Equation (only qualitative treatment). Wien Effect. Debye–Falkenhagen Effect. Walden's rule	2	11
5.3.	Activity and Activity Coefficient of Electrolytes. Kohlrausch's Law and its Application.	2	12
5.4.	Ionic Mobilities: Transference Number and its Determination by Hittorff's and Moving Boundary Methods. Abnormal Transference Number.	2	13
5.5.	Applications of Conductivity Measurements: Determination of Degree of Dissociation of Weak Electrolytes, Degree of Hydrolysis, Solubility of Sparingly Soluble Salts,	2	13
5.6	Conductometric Titrations involving Strong Acid - Strong Base, Strong Acid – Weak Base, Weak Acid - Strong Base, Weak Acid – Weak Base and Precipitation.	2	14
Module 6	**Electromotive Force**	**12**	
6.1.	Electrochemical Cells (brief explanation). Types of Electrodes – Metallic Electrodes, Gas Electrodes, Anion Reversible Electrodes and Redox Electrodes.	2	15
6.2.	Reference Electrodes – Standard Hydrogen and Calomel Electrodes. Electrode Reactions and Cell Reactions.	1	15
6.3.	Derivation of Nernst Equation for Electrode Potential and Cell Potential. Gibbs-Helmholtz Equation and EMF of a Cell. Calculation of ΔG, ΔH, ΔS and Equilibrium Constant from EMF Data.	2	16
6.4.	Concentration Cells with and without Transference: Electrode and Electrolyte Concentration Cell. Derivation of Equation for the EMF of Concentration Cell with and without Transference. Liquid Junction Potential.	2	17
6.5.	Fuel Cells: Principle, H_2-O_2 and Hydrocarbon-O_2 Fuel Cells. Over Voltage.	2	17
6.6.	Applications of Potential Measurements: Determination of Ionic Product of Water, Hydrolysis Constant and Solubility Product. pH Value using Quinhydrone and Glass Electrodes.	2	18
6.7.	Potentiometric Titrations of Acid – Base and Redox Reactions.	1	18

(At least 100 problems are to be worked out from all units together. 30% of the questions for Examination shall contain problems.)

Text Books

1. S. Glasstone and G. N. Lewis, Elementary Physical Chemistry, Longman, 1963.
2. N. Kundu and S. K. Jain, Physical Chemistry, S. Chand, 1998.
3. K. L. Kapoor, Elements of Physical Chemistry, Macmillan, 2012.
4. G. M. Barrow, Physical Chemistry, McGraw-Hill, 1996.
5. R. A. Alberty and R. J. Silbey, Physical Chemistry, John Wiley, 2004.
6. G. W. Castellan, Physical Chemistry, Narosa, 2015.
7. P. W. Atkins, Physical Chemistry, Oxford University Press; International Eleventh edition, 2018.
8. B. R. Puri, L. R. Sharma, M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 2020.
9. Gurdeep Raj, Advanced Physical Chemistry, GOEL Publishing House, 2020.
10. Anthony R. West, Solid State Chemistry and its Applications, Wiley Eastern, 2014.
11. F. Daniels and R. A. Alberty, Physical Chemistry, Wiley Eastern, 2004.
12. L. V. Azaroff, Introduction to Solids, McGraw Hill, 2017.
13. N. B. Hannay, Solid State Chemistry, Prentice Hall, 1967.

Weightage of marks*:*

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 Admission onwards
SEMESTER V
Core Course VI Course Code- PO1542 Credit 4
PHYSICAL CHEMISTRY – II

Time: 3 hours Maximum marks: 80

Section A

(Answer **all** questions. Each question carries **1** mark)

1. Write van der Waals' equation for n moles of a gas
2. The average speed of a certain gas at 27^0C is 200 ms^{-1}. Calculate the temperature at which the speed will be 600 ms^{-1}
3. What is meant by molarity of a solution?
4. How is inversion temperature related to Vander Waal's constant?
5. The total number of Bravais lattices in a crystal is ----------
6. Write Debye Huckel Onsagar equation.
7. The van't Hoff equation for osmotic pressure of a solution is ---------
8. Give an example for a system with congruent melting point
9. Write the reduced phase rule equation
10. Give the Nernst equation for the potential of a hydrogen electrode

(10 × 1 =10 marks)

Section B

(Answer any **8** questions. Each question carries **2** marks)

11. State and explain the law of rationality of indices.
12. Distinguish between collision frequency and collision number
13. What is meant by surface tension of a liquid and write Poisuellie's equation
14. Explain the terms unit cell and space lattice
15. Explain the effect of temperature on the distribution of molecular velocity
16. Briefly explain van't Hoff factor
17. What is meant by liquid junction potential? How can it be eliminated?
18. How will you construct a calomel electrode?
19. What is Debye Falkenhagen Effect?
20. Write a note on conductometric titration of sodium hydroxide against HCl.
21. Describe with example triple point and eutectic point
22. Explain the term incongruent melting point with an example

(8 × 2 = 16 Marks)

Section C

(Answer any **6** questions. Each question carries **4** marks)

23. Derive most probable velocity and root mean square velocity from Maxwell- Boltzmann Equation.
24. How will you experimentally determine the critical constants of a gas?
25. Give an account of the Rotating crystal method for the determination of crystal structure.
26. Discuss the moving boundary method for the determination of the transference number of an Ion.
27. Write a note on Rast's method and cooling curve method of determining molar mass
28. Explain the terms Efflorescence and Deliquescence
29. How will you determine pH of a solution using quinhydrone and glass electrode?
30. Explain the principle of freezing mixture by taking KI-H_2O system as example
31. An aqueous solution containing 0.25g of a solute dissolved in 20g of water froze at -0.42^0C. Calculate the molar mass of solute. Molar heat of fusion of ice at 0^0C is 6.025 KJ and R = 8.314 J K^{-1} mol^{-1}

(6 × 4 = 24 marks)

Section D

(Answer any **2** questions. Each question carries **15** marks)

32. a) Derive van der Waal's equation of gas
    b) Describe Linde's method of liquefaction of gas
33. a) Explain Schottky and Frenkel defect
    b) Write a brief note on different types of liquid crystals and their molecular arrangement. Explain any three applications of liquid crystals
34. a) Discuss Pattinson's process for the desilverisation of lead
    b) Explain the application of phase rule to the study of dissociation of hydrates of copper sulphate
35. a) Explain Debye Huckel theory of strong electrolytes
    b) What are concentration cells? Derive an equation for the E.M.F of a concentration cell with transference

(2 × 15 = 30 marks)

Note: At least 25% of the questions should contain numerical problems

UNIVERSITY OF KERALA

SYLLABUS FOR B.Sc. POLYMER CHEMISTRY

FIRST DEGREE PROGRAMME

2021 Admission onwards

Semester	V
Course	Core Course VII
Course Name	**POLYMER CHEMISTRY I**
Course Code	PO1543
Credit	4
Hours	72
Lecture – tutorial - Lab	4-0-0

Co. No	COURSE OUTCOME *Upon completion of this course , the students will be able to*	Cognitive Level	PSO No
1	Understand the basic concepts and understand various structure of polymers.	U, R	21
2	Discuss chain growth polymerization, with respect to mechanisms and kinetics.	A	19
3	Explain kinetics and mechanism of ionic polymerizations, Living polymers, stereo regularity and catalysis	A	22
4	Discuss step growth polymerization, electrification reactions, and copolymerization and polymerization techniques.	U, A	20
5	Estimate the number and weight average molecular mass of polymers, degree of polymerization and mechanical properties relating the molecular mass.	A	23,25
6	Determine the molecular mass of polymers by different methods.	A	22,23

	Course Description	No. of Hrs.	CO No
Module1	**Basic Principles of Chemistry**	**12**	
1.1	Historical development of Polymer Chemistry. Monomers, Polymers, repeating units, Nomenclature of polymers.	3	1
1.2	Classification of polymers, cis trans configuration, DL Isomers and tacticity. Functionality.	3	1
1.3	Inorganic Polymers – importance, advantages and applications – structure, preparation and properties of silicones and poly phosphazenes. Comparison with organic polymers.	3	1
1.4	Importance and applications of polymers-acrylic, vinyl, cellulose, fluorinated, polythene and SAN co polymer	3	1

Module2	**Free Radical Addition Polymerization**	**12**	
2.1	Chain growth polymerization. Mechanism of chain growth polymerization – initiation, propagation and termination.	3	2
2.2	Types of free radical initiators (per oxo, azo and redox initiators)	2	2
2.3	Initiator efficiency, inhibitors and retarders – functions and examples. Chain transfer reactions.	3	2
2.4	Kinetics of chain growth polymerization, kinetic chain length, thermal and electrical polymerization, auto acceleration.	4	2
Module3	**Ionic and Stereo Regular Polymerization**	**12**	
3.1	Ionic polymerization – anionic and cationic catalysis, solvent effects in ionic polymerizations.	3	3
3.2	Mechanism and kinetics of anionic and cationic polymerizations, counter ions. Termination modes.	4	3
3.3	Living polymers, coordination polymerization, and stereo regularity.	2	3
3.4	Zieglar Natta catalysts, Metallocene catalysts, Bimetallic & mono metallic mechanisms.	3	3
Module4	**Condensation and Step Growth Polymerization**	**12**	
4.1	Step growth polymerization, average functionality, basic characteristics, and extent of reaction. Carother's equation, gel an gel point.	3	4
4.2	Mechanism of self –catalyzed and non-catalyzed esterification. Ring opening and interfacial polymerization.	3	4
4.3	Copolymerization, random, alternate, block and graft. Copolymerization involving two monomers (Free radical mechanism).	3	4
4.4	Reactivity ratio, its determination Q-e scheme, polymerization techniques (Bulk, solution, suspension and emulsion). Melt, solution an interfacial condensation.	3	4
Module5	**Molecular Mass and Size of Polymers**	**12**	
5.1	Degree of polymerization and molecular weight. Practical significance of molecular weight. Threshold molecular weight.	3	5
5.2	Concept of average molecular mass and molecular mass distribution. Number average, weight average, and Z average molecular mass and their calculation. Viscosity average molecular mass.	4	5
5.3	Molecular mass distribution curve. Poly dispersity and poly dispersity index of polymers. Examples of monodispersed and polydispersed polymers.	*3*	*5*
5.4	Molecular mass and mechanical properties. Size of polymer molecules.	2	5
Module6	**Determination of molecular mass of polymers**	**12**	
6.1	Absolute and relative methods of molecular mass determination.	3	6

6.2	Determination of Number, average molecular mass - End group analysis, cryoscopy and vapour phase osmometry.	3	6
6.3	Weight average molecular mass-ultracentrifugation (principle only), Light scattering method (No experimental details expected)	3	6
6.4	Viscosity average molecular mass, Gel permeation chromatography.	3	6

Text Books

1. Malcon P. Steves, Polymer chemistry-An introduction, 3rd edition, Oxford University Press, 1999.
2. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley & Sons, 1984.
3. V. R. Gowariker, N. V. Viswanathan &J. Sreedhar, Polymer Science, New Age International Publishers, 2005.
4. P. Bahadur & N. V. Sastry, Principles of Polymer Science, Narrora Publishing House, 2nd Edition, 2006.
5. Premamoy Ghosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.
6. G. Odian, Principles of polymerization, 3rd edition, John Wiley & Sons, 2004.
7. G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi, 1993.
8. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, Ane Books, India, New Delhi, 2016.
9. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi, 2014.

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 Admission onwards
SEMESTER V
Core Course VII Course Code - PO1543 Credit 4
POLYMER CHEMISTRY – I

Time: 3 hours Maximum marks: 80

Section A

(Answer **all** questions. Each carries **1** mark)

1. Write the repeating units in (a) Nylon 6 (b) Nylon 6, 6
2. What is the functionality of phenol in polymerization reactions?
3. Write the IUPAC name of (a) polymethyl methacrylate (b) polyvinyl acetate.
4. Show the influence of solvent of solvent on cationic polymerization mechanism.
5. What is meant by end group analysis of a polymer?
6. What are the minimum requirements for a molecule to undergo condensation polymerization?
7. What is auto accelaration?

