UNIVERSITY OF KERALA

# FIRST DEGREE PROGRAMME IN **POLYMER CHEMISTRY**

UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM
FOR **2018** ADMISSIONS ONWARDS

SYLLABUS AND SCHEME
FOR THE PROGRAMME AND EVALUATION

BOARD OF STUDIES
IN POLYMER CHEMISTRY
UNIVERSITY OF KERALA

With Effect From 2018 Admissions

FIRST DEGREE PROGRAMME IN POLYMER CHEMISTRY
UNDER CHOICE BASED CREDIT AND SEMESTER SYSTEM
FOR 2018 ADMISSIONS ONWARDS

PROGRAMME STRUCTURE

The Bachelor of Science (B.Sc.) Under Graduate Degree Programme in Polymer Chemistry covers three academic years consisting of six semesters each with a total of 450 teaching hours in 18 weeks; 25 hours of work per week. The syllabus will be in effect for admissions in 2018 – '19 academic year onwards in the affiliated colleges of the University.

The Programme consists of a total of 37 Courses which are:

(i) 9 Language Courses;
(ii) 2 Foundation Courses;
(iii) 9 Complementary Courses;
(iv) 14 Core Courses;
(v) 1 Open Course
(vi) 1 Elective Course and
(vii) 1 Project

The total minimum credits that should be accrued for successful completion of the programme are 120. This minimum number of credits is distributed in the 1$^{st}$ to the 6$^{th}$ semesters as:

Semester I =18,
Semester II =18,
Semester III =18,
Semester IV =24,
Semester V =18 and
Semester VI =24 respectively.

The details of the programme structure,course structure, and scheme of instruction and evaluationare given in Tables I and II.

## B.Sc. Degree Programme in Polymer Chemistry

## Table I: Course Structure, Scheme of Instruction and Evaluation

| Semester | Course Code | Study Component | Instructional Hours/Weeks | | Credits | Duration of Uty Exam | Evaluation (Marks) | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | T | P | | | CE | ESE | |
| I | EN 1111.1 | English I | 5 | | 4 | 3 hours | 20 | 80 | 18 |
| | 1111.1 | Additional Language I | 4 | | 3 | 3 hours | 20 | 80 | |
| | EN 1121 | Foundation Course I | 4 | | 2 | 3 hours | 20 | 80 | |
| | PY 1131.2 | Complementary Course I(Physics-I) | 2 | | 2 | 3 hours | 20 | 80 | |
| | | Complementary Course lab of PY 1131.2 | | 2 | – | – | – | – | |
| | MM1131.2 | Complementary Course-II(Maths-I) | 4 | | 3 | 3 hours | 20 | 80 | |
| | PO 1141 | Core Course I | 2 | | 4 | 3 hours | 20 | 80 | |
| | | Core Course lab I of PO 1141 | | 2 | – | – | – | – | |
| II | EN 1211.1 | English - II | 5 | | 4 | 3 hours | 20 | 80 | 18 |
| | EN 1212.1 | English -III | 4 | | 3 | 3 hours | 20 | 80 | |
| | 1211.1 | Additional Language II | 4 | | 3 | 3 hours | 20 | 80 | |
| | PO 1221 | Foundation Course II | 2 | 2 | 3 | 3 hours | 20 | 80 | |
| | PY 1231.2 | Complementary Course III(Physics-II) | 2 | | 2 | 3 hours | 20 | 80 | |
| | | Complementary Course Lab of PY 1231.2 | | 2 | – | – | – | – | |
| | MM1231.2 | Complementary Course IV(Maths-II) | 4 | | 3 | 3 hours | 20 | 80 | |

## B.Sc. Degree Programme in Polymer Chemistry
## Table I: Course Structure, Scheme of Instruction and Evaluation

| Semester | Course Code | Study Component | Instructional Hours/Weeks | | Credits | Duration of Uty Exam | Evaluation (Marks) | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | T | P | | | CE | ESE | |
| III | EN1311.1 | English IV | 5 | | 4 | 3 hours | 20 | 80 | 18 |
| | 1311.1 | Additional Language III | 5 | | 4 | 3 hours | 20 | 80 | |
| | PY1331.2 | Complementary Course V(Physics-III) | 3 | | 3 | 3 hours | 20 | 80 | |
| | | Complementary Course lab of PY 1331.2 | | 2 | – | – | – | – | |
| | MM1331.2 | Complementary Course-VI(Maths-III) | 5 | | 4 | 3 hours | 20 | 80 | |
| | PO 1341 | Core Course II | 3 | | 3 | 3 hours | 20 | 80 | |
| | | Core Course lab II of PO 1341 | | 2 | – | – | – | – | |
| IV | EN1411 | English - V | 5 | | 4 | 3 hours | 20 | 80 | 24 |
| | 1411 | Additional Language IV | 5 | | 4 | 3 hours | 20 | 80 | |
| | PY1431.2 | Complementary Course VII(Physics-IV) | 3 | | 3 | 3 hours | 20 | 80 | |
| | PY1432.2 | Complementary Course VIII-physics Lab of PY1131.2, PY1231.2, PY1331.2 & PY 1431.2 | | 2 | 4 | 3 hours | 20 | 80 | |
| | MM1431.2 | Complementary Course IX(Maths-IV) | 5 | | 4 | 3 hours | 20 | 80 | |
| | PO 1441 | Core Course III | 3 | | 3 | 3 hours | 20 | 80 | |
| | PO 1442 | Core Course IV-Chem Lab I & II of PO 1141, PO 1341 &PO 1441 | | 2 | 2 | 6 hours | 20 | 80