8. If the degree of polymerization of polyethylene is 100. What is its molecular mass?
9. Write the expression for Z– average molecular mass
10. Write the structure of AIBN **(10 × 1 = 10 Marks)**

Section B

(Answer any **8** questions. Each question carries **2** marks)

11. Write the structures showing the isotactic & syndiotactic arrangements in polypropylene
12. Name two commonly used packing materials in Gel Permeation Chromatography
13. What is meant chain transfer reactions? Give an example of a chain transfer agent
14. Why is molecular mass of a polymer quoted as an average?
15. Comment on the specificity in coordination polymerization
16. What is ring opening polymerization?
17. Define kinetic chain length. How is it related to degree of polymerization?
18. Name two natural and two synthetic fibres
19. Compare the properties of inorganic & organic polymers
20. Mention the important applications of acrylic & fluorinated polymers
21. What is the practical significance of polymer molecular weight?
22. What is telomerisation? Give an example **(8 × 2 = 16 Marks)**

Section –C

(Answer any **6** questions. Each question carries **4** marks)

23. Name four important events in the history of polymer chemistry
24. Define ladder and spiral polymer with examples
25. Make a comparative study of addition & condensation polymerization
26. Explain the polymerization using anionic initiators
27. Write short note on gel permeation chromatography
28. What are living polymers? Write any one method of preparation
29. Describe polydispersity & polydispersity index of polymers
30. Explain the kinetics of step growth polymerization
31. Discuss the size of polymer molecules **(6 × 4 = 24 Marks)**

Section D

(Answer any **2** questions. Each question carries **15** marks)

32. (a) Describe the importance of inorganic polymers
    (b) Write the preparation, properties & applications of polyphosphazines
33. Explain the determination of molecular weight of a polymer by
    (a) Osmometry
    (b) Light scattering method
34. (a) Write the bimetallic mechanism of Ziegler-Natta polymerization
    (b) Explain melt & interfacial polymerization techniques
35. (a) Describe solution & suspension polymerization techniques
    (b) Explain the mechanism of non –catalysed etherification **(15 × 2 = 30 Marks)**

UNIVERSITY OF KERALA
SYLLABUS FOR B.Sc. POLYMER CHEMISTRY
FIRST DEGREE PROGRAMME
2021 Admission onwards

Semester	VI
Course	Core course-X
Course name	**INORGANIC CHEMISTRY II**
Course Code	PO 1641
Credit	3
Hours	54 hours
Lecture-Tutorial-Lab	3-0-0

CO No.	**COURSE OUTCOME** *Upon completion of this course, the students*	**Cognitive Level**	**PSO No.**
1	Discuss the electronic configuration and related properties of transition elements and inner transition elements	U	11
2	Understand the occurrence and separation of lanthanides and actinides.	U, A	11
3.	Compare lanthanide and actinide contraction and their consequences.	U	11
4.	Name coordination complexes, discuss their properties and bonding	U	11
5	Understand stability of complexes and factors affecting stability	U	3
6	Describe isomerism in coordination compounds	U, A	3
7	Discuss spectrochemical series, CFSE and their consequences	U	3
8	Correlate geometry , stability and Jahn Teller effect and its causes	A	11
9	Discuss the elements of symmetry and point group of simple molecules.	U	11
10	Name and Classify organometallic compounds	U	3
11	Discuss preparation and properties and bonding of carbonyls	U	3
12	Identify the role of organometallic compounds in organic Synthesis.	U	10
13	Discuss the chemistry of Boron compounds, various types pf halogen compounds, cement, glass, ceramics and xenon compounds	U	7,3 & 8
14	Understand reactions in non-aqueous solvents.	U	11
15	Discuss the role of inorganic ions in biological systems and biochemistry of haemoglobin, myoglobin, cytochromes, iron sulphur proteins	U	10
16	Discuss various bioinorganic processes like photosynthesis, working of sodium potassium pump, etc	U	17

	Course Description	Hrs	CO No.
Module 1	**Transition Elements and Inner Transition Elements**	**9**	
1.1	Transition elements –Electronic configuration& general characteristics, abundance, difference between the I^{st} row and the other two rows.	2	1
1.2	Lanthanides – Electronic configuration &general properties, occurrence, separation – chemical &ion exchange methods.	2	2
1.3	Lanthanide contraction & its consequences, magnetic properties &complex formation behaviour.	2	3
1.4	Actinides - Electronic configuration& position in periodic table oxidation state, occurrence.	2	1
1.5	Trans actinides – Names & symbol.	1	3
Module 2	**Coordination Chemistry - I**	**9**	
2.1	Double salts & coordination compounds, nomenclature.	2	4
2.2	Werner's theory, EAN rule, shapes of d orbitals.	2	4
2.3	Bonding in transition metal complexes- V. B. Theory, Crystal field theory - explanation of magnetic properties, geometry, and colour, electronic spectra of d1 & d9 systems.	3	4
2.4	Spectrochemical series, effects of crystal field splitting, Jahn – Teller distortion, M. O. theory, chelates – application.	2	7 &8
Module 3	**Coordination Chemistry - II**	**9**	
3.1	Isomerism & stability of complexes, factors affecting stability.	3	5 &6
3.2	Geometry of different coordination numbers, application of complexes in qualitative& quantitative analysis.	2	8
3.3	Group theory – elements of symmetry, proper & improper axis of symmetry, plane of symmetry, centre of symmetry & identity element.	2	9
3.4	Combination of symmetry, elements, point groups (C2v & C3v). Schoenflies symbol of simple molecules like H_2O, NH_3& BF_3.	2	9
Module 4	**Organometallic Compounds**	**9**	
4.1	Definition, nomenclature & classification, 18 electron rule.	2	10
4.2	Metal carbonyls (mono nuclear & poly nuclear - examples of carbonyls of Fe, Co, & Ni).	2	11
4.3	Preparation & properties of carbonyls of Fe & Ni, structure & nature of metal –carbonyl bonding in mononuclear Ni carbonyls.	2	11
4.4	Bonding in ferrocene, structure & application of Ziese's salt, Wilkinson's catalyst.	2	11
4.5	Application of organo metallic compounds.	1	12
Module 5	**Compounds of Non-Transition Elements & Non –Aqueous Solvents**	**9**	
5.1	Preparation, properties & structural aspects of following: boron nitrides, borazole, boron hydrides.	2	13
5.2	Preparation & properties of hypohalous acids, per halic acid &pseudo halogens	2	13

5.3	Chemistry of cement, glass, ceramics & Xenon compounds.	2	13
5.4	Non – aqueous solvents – Classification of solvents, characteristics of common solvents, protic & aprotic solvents	2	14
5.5	Liquid ammonia solutions of alkali metals, reactions in liquid SO_2 & liquid HF.	1	14
Module 6	**Bioinorganic Chemistry**	**9**	
6.1	Role of alkali & alkaline earth metal ions in biological systems, biological functions, excess &deficiency diseases of Cr, Mn, Cu, Fe, Ni & Co.	2	15
6.2	Toxicity of metal ions (Pd, As, Cd, Mg), oxygen carriers, haemoglobin & myoglobin - structure & mechanism of action, cooperative effect in Hb, biochemistry of iron.	3	15
6.3	Biological role of Mg & Ca ions, elementary idea of cytochromes, ferretin & ferredoxines,	2	15
6.4	Metallo enzymes –carbonic anhydrase& peroxidase, photosynthesis, principle & mechanism.	2	16

Text Books

1. J. D. Lee, Concise inorganic chemistry, Chapman & Hall India., 1991.
2. Sathya Prakash, G. D. Tuli, S. K. Basu & R. D. Madan, Advanced Inorganic Chemistry, (Vol.I), S .Chand & Com. Ltd ., New Delhi, 1944.
3. F .A .Cotton, P. L .Gaus & G. Wilkinson, Basic Inorganic Chemistry, John Wiley & Sons, 1994.
4. B. R. Puri, L. R. Sharma & K .C. Kalia, Principles of Inorganic Chemistry, Vishal Publishing Co, New Delhi, 2020.
5. D. F. Shriver, P .W. Atkins & C .H .Langford, Inorganic Chemistry, Oxford Univ. Press, 1990.
6. M .C. Day & J. Selbin, Theoretical Inorganic Chemistry, East West press pvt. Ltd, 2008.
7. R. D. Madan, Modern Inorganic Chemistry, S. Chand &Company Ltd .New Delhi, 2019.
8. Sathya Prakash, G. D. Tuli, Basu S. K. & Madan R. D., Advanced Inorganic Chemistry, (Vol. II), S .Chand & Com. Ltd, New Delhi, 1944.
9. W. U. Malik, G. D. Tuli & R. D. Madan, Selected Topics in inorganic chemistry, S. Chand & Co. Ltd, New Delhi, 2010.
10. M. N. Hughes, The Inorganic Chemistry of Biological Processes, John Wiley and Sons, 1981.

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 Admission onwards
SEMESTER VI
Core Course X Course Code - PO1641 Credit 3
INORGANIC CHEMISTRY - II

Time: 3 hours Maximum marks: 80

Section A
(Answer **all** questions. Each question carries **1** mark)

1. Give the general electronic configuration of transition elements
2. What is the theoretical magnetic moment of Ti^{+3}
3. Write the IUPAC Name of $[CuCl_2 (CH_3NH_2)_2]$
4. What is spectrochemical series?
5. What are chelates?
6. Write the Shoenflies symbol of H_2O
7. What is improper axis of symmetry?
8. Give the formula of a metal carbonyl which do not obey 18 electron rule
9. Write the structure of Ziese's salt
10. Give the structure of borazole

(10 × 1 = 10 Marks)

Section B
(Answer any **8** questions. Each question carries **2** marks)

11. Differentiate between double salts and coordination compounds
12. State and explain EAN rule
13. Solutions of the hydrated Ti^{+3} ions are reddish violet colored. Give reason
14. State and explain Jahn -Teller distortion
15. Write any one method for the preparation of polynuclear carbonyl of Cobalt
16. Comment on the nomenclature of organo metallic compounds
17. What are pseudohalogens? Give an example
18. What are protic and aprotic solvents?
19. List the role of alkaline earth metal ions in biological systems
20. Write excess and deficiency diseases of Cu and Mn
21. Describe the biological role of Mg
22. What are metalloenzymes? Give an example

(8 × 2 = 16 Marks)

Section C
(Answer any **6** questions. Each question carries **4** marks)

23. Describe the variable oxidation state shown by transition metals
24. Discuss the drawback of VB Theory of complexes
25. Explain the stereoisomerism shown by the complex $[Co (NH_3)_4Cl_2]^+$
26. Discuss the nature of metal carbonyl bonding in mononuclear carbonyl of Ni
27. Mention the application of organometallic compounds in medicine
28. Narrate the reactions of alkali metals in liquid HF

29. Give an account of the preparation and properties of hypochlorous acid
30. Explain the principle and mechanism of photosynthesis
31. Narrate the toxic effect of cadmium and mercury

(6 × 4 = 24 Marks)

Section D

(Answer any **2** questions. Each question carries **15** marks)

32. (a) Make a comparative study of 3d, 4d and 5d transition series
    (b) What is Lanthanide contraction? Explain its causes and consequences.
33. (a) Explain the electronic spectra of d^1 and d^9 systems
    (b) Comment on the factors that affect the stability of coordination complexes
34. (a) Narrate the application of complexes in qualitative analysis
    (b) Describe the bonding in ferrocene
35. (a) Give an account on the structure of Xenon compounds
    (b) Describe the biochemistry of iron

(2 × 15 = 30 Marks)

UNIVERSITY OF KERALA
SYLLABUS FOR B.Sc. POLYMER CHEMISTRY
FIRST DEGREE PROGRAMME
2021 Admission onwards

Semester	VI
Course	Core course-XI
Course name	**PHYSICAL CHEMISTRY III**
Course Code	PO 1642
Credit	4
Hours	72 hours
Lecture-Tutorial-Lab	4-0-0

CO No.	COURSE OUTCOMES *Upon completion of this course, the students*	Cognitive Level	PSO
1	Recall the basic physical concepts in quantum mechanics, spectroscopy, photochemistry, catalysis, colloids and adsorption	R	4
2	Understand the physical concepts in quantum mechanics, spectroscopy, photochemistry, catalysis, colloids and adsorption	U	4
3	Demonstrate the origin of quantum numbers by correlating the Cartesian and spherical polar coordinates of hydrogen atom.	A	4

4	Understand the basics of spectroscopic techniques- Rotational, Vibrational , UV-Vis and Raman Spectroscopy	U	2
5	Compare NMR and ESR spectroscopy, Recognize the Applications of NMR, ESR and mass spectroscopy.	U, A	3
6	Evaluate physical and chemical quantities using non-spectroscopic techniques.	U,E	4
7	Differentiate diamagnetism and paramagnetism, measurement of magnetic susceptibility	U	11
8	Correlate dipole moment with geometry of molecules	R, A	4
9	Perform calculations involving physical concepts and equations	A	4
10	Understand terminology, Understand different laws and principles of physical chemistry.	U	11
11	Identify and recognize the applications of various principles, equations and physical processes.	A	4
12	Derive and Interpret important theories and equations involved in physical chemistry	A	3

	COURSE DESCRIPTION	**Hrs**	**CO No**
Module 1	**Quantum mechanics**	**12**	
1.1	Radiation phenomena: Black body radiation. Planck's quantum theory, Photoelectric effect, Compton effect and atomic spectra.	2	1,2,10
1.2	Concept of operators: Linear, Laplacian, Hamiltonian and Hermitian operators. Postulates of quantum mechanics. Derivation of Schrodinger wave equation and its significance. Eigen functions and Eigen values.	3.5	1,2,12
1.3	Application of quantum mechanics to simple systems: Particle in 3D box and its complete solution. Concept of degeneracy. Schrodinger equation for H atom - Separation into three equations (without derivation).	3.5	1,2 ,9 ,12
1.4	Simple harmonic oscillator: Classical treatment - Derivation of total energy of the oscillator. Quantum mechanical treatment - Schrodinger equation of the particle executing simple harmonic motion and energy expression (No derivation)	3	3

Module 2	**Rotational and Vibrational Spectroscopy**	**12**	
2.1	Regions of electromagnetic spectrum. Different units of energy (erg, Joule, calorie, and cm^{-1}, Hz, Å and eV) and their interconvertions. Interaction with matter-Quantization of energy- photon, various types of molecular excitation and types of molecular spectra. Born-Oppenheimer approximation.	3	1,2,4,11
2.2	Rotational spectroscopy: Microwave spectra of rigid diatomic molecules. Moment of inertia. Derivation of energy expression and rotational energy levels. Selection rule. Determination of bond length. Effect of isotopic substitution.	3	1,2,4,11
2.3	Vibrational spectroscopy: Harmonic oscillator. IR spectra of diatomic molecules. Energy expression. Selection rules. Frequency of separation. Calculation of force constant. Anharmonic oscillators.	3	1,2,4,11
2.4	Morse equation. Fundamental and overtone transitions. Combination bands and hot bands. Degree of freedom of polyatomic molecules. Group frequencies and application of IR spectra.	3	1,2
Module 3	**Raman, UV-Vis and NMR Spectroscopy**	12	
3.1	Raman spectroscopy: Stokes and antistoke's lines. Quantum and classical theory of Raman effect. Rotational Raman spectrum. Selection rule. Frequency of separation. Vibrational Raman spectrum. Mutual exclusion principle. Advantages of Raman Spectroscopy.	2 .	1,2,4,9
3.2	Electronic spectroscopy: Electronic spectra of diatomic molecules. Franck-Condon principle. Singlet and triplet states.	2	1,2,4,9
3.3	Dissociation and pre dissociation. Dissociation energy. Selection rules. Electronic spectra of polyatomic molecules (qualitative idea only).	2	1,2,4
3.4	NMR spectroscopy: Principle of NMR, Nuclear spin. Interaction of nuclear magnet with external magnet. Precession.	2	1,2,5,9
3.5	Relaxation. Shielding and deshielding effect. Chemical shift. Delta and tau scales. Spin – spin coupling.	2	1,2,11
3.6	Low and high resolution spectra. Interpretation of PMR spectra of simple molecules such as ethyl bromide, ethanol, acetaldehyde, ethyl acetate, toluene and acetone.	2	1,2,11,12

Module 4	**ESR, EIMS and Non Spectral Methods**	**12**	
4.1	Electron spin resonance spectroscopy: Principle. Types of substances with unpaired electrons. Interaction of electron magnet with external magnet. Energy level splitting. Lande splitting factor.	2	1,2,5,11
4.2	Presentation of ESR spectrum, the normal and derivative spectra. Hyperfine splitting. Simple examples of methyl and benzene radicals.	2	1,2,5
4.3	Mass spectrometry: Theory of mass spectrum. Production of ions. Base peak and molecular ion peak. Common types of dissociation. Mass spectra of simple molecules. Application of mass spectrometer in the determination of molar mass.	2	1,2,5,9
4.4	Dipole moment. Debye equation and Clausius–Mosotti equation. Measurement of dipole moment by temperature method. Dipole moment and molecular structure.	2	1,6,7,8
4.5	Diamagnetism and paramagnetism, Magnetic susceptibility and unpaired electrons, measurement of magnetic susceptibility,	2	1,6,7
4.6	Molar refraction and molecular structure, Atomic refraction, Optical exaltation, Parachor and atomic equivalent of parachor.	2	1,6,7
Module 5	**Photochemistry and Catalysis**	**12**	
5.1	Grothus-Draper, Beer- Lambert and Stark- Einstein laws.	2	1,2,6,10
5.2	Quantum yield, Reason for very low and very high quantum yields, Rate equation for decomposition of hydrogen iodide, Qualitative treatment of H_2-Cl_2 reaction and H_2-Br_2 reaction	2	1,2,9
5.3	Fluorescence and phosphorescence, chemiluminescence and photosensitization, Explanation and examples	2	1,2,5,8
5.4	Catalysis:- Theories of catalysis, Intermediate compound formation theory, steady state method	3	
5.5	Enzyme Catalysis-mechanism. Effect of temperature on enzyme catalysis. Michaelis-Menten equation.	3	
Module 6	**Colloids and Adsorption**	**12**	
6.1	Colloidal state: Classification of colloids- Kinetic, optical and electrical properties ofcolloids.	1	1,2
6.2	Purification of colloids – ultra filtration and electro dialysis,	1	1,2
6.3	Ultra microscope, Electrical double layer and zeta potential. Coagulation of colloids, Hardy-Schulz rule, Gold number. sedimentation and streaming potential	2	1,2

6.4	Gels: Elastic and non-elastic gels, Imbibition and syneresis, Micelles and critical micelle concentration	2	1,2
6.5	Application of colloids – Cottrell precipitator, purification of water and delta formation.	1	1,2
6.6	Adsorption: Physical and chemical adsorption, Freundlich adsorption isotherm	2	1,2
6.7	Derivation of Langmuir adsorption isotherm, Statement and explanation of BET and Gibbs isotherms	2	1,2,12
6.8	Determination of surface area of adsorbents by BET equation. Applications of adsorption	1	1,2,9,11

Weightage of marks*:*

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 Admission onwards
SEMESTER VI
Core Course XI Course Code - PO1642 Credit 4
PHYSICAL CHEMISTRY - III

Time: 3 hours Maximum marks: 80

Section A
(Answer **all** questions. Each question carries **1** mark)

1. Define Laplacian operator
2. Which of the following will show rotational spectrum? H_2, N_2, H_2O, CO_2 and HCl.
3. What is meant by threshold frequency
4. Which valence state of copper will show ESR spectra
5. Predict the number of lines in the ESR spectrum of methyl radical
6. Sketch the high resolution N.M.R spectrum of ethyl alcohol
7. How many fundamental vibrational frequencies are expected for H_2O and CO_2 molecules
8. Give the expression for Gibbs adsorption isotherm
9. Define quantum yield of a photochemical reaction
10. Give an example for chemiluminescence

(10 × 1=10 Marks)

Section B
(Answer any **8** questions. Each question carries **2** marks)

11. State and explain zeta potential

12. Distinguish between sedimentation potential and streaming potential
13. Discuss black body radiation
14. What is meant by photoelectric effect
15. Explain chemical shift in NMR spectroscopy
16. How does stokes and anti-stokes lines originate in Raman spectrum
17. How is magnetic susceptibility measured?
18. How does hyperfine splitting arise in ESR?
19. Distinguish between chemical and physical adsorption 20 Convert 15000$cm^{-1}$to frequency and wavelength
20. What are fundamental bands and overtones?
21. Explain the terms singlet and triplet states

(8 × 2 =16 Marks)

Section C

(Answer any **6** questions. Each question carries **4** marks)

22. What are the methods by which ions are produced in mass spectrometer?
23. Explain mutual exclusion principle and how is it useful in structure elucidation
24. What is Debye equation? Explain its significance
25. Discuss harmonic and anharmonic oscillator
26. Explain Franck- Condon principle
27. Explain the terms fluorescence and phosphorescence
28. What are the postulates of quantum mechanics? Explain
29. Explain spin – spin coupling and high resolution spectra in nmr with an example
30. The fundamental vibrational frequency of carbon monoxide molecule is 2170 cm^{-1}. Calculate the force constant of the molecule.

(6 × 4 = 24 Marks)

Section D

(Answer any **2** questions. Each question carries **15** marks)

31. a) Derive Langmuir adsorption isotherm
    b) Explain the determination of surface area of a solid by Langmuir adsorption isotherm
32. Derive a)The expression for the kinetics of decomposition of HI
    b) Michaels – Menten equation
33. a) Give a brief account of the application of IR spectroscopy in the structure determination of organic molecules
    b) Derive an equation to determine the moment of inertia and energy of a rigid diatomic molecule in Rotational spectroscopy
34. a) Explain the application of mass spectra in the determination of molar mass
    b) Derive the expression for total energy of a particle in a three dimensional box

(2 × 15 = 30 Marks)

Note: At least 25% of the questions should contain numerical problems

UNIVERSITY OF KERALA

SYLLABUS FOR B.Sc. POLYMER CHEMISTRY

FIRST DEGREE PROGRAMME

2021 Admission onwards

Semester	VI
Course	Core Course XII
Course Name	**Polymer Chemistry II**
Course Code	PO1643
Credit	4
Hours	72
Lecture – tutorial - Lab	4-0-0

Co. No	Expected Course Outcomes upon completion of this course	Cognitive Level	PSO No
1	The final outcome of the subject will result an enhancement in understanding the basic concepts and understand various structure of polymers.	U, R	21
2	Discuss chain growth polymerization, with respect to mechanisms and kinetics.	A	20
3	Explain kinetics and mechanism of ionic polymerizations, Living polymers, stereo regularity and catalysis	A	14,22
4	Discuss step growth polymerization, electrification reactions, and copolymerization and polymerization techniques.	U, A	22
5	Estimate the number and weight average molecular mass of polymers, degree of polymerization and mechanical properties relating the molecular mass.	A	25
6	Determine the molecular mass of polymers by different methods.	A	26

	Course Description	No. of Hrs.	CO No
Module1	**Molecular forces and Bonding in Polymers.**	**12**	
1.1	Primary structure - polarity of monomers Secondary structure - Conformation and configuration Tertiary structure - Crystalline and amorphous polymers	3	1
1.2	Polar and non-polar in interactions. Segmental mobility and total mobility of polymer chains.	2	1
1.3	Solid, liquid, glassy and rubbery states. Amorphous and crystalline behaviors. Tg and Tm Viscoelastic deformation.	3	1
1.4	Determination of Tg. Factors influencing Tg. (molecular geometry, molecular mass, plasticizers, copolymerization), relationship between Tg and Tm. Importance of Tg.	3	1

1.5	Factors influencing crystalline state, polymer single crystals, spherulites.	1	1
Module 2	**Polymer Reactions - I**	**12**	
2.1	Reactions involving hydrolyses, acidolysis, oxidation, hydrogenation, addition and substitution reactions.	4	2
2.2	Cyclisation reactions of PVA and PAN. Pre polymers and curatives. Illustrations of curing of unsaturated polyesters with styrene, thiols with $Pb0_2$ or epoxide or diamine.	4	2
2.3	Cyclisation of NR in acid medium, cross linking-photo chemical through labile intermediate	2	2
2.4	Vulcanization using peroxide, Sulphur, sulphur compounds, mechanism of sulphur vulcanization.	2	2
Module 3	**Polymer Reactions II**	**12**	
3.1	Preparation of block and graft copolymers. Preparation, properties and applications of ion exchange resins.	3	3
3.2	Structure and applications of conducting polymers, photo conducting polymers.	3	3
3.3	Polymer drugs, polymer supported reactions, advantages.	3	3
3.4	Merrifield's solid phase peptide synthesis, dendric polymers (Brief idea)	3	3
Module 4	**Polymer Solutions**	**12**	
4.1	Difference of polymer solution from that of low molecular mass solutes. Swelling formation of Ellipsoid, viscosity changes, Gel-sol systems. Good and poor solvents.	4	4
4.2	Fractionation of polymers. Fractional precipitation, Gradient illusion and gel permeation chromatography.	2	4
4.3	Cohesive dispersion forces, cohesive energy density (CED), solubility parameter, thermodynamics of polymer dissolution	3	4
4.4	Nature, size and shape of macro molecules in solution. End to end distance and radius of gyration. Perturbed and unperturbed dimensions. θ solvent and θ temperature	3	4
Module 5	**Polymer Degradation**	**12**	
5.1	Process of degradation. Random and chain end degradation. Methods of degradation. Thermal degradation – Factors affecting thermal stability.	3	5
5.2	Mechanical degradation – Milling and mastication. Photo degradation – Photo stabilizers	3	5
5.3	Oxidative degradation – oxidants and antioxidants, hydrolytic degradation.	3	5
5.4	Degradation by high energy radiation, chemical degradation, polymer waste management	3	5
Module 6	**Bio Polymers and Biodegradable Polymers**	**12**	
6.1	DNA and RNA – structure and functions. Structure of proteins,	4	6

	preparation, properties and applications of cellulose derivatives. Cotton and rayon.		
6.2	Cellulose plastics; cellulose acetate, cellulose nitrate and regenerated cellulose. Structure and applications of starch, shellac, chitin and chitosan.	3	6
6.3	Commercial applications of natural polymers – lignin, Kerogen, amber, asphaltenes,	2	6
6.4	Biodegradable polymers, examples. Biomedical applications of polymers.	3	6

Text Books

1. Malcon P. Steves, Polymer chemistry-An introduction, 3rd edition, Oxford University Press, 1999.
2. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley & Sons, 1984.
3. V. R. Gowariker, N. V. Viswanathan&J. Sreedhar, Polymer Science, New Age International Publishers, 2005.
4. P. Bahadur & N. V. Sastry, Principles of Polymer Science, Narrora Publishing House, 2nd Edition, New Delhi, 2006.
5. Premamoy Ghosh, Polymer Science and Technology: Plastics, Rubbers, Blends and Composites, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.
6. G. Odian, Principles of polymerization, 3rd edition, John Wiley & Sons, 2004.
7. G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi, 1993.
8. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, Ane Books, India, New Delhi, 2016.
9. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi, 2014.

Weightage of marks*:*

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
SEMESTER VI
Core Course -XII Course Code - PO1643 Credit 4
POLYMER CHEMISTRY - II

Time: 3 hours Maximum marks: 80

Section A

(Answer **all** questions. Each question carries **1** mark)

1. What is polyelectrolyte?
2. What is acidolysis reaction?
3. Give two examples of conducting polymers.
4. Why do rubbers retain flexibility even after cross linking while thermosets do not?
5. What is meant by leathery state of a polymer?
6. What are cure reactions?

7. Give two examples of antioxidants.
8. Define radius of gyration.
9. What is cohesive energy density?
10. Define the term mastication.

(10 × 1= 10 Marks)

Section B

(Answer any **8** questions. Each question carries **2** marks)

11. How is melting point of polymers differing from that of other materials?
12. Why do aramids exhibit high Tm?
13. What are good & poor solvents?
14. Write any two chemical reactions of polyacrolein.
15. What is carbon fibre? Mention its use.
16. What are photo stabilizers? Give two examples.
17. What is controlled drug release?
18. Explain the formation of single crystals from polymer melt.
19. Mention the commercial applications of cellulose acetate.
20. Discuss the process of polymer recycling.
21. Comment the vulcanization of rubber using sulphur compounds.
22. Write the cyclisation reactions of rubber in acid medium.

(8 × 2 = 16 Marks)

Section C

(Answer any **6** questions. Each question carries **4** marks)

23. Describe the factors influencing crystallinity of polymers
24. Narrate the nature & size of macromolecules in solution
25. Describe the curing reaction of unsaturated polyesters.
26. Distinguish chain scission & non-chain scission degradation.
27. Write the structure & applications of chitin & chitosan.
28. Describe any one method of determination of Tg of a polymer sample.
29. Discuss the factors influencing Tg of polymers.
30. Write short note on genetic engineering.
31. Briefly explain the preparation & properties of Rayon

(6 × 4 = 24 Marks)

Section D

(Answer any **2** questions. Each question carries **15** marks)

32. Describe dissolution process of polymers in solvents. Discuss thermodynamics of polymer dissolution.
33. Explain polymer supported reactions. Explain the structure &applications of ion exchange resins.
34. Write short note on the factors affecting thermal stability of polymers. Explain oxidative Degradation& the methods to prevent it.
35. Narrate the structure & functions of DNA. Write short note on the biomedical applications of polymers.

(2 × 15 = 30 Marks)

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LAB COURSES

(For all Lab courses scheme of ESE is decided by the Board of Examiners in each year)

Computer Lab for Foundation Course II (PO 1221)

SEMESTER II (No ESE)

Semester	II
Hours	2 hours/week
Lecture-Tutorial-Lab	0-0-2

CO No.	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive Level	PSO No.
1	Get acquainted with Computer Lab based instruction on the use of computer and internet in learning.	U	5
2	Use of educational software, information mining from internet and using INFLIBNET/NICNET, NPTEL and VIRTUAL LABS OF MHRD.	A	5
3	Learn Word processing and document preparation. Use of Spread sheets in Data handling and presentation	U	5
4	Develop skill in chemical structure drawing and visualization of molecules using chemistry software	U	5

Students should submit the following documents, certified by Teacher in charge, along with LAB COURSE I records for ESE

1. Structure of any five simple organic molecules using Chem Sketch or Chemdraw

2. Any five chemistry related graphical plots using Excel

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2021 Admission onwards

(ESE at IV Semester)

Semester	I, III & IV
Course	Core Course-IV, Lab Course I & II
Course name	**Inorganic Qualitative And Volumetric Analysis**
Course Code	PO1442
Credit	2
Hours	2 hours/week
Lecture-Tutorial-Lab	0-0-2

CO No.	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive Level	PSO No.
1	Obey Lab safety instructions, develop qualities of punctuality, regularity and scientific attitude, outlook and scientific temper (GOOD LAB PRACTICES)	U	1
2	Develop skill in safe handling of chemicals, take precaution against accidents and follow safety measures	A	2,8
3	Use glass wares ,electric oven, burners and weighing balance	A	1
4	Develop skill in observation , prediction and interpretation of reactions	A	1
5	Detect solubility, and classify compounds according to their solubility	U	3
6	Apply the principle of common ion effect and solubility product in the identification and separation of ions	A	1,2
7	Develop skill in selecting, primary and secondary standards	U	1
8	Develop skill in weight calculation of primary standards weighing by electronic balance, making of solutions of definite strength (standard solutions)	A	2 ,8
9	Use sophisticated glass wares, calibrate apparatus and develop skill in keen observation , prediction and interpretation of results	A	1
10	Perform volumetric titrations under acidimetry-alkalimetry, permanganometry, dichrometry, iodimetry-iodometry, cerimetry, argentometry and complexometry	A	1
11	Compare the advantages and disadvantages of different volumetric techniques	U	1
12	Practice Punctuality and regularity in doing experiments and submitting Lab records	A	1

	COURSE DESCRIPTION	Hrs	CO No.
Module I	**Lab Safety Measures**	**2**	1
A	**General Instructions**	**8**	
1	Readiness to follow Laboratory rules and regulations and cooperating with Lab instructors and staff for avoiding accidents	2	1
2	Laboratory safety measures, develop safety skills by wearing lab coats, gloves and safety eye glasses wherever necessary (Necessity of **FIRST AID** and of keeping first Aid box in Lab)	2	1

3	Procedures adopted in chemical splashes to skin, eyes, burns and electric shock, Instruction for emergency use of **Fire extinguishers in Lab**	2	1,2
4	Labels and warning symbols for Safe handling of Toxic and corrosive chemicals	2	1,2

Module II	**Qualitative Inorganic Analysis (Micro Analysis)**	**44**	4,5, 6
1	Studies of the reactions of the following basic radicals with a view to their identification and confirmation: Lead, Copper, Bismuth, Cadmium, Tin, Antimony, Ferrous, Ferric ions, Aluminum, Chromium, Zinc, Manganese, Cobalt, Nickel, Calcium, Strontium, Barium, Magnesium, Potassium and Ammonium ions/radicals	4	
2	Studies of the reactions of the following acid radicals with a view to their identification and confirmation: Carbonate, Sulphide, Nitrite, Nitrate, Fluoride, Chloride, Bromide, Iodide, Borate, Acetate, Oxalate, Chromate, Phosphate and Sulphate anions.	4	
3	Systematic qualitative analysis by **microscale methods** of salt mixtures containing two acidic and two basic radicals from the above list (more than one interfering radical should be avoided).	36	

Module III	**Qualitative Volumetric Analysis**	**54**	CO No.
A	**Preparation of Standard Solutions**	**4**	7,8
1	Calculation of mass of a primary standard substance and preparing its standard solution (use of constant boiling hydrochloric acid and Analytical Grade Reagents is recommended)	**2**	
2	Preparation of a solution of definite strength by Dilution techniques	**1**	
3	Preparation of carbonate free sodium hydroxide.	**1**	
B	**Inorganic Volumetric analysis (one burette titration)**	**50**	
(a)	**Acidimetry and Alkalimetry**	**20**	9,10
1	Standardization of HCl using Analytical Grade Na_2CO_3	2	
2	Titrations of Strong acid (HCl, HNO_3 and H_2SO_4) by strong bases (NaOH, KOH)	8	
3	Strong base (NaOH, KOH) - weak acid (Oxalic acid)	4	
4	Strong acid - (HCl, HNO_3 or H_2SO_4) by weak base (Na_2CO_3 solution)	4	

5	Determination of Na_2CO_3 and $NaHCO_3$ in a mixture by indicator method	1	
6	Estimation of NH_3 in an ammonium salt by direct and indirect methods	1	
(b)	**Permanganometry**	**18**	9,10
1	Standardization of Potassium permanganate using A.R Oxalic acid/Mohr's salt	3	
2	Estimation of Ferrous iron	3	
3	Estimation of Oxalic acid	3	
4	Estimation of Hydrogen peroxide	3	
5	Estimation of Calcium	4	
6	Estimation of Nitrite	1	
7	Estimation of MnO_2 in pyrolusite	1	
(c)	**Dichrometry**	**2**	9,10
1	Determination of Ferrous iron using internal & external indicator	1	
2	Determination of Ferric iron after reduction with $SnCl_2$.	1	
(d)	**Cerimetry**	**2**	
1	Standardization of ceric ammonium sulphate with Mohr's salt.	1	
2	Determination of oxalic acid using ceric ammonium sulphate.	1	
(e)	**Iodimetry & Iodometry**	**3**	9,10
1	Standardization of thiosulphate using KIO_3	1	
2	Standardisation of iodine using thiosulphate	1	
3	Determination of copper in copper sulphate	1	
(f)	**Precipitation Titration**	**1**	9,10
	Determination of chloride in neutral medium	1	
(g)	**Complexometry**	**4**	9,10
1	Standardization of EDTA solution with $ZnSO_4$	1	
2	Determination of Zinc, using EDTA	1	
3	Determination of Magnesium	1	
4	Determination of permanent and temporary hardness of water using standardized EDTA	1	

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2021 Admission onwards

(ESE at V Semester)

	V
Course	Core Course-VIII, Lab Course III
Course name	**ORGANIC CHEMISTRYEXPERIMENTS**
Course Code	PO1544
Credit	3
Hours	6 hours/week (108 Hrs)
Lecture-Tutorial-Lab	0-0-6

CO No.	**COURSE OUTCOME** *Upon completion of this course, the students*	**Cognitive Level**	**PSO No.**
1	Develop curiosity in systematically analysing organic compounds	A	1
2	Differentiate and identify organic compounds by their characteristic reactions towards standard reagents	U	10
3	Confirm their findings by preparing solid derivatives, and thus understand reliability of experimental results	A	2
4	Determine physical constants of organic compounds	A	3
5	Separate organic compounds by TLC/paper/column chromatographic techniques	A	3
6	Prepare soaps	A	18
7	Apply the principles and techniques in organic chemistry, thereby developing skill in designing an experiment to synthesize and purify organic compounds	A	18
8	Practice systematic scientific procedure and prepare adequate report of them	A	16
9	Understand the chemistry behind organic reactions	A	10

	COURSE DESCRIPTION	**Hrs**	CO No.
Module I	**Detection of Elements**	6	
	Lassaign's test for Nitrogen, Sulphur and Halogen		

Module II	**Solubility Tests**	5	2
1	Classification of compounds into water soluble/insoluble		
2	Classification of compounds into ether soluble/insoluble		
3	Solubility in Na_2CO_3		
4	Solubility in NaOH		
5	Solubility in HCl		
Module III	**Tests for Aliphatic and Aromatic compounds**	5	2
	(i) Ignition test (ii)Nitration test		
Module IV	**Tests for Saturated and Unsaturated Compounds**	4	2
	(ii) Oxidation (ii) Bromination		
Module V	**Tests to distinguish between following compounds**	8	2
1	Monocarboxylic acid and dicarboxylic acid		
2	Primary, secondary and tertiary amines		
3	Monoamide and diamide		
4	Aldehyde and ketone		
5	Reducing and non-reducing sugars		
6	Monohydric phenols and dihydric phenols		
Module VI	**Reactions of common functional groups using known organic compounds**.	6	6
Module VII	**Systematic qualitative analysis with a view to characterization of the following functional groups**	40	6
1	Halo compounds :chlorobenzene, benzyl chloride,		
2	Phenols: phenol, *o* ,*m* ,*p* -cresols, naphthols, resorcinol		
3	Aldehydes and ketones: benzaldehyde, acetophenone, benzophenone		
4	Carboxylic acids: benzoic, phthalic, cinnamic and salicylic acids		
5	Esters: ethyl benzoate, methyl salicylate		
6	Amides: benzamide, urea		
7	Anilines: aniline, *o,m, p* - toluidines, dimethylaniline		
8	Nitro compounds: nitrobenzene, *o*- & *p*- nitro toluene		
9	Poly nuclear hydrocarbons: naphthalene, anthracene		
10	Reducing and non-reducing sugars: glucose and sucrose		

Module VIII	**Preparation of Organic Compounds**	20	5&6
1	Halogenation: Bromination of acetanilide		
2	Nitration of Acetanilide or nitrobenzene		
3	Oxidation of benzaldehyde/Toluene/Benzyl chloride		
4	Acetylation of salicylic acid or aniline Benzoylation of phenol or aniline		
5	Hydrolysis of ethyl acetate and benzamide		
Module IX	**Chromatography**	10	4
1.	**TLC of simple organic compounds (using TLC sheets)		
2	*Paper chromatographic separation of mixture of inks and sugars		
3	*Column chromatographic separation of a mixture of dyes		
Module X	***Organic estimations**	4	8
1	Estimation of phenol		
2	Estimation of Aniline		

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2021 Admission onwards

(ESE at V Semester)

Semester	V
Course	Core Course IX
Course Name	**POLYMER CHEMISTRY EXPERIMENTS (Lab Course No.IV)**
Course Code	PO1545
Credit	2
Hours	54
Lecture – tutorial - Lab	0-0-3

Co. No	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive Level	PSO No
1	Students will be able to understand the quality of rubber latex by determining DRC, TSC and ammonia content.	U, A	24,26
2	To determine the ash content, volatile matter and metal content of dry rubber.	A	25
3	Differentiate whether the given polymer is plastic or rubber and find out the exact given polymer and different chemical reactions involved in it.	U	23,22

4	Carry Out a polymer synthesis based on a given protocol and explain what preparations are need to carry out for a polymer synthesis.	A	22

Module	Course description	No. of Hours	CO No
1	Determination of ammonia content, total solid content, dry rubber content, KOH number, acid value, iodine value, estimation of hydroxyl graphs, estimation of nitrogen in polymer and related samples.	15	1
2	Determination of ash content, volatile matter and metal (Cu, Fe and Th) content of dry rubber.	15	2
3	Qualitative analysis of plastic and rubber	12	3
4	Synthesis of different polymers involving various polymerization process and techniques.	12	4

Text Book

Handbook for analysis of synthetic polymer and plastics, J. Urbanski, W. Czerwinski, K. Janicka et al., Ellis Harwood Ltd

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2021 Admission onwards
(ESE at VI Semester)

Semester	VI
Course	Core Course-XIII
Course name	**GRAVIMETRIC EXPERIMENTS (Lab Course V)**
Course Code	PO 1644
Credit	3
Hours	2 hours/week (36Hrs)
Lecture-Tutorial-Lab	0-0-2

CO No.	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive Level	PSO No.
1	Understand precipitation techniques in quantitative context	U	1
2	Appreciate the application of silica crucible and sintered crucible in gravimetry	A	2,8
3	Practice technique of making, diluting solutions on quantitative basis	A	1

4	Realise the factors affecting precipitation/crystallisation	A	1
5	Take precautionary measures in filtration , drying and incineration of precipitates	U	3
6	Understand the principle of colorimetry to estimate Fe^{3+} and ammonia	A	1,2
7	Practice Punctuality and regularity in doing experiments and submitting Lab records	A	18

	COURSE DESCRIPTION	**Hrs**	CO No.
Module I	**Precipitation and Filtration Techniques**	2	1,2
1	True solution , Colloids, Precipitates		
2	Saturated and super saturated solutions		
3	Solubility product and common ion effect		
4	Precipitating agents		
5	Co-precipitation and post precipitation		
6	Washing of precipitate based on principle of solvent extraction		
7	Filtration using Whatmann Filter paper		
8	Desiccating agents and use of desiccators and vacuum desiccators		
9	Incineration in silica crucible		
10	Use of sintered crucible and its advantages and limitations		
Module II	**Gravimetric Estimations**		
A	**Estimations using silica crucible**	32	1,2
1	Estimation of water of crystallization in hydrated Barium chloride		
2	Estimation of Barium as Barium sulphate		
3	Estimation of sulphate as Barium sulphate		
4	Estimation Iron as Fe_2O_3		
5	Estimation Calcium as $CaCO_3$		
6	Estimation Aluminium as Al_2O_3		
7	Estimation Magnesium as $Mg_2P_2O_7$		
B	**Estimations using sintered crucible**	2	1,2
1	Magnesium as oxinate		

2	Nickel as nickel dimethyl glyoximate		
3	Copper as copper thiocyanate		
4	Silver as silver chloride		

Textbooks

1. A. I. Vogel, "A text book of Qualitative Analysis including semi micro methods" Longmans, fifth edition, 1979.
2. V. V. Ramanujam, "Semi micro Qualitative Analysis", 3rd Edition, National Publishing Company, 2004.
3. E. S. Gilreath "Qualitative Analysis using semi micro method" Mc Graw Hill, 1954.
4. A. I. Vogel, "A text book of Qualitative Inorganic Analysis" Pearson Education India, 2012.
5. A. I. Vogel, "Elementary Practical Organic Chemistry" Longmans, 1958.
6. J. B. Yadav, Advanced Practical Physical Chemistry, Goel, Publishing House, 1981.

For Further Reading

1. Day and Raman, "Laboratory Manual of Organic Chemistry".
2. B. Viswanathan and P.S Raghavan, "Practical Physical Chemistry" 2005 Edn. Viva Books (Pvt. Ltd), 2005.
3. F.G Mann and B.C Saunders, "Practical Organic Chemistry" 4th Edn, Pearson Education India, 2009.
4. A. Findlay, "Practical Physical Chemistry" Franklin Classics Trade Press, 2018.
5. R. C. Das and E. Behara, "Experimental Physical Chemistry", Tata Mc Graw Hill, 1983
6. N. K.,Vishnu, "Advanced practical organic chemistry" Vikas publishing house, New Delhi, 2015.

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FIRST DEGREE PROGRAMMAE
2021 Admission onwards
(ESE at VI Semester)

Instructions for use of computer software and programmes in the physical chemistry experiments

1. Computer software (Excel) is to be used for plotting graph or calculations.
2. Spread sheet program can be used for determining Equivalence point in potentiometric and conductometric titrations.
3. Data analysis of kinetic experiments using spreadsheet program (determination of rate constant)
4. Plot scatter diagram (wherever applicable in physical experiments)

Semester	VI
Course	Core Course XIV, Lab Course VI
Course name	**PHYSICAL CHEMISTRY EXPERIMENTS**
Course Code	**PO1645**
Credit	2
Hours	6 hours/week (108Hrs)
Lecture-Tutorial-Lab	0-0-4

CO No.	**COURSE OUTCOME** *Upon completion of this course, the students*	**Cognitive Level**	**PSO No.**
1	Develop Scientific outlook and approach in applying principles of physical chemistry in chemical systems/reactions	U	1
2	Use computational methods for plotting graph	A	2,8
3	Describe systematic procedures for physical experiments	U	1
4	Acquire Instrumentation skill in using conductometer, potentiometer, refractometer, stalagmometer and Ostwald's viscometer.	U	3
5	Compare theory with experimental findings	A	1, 2
6	Practice Punctuality and regularity in doing experiments and submitting Lab records	A	

	COURSE DESCRIPTION	**Hrs**	CO No.
Module I	**Conductometry**	20	1-6
1	Determination of cell constant		
2	Conductometric titration of NaOH using HCl		
Module II	**Potentiometry**	10	1-6
1	Potentiometric titration of Fe^{2+} *versus* $Cr_2O_7^{2-}$		
2	Potentiometric titration of $KMnO_4$ *versus* KI		
3	Potentiometric titration of HCl *versus* NaOH using quinhydrone electrode		
Module III	**Phenol-water (Binary liquid systems)**	20	1-6
1	Critical solution temperature of phenol –water system		
2	Influence of KCl(impurity) on the miscibility temperature of phenol-water system .Determination of concentration of given KCl solution		

Module IV	**Transition temperature depression methods**	20	1-6
1	Determination of transition temperature of a salt hydrate.		
2	Determination of Kt of salt hydrate		
3	Determination molar mass of a solute using transition point depression method		
Module V	**Kinetics**	6	1-6
	Kinetics of hydrolysis of an ester (methyl acetate/ ethyl acetate)		
Module VI	**Surface tension**	6	1-6
1	Determination of Surface tension of any three liquids		
2	Surface tension of binary mixtures and determination of concentration of an unknown mixture		
Module VII	**Viscosity**	6	1-6
1	Determination of viscosity of any three liquids		
2	Viscosity of binary mixtures and determination of concentration of an unknown mixture		
Module VIII	**Refractive index experiments**	6	1-6
1	Determination of refractive indices of any three liquids		
2	Refractive indices of KCl solutions of different concentrations and determination of concentration of unknown KCl solution		
Module IX	**Heat of neutralization**	6	1-6
	Determination of water equivalent of Calorimeter and heat of neutralization of strong acid and strong base		
Module X	**Partition experiments**	8	1-6
	Partition coefficient of iodine between CCl_4 and H_2O or Partition coefficient of ammonia between $CHCl_3$ and H_2O		

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2020 Admission onwards

Semester	V-VI
Course	**PROJECT COURSE**
Course name	**PROJECT**
Course Code	**PO1646**
Credit	4
Marks	100 (No CE marks)
Lecture-Tutorial-Lab	0-0-2 (V) & 0-0-3(VI)

CO No.	COURSE OUTCOME *Upon completion of this course, the students*	Cognitive Level	PSO No.
1	Develop an aptitude for research in chemistry	U,A	1
2	Practice research methodology and literature search	A	2
3	Critically choose appropriate research topic and presentation	A	8

GUIDELINES FOR PROJECT COURSE (Course Code PO1646)

- The board of examiners can decide the scheme of evaluation of project , study tour report and viva voce
- Topics of chemical interest can be selected for the project. Project is to be done by a group not exceeding5 students on approval by the teacher in charge.
- Every student should submit typed (A4 paper, 12 Font, 1.5 Space, 20- 30 pages), spirally bind Project report duly attested by the supervising teacher and the Head of the Department on the day of practical examination before a board of two Examiners for ESE.
- The viva-voce based on the project is conducted individually.
- Project topic once chosen shall not be repeated by any later batches of students.
- List of projects submitted year wise is to be maintained in a register and submitted before the examiners if necessary.

THE PROJECT REPORT MAY CONTAIN THE FOLLOWING SECTIONS

1. Preliminary (Title page, declaration, certificate of the supervising teacher, content etc.)
2. Introduction with relevant literature review and objective
3. Materials and Methods
4. Results
5. Discussion
6. Conclusion / Summary
7. References

STUDY TOUR AND FACTORY VISIT

Students are directed to

- Visit at least one chemical factory preferably with in the state of Kerala.
- Submit scientifically prepared hand written study tour report along with photographs of candidate at the places of visit for ESE on the day of the examination of project evaluation.

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FIRST DEGREE PROGRAMME

2021 Admission onwards

OPEN COURSE FOR OTHER MAJORS

Semester	V
Course	Open Course
Course name	**CHEMISTRY IN EVERY DAY LIFE**
Course Code	PO 1551.1
Credit	2
Hours	54 hours
Lecture-Tutorial-Lab	3-0-0

CO No.	COURSE OUTCOME *Upon completion of this course, students*	Cognitive level	PSO
1	Discuss the course of development of structure of atom, properties of atom, classification of elements in to a periodic table	U	1
2	Apply rules for filling electrons in classifying elements into s, p, d and f blocks	C	1
3	Explain different types of bonding and predict stability	U	4
4	Develop curiosity and scientific attitude towards the application of chemistry in daily life	C	1
5	Appraise the current development in Chemistry and contribution of chemistry for sustainable development	E	1
6	Adopt safer and healthier life skills in harmony with nature	A	21
7	Realises the importance of microscale approaches and nano material research	U	13 ,21
8	Recognise the necessity of green approaches to protect nature	R	14

	COURSE DESCRIPTION	Hrs	CO No.
Module 1	**Basic Concept of Chemistry**	**9**	
1.1	Importance of chemistry, subatomic particles-proton, electron, neutron, Bohr model of Atom, Dual behaviour, Heisenberg's uncertainty principle, orbital concept.	3	1
1.2	Aufbau principle, Hund's rule, Pauli's exclusion principle, electronic configuration.	2	2
1.3	Modern periodic table, types of elements.	2	1
1.4	Chemical bonding – energetic of bond formation, ionic &covalent bond, H-bond, effect of H- bonding on physical properties.	2	3
Module 2	**Fundamentals of Biochemistry**	**9**	
2.1	Biochemistry, elements in living organism, Carbohydrates – definition, classification based on taste, functions.	1	4
2.2	Proteins – amino acids, simple examples, structure, classification, essential & non-essential amino acids, peptide bond, proteins – classification on the basis of molecular structure, difference between fibrous & globular proteins, biological functions of proteins, denaturation of protein.	2	4
2.3	Enzymes – Definition, characteristics, function, coenzymes (papain). Nucleic acids – Definition, biological functions of DNA & RNA, genetic code, mutation (only brief idea).	2	4
2.4	Vitamins – Definition, classification, physiological functions, important vitamins, their sources& deficiency diseases (vitamin A, B1, C, D, E, K, & H).	2	4
2.5	Lipids – Definition, classification, fatty acids, fat, oil, waxes. Hormones- definition, function, classification & sources (androgen, oestrogen, progesterone, testosterone).	2	4
Module 3	**Chemistry in Action**	**9**	
3.1	Drugs- medicine, chemotherapy, classification, analgesics, antipyretics, antiseptics, disinfectants, Tranquilisers, antimicrobial, antibiotic (penicillin & its modification), sulpha drugs – General structure, name & uses. Brief idea about anti histamines, antacids, narcotics – examples.	3	5
3.2	Dyes- definition, classification based on application, uses & examples.	2	5

3.3	Soaps & Detergents: Hard & soft soaps, cleaning action of soap, preparation. Detergents- cationic, anionic & non-ionic detergents, superiority of detergents over soaps.	2	5
3.4	Antioxidants, artificial sweetening agents, carotenoid, flavonoids& food preservatives (brief idea).	2	5
Module 4	**Chemistry & Industry**	**9**	
4.1	Polymers- Preparation, uses & application of PE, PS, PVC,PTFE, Polyvinyl acetate, Nylon 6, Nylon 66, cellulose acetate, viscose rayon, silicone rubber.	4	5
4.2	Advanced materials- carbon fibres- CFRP & CFRC, advantages & application.	2	6
4.3	Silicates – General idea &application of cement, ceramics & glass.	3	5
Module 5	**Environmental Chemistry**	**9**	
5.1	Pollution- types of pollution, air pollution, air pollutants, acid rain, photochemical smog, particulates, ozone layer depletion, air pollution control.	2	6
5.2	Water pollution – Types of pollutants, characterization of waste water, methods used in waste water treatment, characteristics of potable water, treatment of water for municipal purposes, fluoride problem in drinking water.	3	6
5.3	Soil pollution- sources of soil pollution, effects of soil pollutants, control.	2	6
5.4	Nuclear hazards- sources of radioactive pollution, damages to biological systems, hazards & control.	2	6
Module 6	**Frontiers in Chemistry**	**9**	
6.1	Nano chemistry –Basic concept, classification, fullerene nano particle, carbon nano tube, quantum Dot.	2	7
6.2	Application of nanotechnology in drug delivery, fluorescent biological labels, colorimetric assay, dendrimers, Nano robots& biosensors (Brief idea only).	3	7
6.3	Green chemistry –Role of chemical industries in polluting the environment, waste management in our city, polymer recycling, biodegradable polymers.	2	8
6.4	Introduction to the principles of green chemistry, basic aspects of atom economy calculations.	2	8

Text Books

1. J. D. Lee, Concise Inorganic Chemistry, Oxford University Press; Fifth edition, 2008.
2. John McMurry Fay & Robert C. Fay, Chemistry 4th edition, Pearson, 2004.
3. Arun Bahl & B. S. Bahl , A Text book of Organic Chemistry, S. Chand, 2016.
4. Premamoy Ghosh, Polymer Science & Technology, Tata McGraw Hill Education, 2001.
5. S. P. Bhutani, Chemistry of biomolecules, Ane Books, 2009.
6. S. Shanmugham, Nanotechnology, MJP Publishers, 2010.
7. Dominic W. S.Wong Mechanism & Theory in food chemistry, CBS Publishers, 1996.
8. S. S. Dara, D. D. Misra, A Text book of environmental Chemistry& Pollution control, 2004.
9. Anastas, P.T., Warner, J. C., Green Chemistry-Theory & Practice, Oxford Univ. Press, 1998.

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

#Since B.Sc. Polymer Chemistry and B.Sc. Chemistry are considered equivalent, B.Sc. Polymer Chemistry Department can also adopt the Open Courses designed by the Board of Studies, Chemistry to students of other core subjects.

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
B.Sc. Degree Programme in Polymer Chemistry
SEMESTER V
COURSE CODE - PO1551.1 CHEMISTRY IN EVERY DAY LIFE

Time: 3 hours Maximum marks: 80

Section A

(Answer **all** questions. Each question carries **1** mark)

1. State Pauli's exclusion principle.
2. Write the actual electronic configuration of Cu.
3. Give the name of any two additives used in food industry.
4. What are anionic detergents?
5. Name any two antibiotics
6. Give the names of any two reinforced carbon fibre
7. What is the size of gold in nanometer.
8. Give an example of a green catalyst
9. What is BOD?
10. What is biodegradable polymer?

(10 × 1 = 10 marks)

Section B

(Answer any **8** questions. Each question carries **2** marks)

11. What are antibiotics? Give two examples.

12. Why the use of narcotics as analgesics should be avoided.
13. What are antacids? Give two examples
14. What are the magnetic properties of nanoparticles?
15. Write short note on genetic code
16. Give one method to remove permanent hardness of water
17. How fertilizers cause soil pollution?
18. Write short note on fluoride problems in drinking water
19. List four air pollution control methods
20. Write short note on viscose rayon
21. Describe the role of chemical industries in polluting the environment
22. State and explain Heisenberg's uncertainty principle

(8 × 2 = 16 marks)

Section C

(Answer any **6** questions. Each question carries **4** marks)

23. Explain the cleaning action of soap
24. What are the ideal requirements for a drug
25. Define antiseptic and disinfectants and give two examples each.
26. Describe the following with two examples
    a) Food preservatives.
    b) Artificial sweetners.
27. List any two types of ceramics and their uses.
28. What are lipids? How they are classified?
29. Explain the Bohr model of atom.
30. Write short note on the nuclear hazards and its damages to biological systems.
31. Describe the functions of sex hormones in our biological system

(6 × 4 = 24 marks)

Section D

(Answer any **2** questions. Each question carries **15** marks)

32. Narrate the biological function of proteins. Explain water pollution? How is water purified?
33. Explain
    a) Consequences of H-bonding.
    b) Different types of chemical bonding with examples.
34. Explain
    a) applications of nanoparticles
    b) the sources, function and deficiency disease of vitamin A,B,C,D and K
35. Write short note on
    a) Dyes
    b) Silicon rubber
    c) Silicates

(2 × 15 = 30 marks)

UNIVERSITY OF KERALA

SYLLABUS FOR B.Sc. POLYMER CHEMISTRY

FIRST DEGREE PROGRAMME

2021 Admission onwards

OPEN COURSE FOR OTHER MAJORS

Semester	V
Course	Open Course
Course name	**CHEMISTRY AND ITS APPLICATIONS**
Course Code	PO 1551.2
Credit	2
Hours	54 hours
Lecture-Tutorial-Lab	3-0-0

CO No.	COURSE OUTCOME *Upon completion of this course, students*	Cognitive level	PSO
1	Appreciate the history of evolution of science	U	1
2	Develop curiosity and scientific attitude towards the application of chemistry in daily life	C	1
3	Appraise the current development in Chemistry and contribution of chemistry for sustainable development	E	1
4	Identify the common ingredients of house hold synthetic products	U	8
5	Classify chemicals according to their uses	U	3
6	Critically choose cosmetics and cleansing agents for daily use	E	15
7	Adopt safer and healthier life skills in harmony with nature	A	21

	COURSE DESCRIPTION (No Chemical structure required)	Hrs	CO No.
Module 1	**Evolution of Chemistry as a Discipline of Science**	**9**	1
1.1	Evolution of Chemistry - ancient speculations on the nature of matter, early form of chemistry-alchemy.	1	
1.2	Chemical revolution, Atomic and Molecular Theory	1	
1.3	Comparison of Rutherford's atom model with solar system	2	
1.4	Major contributions of Mendeleev, Michael Faraday and Marie Curie.	1	
1.5	Scope of Chemical Science, branches of Chemistry, Basic idea of interdisciplinary areas involving Chemistry	1	

Module 2	**Chemistry for Energy Production**	**9**	3
2.1	Electrochemical cell-cathode and anode, Daniel cell, Dry cell	**2**	
2.2	Fuels: Definition and classification of fuels, characteristics of a good fuel, Combustion, calorific value, Wood, coal, Classification based on carbon content	2	
2.3	Petroleum, Origin, Petrol- Diesel, Flash point. Aviation fuels	2	
2.4	Natural gas, biogas, and LPG- composition Pollution due to burning of fossil fuels	2	
2.5	Solar energy and solar cells (applications only)	1	
Module 3	**Vitamins , Hormones, Enzymes and Nucleic Acids**	**9**	2
3.1	Vitamins: Vitamin A, B_2, C, D, E and K source, function and deficiency diseases	3	
3.2	Hormones: Insulin and its function, Thyroid hormones, Iodine deficiency condition	2	
3.3	Enzymes: as Biological catalysts,– Role of enzymes in digestion of food	2	
3.4	Nucleic acids: RNA and DNA, Role of nucleic acids in life process (No structure or chemical reactions)	2	
Module 4	**Chemistry in Day Today Life**	**9**	3,7
4.1	**Food Chemistry**: Food additives, preservatives, anti-oxidants, commonly used permitted and non-permitted food colours - artificial sweeteners-taste enhancers Health effects of fast foods, instant foods, dehydrated foods and junk foods	2	
4.2	**Cosmetics**: talcum powder, lip sticks, nail polish, moisturiser Sun screen lotions and hair dye	2	
4.3	**Cleansing agents**: Soaps- Hard and soft soaps, alkali content-TFM, Detergents and Shampoos.	1	
4.5	**Plastics**: Thermoplastics and thermosetting plastics, Plastic identification codes, biodegradable plastics (PGA,PLA and PHBV) and their applications, Importance of Plastic recycling	2	
4.6	**Pharmaceuticals**: Drugs, classification into analgesics, antacids, antibiotics, antiseptics, disinfectants, anaesthetics, tranquilisers, narcotics and antidepressants- one example	2	

Module 5	**Environmental Chemistry I**	**9**	**2,7**
5.1	Air pollution: Composition of air, major causes of air pollution, Pollutants in air-carbon monoxide, carbon dioxide, oxides of Nitrogen and sulphur , chlorofluro carbons- effect of using refrigerators and air conditioners, Particulate matter- Acid rain, Greenhouse effect, ozone layer and its depletion	2	
Module 6	**Environmental Chemistry II**	**9**	2,7
6.1	Water pollution: causes- heat, industrial waste, sewage water, detergents, agricultural pollutants Treatment of industrial waste water- Activated charcoal, Reverse osmosis Quality of drinking water- Indian Standard and WHO standard- Dissolved oxygen- BOD , COD	6	
6.2	Soil pollution: pesticides, fertilizers, Industrial waste, Plastic.	3	

Text Books

1. T. F. Giereyn, Cultural boundaries of science) University, Chikago Press, 1999.
2. N. C. Dutta, The Story of Chemistry, Universities Press, 2005.
3. MSR Winter, A Consumer's dictionary of cosmetic ingredients, 7th edition, Three
4. Rivers Press, New York, 2009.
5. B. K. Sharma, Polymer chemistry, Goel Publishing House, Meerut, 1989.
6. B. K. Sharma, Industrial chemistry, 11th edition, Goel Publishing House, Meerut, 2000.
7. A. K. Day, "Environmental chemistry-An Introduction", New Age Publisher, 8th edition
8. B. Srilakshmi, Food Science, 5th edition, New Age Publishers, New Delhi, 2010
9. Organic Chemistry of Drug action and drug design-L B Silverman, Elsevier, 2004.
10. Medicinal Chemistry , An introduction, IInd edition Gareth Thomas, Wiley, India,2011

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA

MODEL QUESTION PAPER

B.Sc. Degree Programme in Polymer Chemistry

SEMESTER V

COURSE CODE - PO1551.2 CHEMISTRY AND ITS APPLICATIONS

Time: 3 hours Maximum marks: 80

SECTION A

(Answer **all** questions in one word, each question carry **1** mark)

1. Name any one interdisciplinary area of chemistry
2. Early form of chemistry is called--------
3. Enzymes are called biological ---------
4. Name the hormone produced by Pancreas
5. Alkali content of soap is expressed as ------
6. PGA is a biodegradable plastic. State true or false
7. Name the main constituent of LPG
8. White lead is a --------
9. Which among DNA and RNA determine heredity?
10. Night blindness is caused by deficiency of
    a) Vitamin b) Vitamin c) Vitamin. d) Vitamin K

(10 × 1 = 10 marks)

SECTION B

(Answer any **8** questions, each question carries **2** marks)

11. Give two examples each for enzymes and hormones.
12. How will you distinguish between hard and soft soaps?
13. What are nucleic acids? Give examples.
14. How acid rain does occurs?
15. Define calorific value of a fuel.
16. Suggest a natural way of harvesting solar energy. Explain.
17. How will you classify fuels?
18. Name two petroleum based fuels.
19. How do iodine deficiency affect human beings?
20. What is an electrochemical cell?
21. Name the electrodes in Daniel cell.
22. What is the cause of greenhouse effect?

(8 × 2 = 16 marks)

SECTION C

(Answer any **6** questions, each question carries **4** marks)

23. Explain the source and hazards of fly ash and asbestos.
24. Explain briefly soil pollution.
25. Write a note on enzymes.
26. List four different types of drugs
27. Distinguish between antiseptics and disinfectants

28. What are the characteristic of a good fuel?
29. What are the functions and deficiency diseases of Vitamin C, Vitamin D?
30. Write a note on Enzymes.
31. Discuss on the health effects of fast food and junk food.

(6 × 4 = 24 marks)

SECTION D

(Answer any **2** questions, each question carries **15** marks)

32. a) Discuss on the major contributions of Rutherford.
    b) Differentiate between cathode and anode. Identify the anode and cathode in Dry cell
    c) Chemistry is the central science of many other disciplines. Justify (5 × 3 = 15 marks)

33. a) Write a note on Dalton's atomic theory.
    b) Refrigerators cause air pollution? Explain.
    c) Write a note on vitamin deficiency disease. (5 × 3 = 15 marks)

34. a) What are the 'Three R's of plastic control?
    b) What is meant by DNA? Name the sugar unit present in DNA.
    c) Write a note on Drugs. (5 × 3 = 15 marks)

35. a) Explain the cleansing action of soap.
    b) What is antibiotic? Give the names of the first antibiotic and the scientist who discovered it.
    c) Give an account of the greenhouse effect. (5 × 3 = 15 marks)

(2 × 15 = 30 marks)

UNIVERSITY OF KERALA
OPEN COURSE FOR OTHER MAJORS
SEMESTER-V CREDIT-2 COURSE CODE-PO1551.3

Semester	V
Course	Open Course
Course name	**FUNDAMENTALS OF CHEMISTRY AND ITS APPLICATION TO EVERYDAY LIFE**
Course Code	PO1551.3
Credit	2
Hours	54 hours
Lecture-Tutorial-Lab	3-0-0

CO No.	COURSE OUTCOME *Upon completion of this course, students*	Cognitive Level	PSO No.
1	Appreciate the evolution of Science and Chemistry and the early form of chemistry	U	1
2	Understand the development of Chemistry as a discipline and the role of chemistry as a central science	U	1
3	Discuss the fundamental properties of atom, structure of atom, classification of elements in to a periodic table	U	3
4	Differentiate between simple molecules and giant molecules and the bonding nature	U	11
5	Explain different types of bonding and predict stability	U	4
6	Compare properties of graphite and diamond and their structural differences	U	4
7	Identify house hold chemicals, their advantages and disadvantages	U	12
8	Become aware of chemical hazards and the precautions in handling chemicals	A	12
9	Beware of food adulterants	A	12,21
10	Critically select chemical fertilizers, artificial sweeteners, beverages, and food preservatives	A	21

	COURSE DESCRIPTION	Hrs	CO No.
Module 1	**Evolution of Chemistry**	**9**	**2**
1.1	Evolution of Chemistry - ancient speculations on the nature of matter, early form of chemistry -alchemy	3	
1.2	Robert Boyle and the origins of modern chemistry in the latter 1600s - origin of modern chemistry - Antoine Lavoisier and the revolution in chemistry	3	
1.3	Role of Chemistry as a central science connecting Physics, Biology and other branches of science. Basic ideas of interdisciplinary areas involving Chemistry	3	
Module 2	**Atomic Structure**	**9**	**2**
2.1	Atom- model of Dalton- Thomson – Rutherford and Bohr	3	
2.2	Nature of electron proton and neutron – atomic number – mass number- isotopes -state the relative charges and approximate relative masses of a proton, a neutron and an electron	3	
2.3	Description with the aid of diagrams, the structure of simple atoms as containing protons and neutrons (nucleons) in the nucleus and electrons arranged in shells (energy levels-K,L,M etc) (mention only of s, p, d and f orbitals)	3	

Module 3	**Periodic table**	**9**	**2**
3.1	The Periodic Table - Periodic trends, Group properties - describe the relationship between group number and the ionic charge of an element-	3	
3.2	similarities among the elements in the same group - metallic to non-metallic character from left to right across a period of the Period Table	2	
3.3	Classification into s, p, d and f block- General Properties of elements in Group I and XVIII using the Periodic	4	
	Table, metals, non-metals, metalloids and inert gases		
Module 4	**Structure and properties of materials**	**9**	**5**
4.1	Elements, compounds and mixtures – elementary idea of ionic bond and covalent bond	2	
4.2	Compare the structure of simple molecular substances, e.g. methane; water, carbon dioxide, iodine, with those of giant molecular substances, e.g. poly(ethene); sand (silicon dioxide);	4	
4.3	Diamond and graphite in order to deduce their properties compare the bonding structures of diamond – graphite, electrical conductivity	3	
Module 5	**Chemicals used in Everyday Life.**	**9**	**8**
5.1	Household materials – Major chemical ingredients (No structural formula and preparation needed), Match Box- Soap- detergent - cooking gas - tooth paste - shampoo- hair dye- nail polish- whitener-moth balls, house hold bleach.	4	
5.2	Reactive inorganic substances and their toxicity (strong acids and bases). Hazards due to chemicals, toxic solids, liquids, gases.	3	
5.3	Explosive chemicals, propellants –fire crackers	2	
Module 6	**Chemicals in Food and Beverages**	**9**	**9**
6.1	Important chemical ingredients/ taste makers used in packed food - soft drinks - and its health hazards ,Chemicals in food production	3	
6.2	Fertilizers used in natural sources - Fertilizers urea, NPK and Super phosphates - uses and hazards.	2	
6.3	Adulterants in milk, ghee, oil, coffee powder, tea, asafoetida, chilli powder, pulses and turmeric powder - identification	2	
6.4	Artificial sweeteners - food preservatives	2	

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA

Model Question Paper First Degree Programme

2021 Admission onwards

SEMESTER V

Course Code PO1551.3 Credit 2

OPEN COURSE FOR OTHER MAJORS

FUNDAMENTALS OF CHEMISTRY & ITS APPLICATION TO EVERYDAY LIFE

Time: Three Hours Maximum Marks: 80

SECTION A

(Answer **all** questions, each question carries **1** mark)

1. Name the early form of chemistry
2. Who is the father of modern chemistry?
3. What is superphosphate?
4. ^{1}H , ^{2}H and ^{3}H are called --------of hydrogen
5. Diamond is chemically ---------- (carbon, gold, Silicon, glass)
6. What is main constituent of LPG?
7. Mercury is a liquid ---------- (metal, non-metal, metalloid, none of the above)
8. Silica is the chemical name of (sand, soap, silver, carbon)
9. Artificial sweeteners and ------- ---- are common in junk food.
10. What is periodicity?

(10 × 1 = 10 marks)

SECTION B

(Answer any **8** questions, each question carries **2** marks)

11. Name any two Toxic Chemicals in Cosmetics
12. Obtain the electron configuration for (a) N; (b) F.
13. Explain Hund's rule of maximum multiplicity with an example.
14. Define electron affinity, explain with an example.
15. Which of the following elements Li, Be, B, C, N, O, F and Ne are metals?
16. Explain Bohr model of atom.
17. Why is the electronegativity value of most noble gases equal to zero?
18. What are the Health Effects of Drinking Soda?
19. Which do you expect to have more metallic character, Lead (Pb) or Tin (Sn)
20. What is a Match Head of match stick made of?
21. Explain why graphite conducts electricity whereas diamond doesn't.
22. Is the reactivity of group I metals increasing or decreasing down the group? Explain why?

(8 × 2 = 16 marks)

SECTION C

(Answer any **6** questions, each question carries **4** marks)

23. Explain the colour of firecrackers.
24. What is the difference between covalent and ionic bonding?
25. What are periods and groups in the periodic table? What is periodicity?
26. What are adulterants?
27. How is Thomson's model of the atom different from Dalton's model of atom?
28. What's the difference between an oxidation number and an ionic charge?

29. Explain the health hazards associated with drinking soft drinks?
30. How can metallic character change across a period?
31. Describe clearly the link between increasing effective nuclear charge across a period and the changes in van der Waals radius.

(6 × 4 = 24 marks)

SECTION D

(Answer any **2** questions, each question carries **15** marks)

32. a) Explain about the pH changes of aqueous solutions of elements in the third period as the period is crossed.
    b) Explain how these changes are directly related to the changes in effective nuclear charge across the period.
    c) Describe the metallic character of elements in a period.

33. a) Explain the role of some chemicals in household items. (8 marks)
    b) Write a short note on food adulteration. (7 marks)

34. a) Write a short note on the uses and hazards of fertilisers. (8 marks)
    b) Draw the structure of carbon and sodium (shell model) (7 marks)

35. a) Draw the structures showing shapes of methane, water and carbon dioxide (8 marks)
    b) Compare the bonding structures of diamond – graphite. (7marks)

(2 × 15 = 30 marks)

UNIVERSITY OF KERALA
OPEN COURSE FOR OTHER MAJORS
2021 Admission onwards

Semester	V
Course	Open Course
Course name	**ENVIRONMENTAL CHEMISTRY**
Course Code	PO 1551.4
Credit	2
Hours	54 hours
Lecture-Tutorial-Lab	3-0-0

CO No.	COURSE OUTCOME Upon completion of this course, students	Cognitive Level	PSO No.
1	Discuss the structure and composition of the atmosphere	U	14
2	Identify, Realise and enlist the causes of pollution to water, soil and air	U	14
3	Become aware of environmental issues and its effect to man and other living beings	U	12
4	Review major environmental disasters and suggest controlling and preventive measures	U	12
5	Discuss the laws of environmental protection	U	21

	COURSE DESCRIPTION	Hrs	CO No.
Module 1	**Environmental Components** Structure and composition of the, Atmosphere, hydrosphere, biosphere and Lithosphere – composition of atmosphere	9	1,2,3
Module 2	**Water pollution** Sources, its effect and control; Sampling and measurement of water quality and their analysis, water quality standards, BOD and COD Hard water – soft water Eutrophication and restoration of lakes.	9	1,2,3
Module3	**Air Pollution** Types and sources of air pollution, Common Air Pollutants - Effects of air pollution; Smog – ozone layer depletion greenhouse effect – acid rain	9	1,2,3
Module4	**Soil Pollution** Sources, types, effects and control of: Land pollution, Marine pollution, Thermal Pollution and Radioactive pollution. Waste separation, storage and disposal; Waste Reduction, Recycling and Recovery of materials. Plastics and their misuses.	9	1,2,3
Module5	**Major Environmental Disasters** Major environmental disasters - mercury poisoning in Minamata, Japan, Itaiitai disease due to cadmium poisoning in Japan - Love Canal toxic waste site, Seveso disaster chemical plant explosion – Bhopal disaster - Chernobyl incident	9	4
Module6	**Major environmental laws:** Environment (Protection Act) - The Air (Prevention and control of pollution) Act - The water (Prevention and control of pollution) Act - The wild life protection Act - Forest conservation Act - The Ozone Depleting Substances (Regulation and Control) Rules - The Plastic Waste (Management and Handling) Rules Rio declaration- Montreal protocol, Kyoto protocol Introduction to Green chemistry (elementary ideas only)	9	5

Text Books

1. Banerji, K. Sameer "Environmental Chemistry", 2009.
2. K. De "Environmental Chemistry - An introduction" New Age International (P)Ltd., 2017
3. B. K. Sharma "Air Pollution", Goel Publishing House, 2014.
4. V. K. Ahluwalia "Environmental Chemistry", books.google.co.in, 2017
5. G.W. van Loon and S. J. Duffy "Environmental Chemistry: A Global Perspective", 1999.
6. S. K. Mohanty, Environment and Pollution Laws, Universal Law Publishing Co. (P) Ltd, 2015.

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA

Model Question Paper for B.Sc. Chemistry Programme

OPEN COURSE FOR OTHER MAJORS

Semester V Course Code PO1551.4 Credit -2

ENVIRONMENTAL CHEMISTRY

Time: 3 hours Maximum Marks: 80

SECTION A

(Answer **all** questions, each question carries **1** mark)

1. What you meant by Triple R in waste management?
2. What type of pollution causes acid rain?
3. What are the misuses of plastics?
4. What are the three major man made sources of air pollution?
5. What kind of materials are discharged into the seas?
6. What increases the amount of carbon dioxide in the atmosphere?
7. Explain the action of zeolites on hard water.
8. What are Freon?
9. Define pollution
10. What is fly ash?

(10 × 1 = 10 marks)

SECTION B

(Answer any **8** questions, each question carries **2** mark)

11. How is pollution related to acid rain?
12. How does ocean pollution affect sea animals?
13. What are the main concepts of Green Chemistry
14. Write short note on Radioactive pollution
15. Discuss the major composition of earth's atmosphere 16. Write about the cause and consequence of Chernobyl incident
16. What is BOD and COD?
17. What causes radioactive pollution?
18. Distinguish between Hard water and soft water.
19. What is the goal of Forest Conservation Act?
20. What is the Greenhouse effect and what is its cause? 22. What are the types of air pollutants?

(8 × 2 = 16 marks)

SECTION C

(Answer any **6** questions, each question carries **4** marks)

21. Write short note on volatile organic compounds.
22. How can thermal pollution be prevented?
23. How do you control radioactive pollution?
24. What is smog? How does smog arise?
25. What is Eutrophication
26. Write a note on Rio-Declaration.
27. Explain the various layers of the Atmosphere
28. What is Air Pollution? How can air pollution be minimized?
29. Briefly explain about the components of atmosphere.

(6 × 4 = 24 marks)

SECTION D

(Answer any **2** questions, each question carries **15** marks)

30. (a) Explain Hardness of water and the different types. (5 marks)
    (b) Discuss about the various sources of water pollution. (5 marks)
    (c) What are the control measures for water pollution? (5 marks)

31. (a) Write short note on causes and problems of ozone layer depletion?
    (b) Explain the various types of smog.
    (c) Discuss the Ozone Depleting Substances (Regulation and Control) Rules

32. (a) Explain thermal pollution
    (b) Discuss about plastics and their misuses
    (c) Discuss about Chernobyl disasters

33. (a) Discuss about green chemistry
    (b) Explain Montreal protocol and Kyoto protocol
    (c) The water (Prevention and control of pollution) Act

(2 × 15 = 30 marks)

UNIVERSITY OF KERALA
SYLLABUS FOR BSc POLYMER CHEMISTRY
First degree programme
2021 admission onwards

Semester	VI
Course	Elective Course
Course Name	**Advanced Polymer Chemistry**
Course Code	PO1661
Credit	2
Hours	54
Lecture – tutorial - Lab	2-0-0

CO. No	COURSE OUTCOME *Upon completion of this course, students*	Cognitive Level	PSO No
1	To recall the preliminary techniques for the characterization of polymers	U, R	21
2	To apply sophisticated techniques to characterize polymers.	A	22. 23
3	To appreciate the industrial applications of polymer chemistry, in particular about the plastic industry. Knowledge of industrial plastics and their synthesis.	A	19, 21
4	Insight into the characterization of elastomers and fibres	U, A	21
5	To identify the key tools used in the industry for processing of plastics and rubber. Familiarity with the various additives used in plastic and rubber industry.	A	19,21
6	Application of technology in polymer processing	A	23

	Course Description	No. of Hrs.	CO No
Module 1	**Characterization of Polymers 1**	**9**	
1.1	Preliminary analysis: solubility, flame test, Lassaigne's test, heating test and melting point test (LDPE and HDPE). Analysis of polystyrene (dye test).	3	1
1.2	Molecular weight (mention any two methods only). Physical properties: stress-strain behavior in tension, fatigue, impact strength, tear resistance	3	1
1.3	Optical properties – transmittance, reflectance; electrical properties – dielectric strength (no experimental details and method of determination).	3	1
Module 2	**Characterization of Polymers 2**	**9**	
2.1	Applications of IR, NMR (proton and C-13) and X-ray diffraction in characterization.	3	2
2.2	Thermal analysis, Differential Thermal analysis and Thermogravimetric analysis in characterization of Polymers	3	2
2.3	Differential scanning caloroimetry in characterization of Polymers.	3	2
Module 3	**Plastics and Engineering Plastics**	**9**	
3.1	Preparation, structure, properties of polyolefins (LDPE, HDPE, LLDPE and PP); Vinyl polymers (PVC, poly vinyl acetals and PMMA); Teflon and polyurethanes.	3	3
3.2	Preparation, structure and properties of phenol formaldehyde and urea formaldehyde resins ; nylons and polyesters (Terylene and Dacron)	3	3
3.3	Preparation, structure and properties of engineering plastics , ABS, polyamides, polycarbonates , PPO, PPS, polysulphones, polyimides, fluoropolymers , ionomers and liquid crystalline polymers.	3	3
Module 4	**Elastomers and fibres**	**9**	
4.1	Natural rubber, composition, preservation & coagulation of latex	2	4
4.2	Structure, properties and preparation of synthetic rubbers (PB, SBR, NBR, polychloroprene, polyisobutylene, IIR, EPDM, buna-N, thiacol). Reclaimed rubbers. Thermoplastic elastomers-advantages, polyurethanes.	4	4
4.3	Fibres: natural (structure and properties);synthetic (structure and properties of nylon, polyester and acrylics)	3	4
Module 5	**Polymer Processing**	**9**	
5.1	Peculiarities in the properties of elastomeric, fibre forming (tenacity, spirality and crimp) and plastic materials: structure, property, relationship.	2	5
5.2	Compounding: additives and functions. Vulcanizers, hard rubber, ebonite, accelerators, activators, extenders, fillers, antioxidants, antiozonants.	4	5

5.3	UV stabilizers, lubricants, plasticizers, flame retardants and colourants, typical examples. Blending methods: milling and internal mixing.	3	5
Module 6	**Technology of Polymer Processing**	9	
6.1.	Moulding processes: Compression moulding- transfer moulding, injection moulding, blow moulding.	3	6
6.2.	Forming techniques- extrusion, spinning, calendaring, and casting.	3	6
6.3	Lamination & reinforcement, foaming, coating, finishing, microencapsulation.	3	6

Text Books

1. Malcon P. Steves, Polymer chemistry-An introduction, 3rd edition, Oxford University Press, 1999.
2. F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley & Sons, 1984.
3. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, Polymer Science, New Age International Publishers, 2005.
4. Premamoy Ghosh, Polymer Science and Technology: Plastics, Rubbers, Blends and Composites, Third Edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.
5. Siddaramaiah, Practicals in Polymer Science, CBS Publishers & Distributors, New Delhi, 2007.
6. P. Bahadur & N. V. Sastry, Principles of Polymer Science, Narrora Publishing House, 2nd Edition, New Delhi, 2012.
7. G. Odian, Principles of polymerization, 3rd edition, John Wiley & Sons, 2004.
8. G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi, 1993.
9. V. K. Ahluwalia & A. Misra, Polymer Science-A Text Book, Ane Books, India, New Delhi, 2016.
10. J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi, 2014.

Weightage of marks:

Module	I	II	III	IV	V	VI
Marks	21	21	22	22	22	22

UNIVERSITY OF KERALA
MODEL QUESTION PAPER
First Degree Programme in Polymer Chemistry
2021 Admission onwards
SEMESTER -VI
Core Course-I Course Code - PO1661 Credit-2
ADVANCED POLYMER CHEMISTRY

Time: 3 hours Maximum marks: 80

Section A

(Answer **all** questions. Each question carries **1** mark)

1. Define fatigue.
2. Write any one test to distinguish LDPE & HDPE.
3. Give two examples of flame retardants.
4. What is ebonite?
5. Give two examples of inorganic fillers.
6. Define the term impact strength.
7. What are extenders? Give an example.
8. Cotton is used as filler. Give reason.
9. Plasticized PVC is considered toxic. Why?
10. Natural rubber needs vulcanization. Why?

(10 × 1 = 10 marks)

Section B

(Answer any **8** questions. Each question carries **2** marks)

11. How is the rate of degradation calculated from TGA curve?
12. Write the composition of natural rubber.
13. How can virgin PVC be made suitable for processing?
14. What is plasticization? Why is it needed in polymer processing?
15. Define yield point & tensile strength.
16. How is transfer moulding superior to compression moulding?
17. Distinguish reinforcing & non-reinforcing fillers.
18. Ionomers are superior to LDPE. Why?
19. What are polyurethanes? Mention its use.
20. Write the properties of FTIR.
21. Write the structure of two synthetic rubbers.
22. Write any four advantages of polysulphones.

(8 × 2 = 16 marks)

Section -C

(Answer any **6** questions. Each question carries **4** marks)

23. Discuss the role of X-ray diffraction studies in polymer characterization
24. Explain the use of differential thermal analysis in polymer analysis

25. Write a note on blending methods in polymer processing
26. Write the preparation & properties of Dacron.
27. What is tear resistance? How is it measured?
28. Discuss liquid crystalline polymers.
29. Write short note on electrical properties of polymers.
30. Discuss the structure & use of phenol formaldehyde resins.

(6 × 4 = 24 marks)

Section D

(Answer any **2** questions. Each question carries **15** Marks)

31. Explain the process microencapsulation in polymer processing technology.
32. Explain the peculiarities in structure & properties of
    a) fibre
    b) elastomeric
    c) Plastic materials.
33. Explain the following.
    a) Compression moulding
    b) Calendaring
    c) Lamination technique.
34. Discuss the structure& properties of
    a) Thiokol
    b) SBR
    c) ABS.
35. Discuss the application of IR, H^1nmr& C^{13}nmr in polymer characterization.

(2 × 15 = 30 marks)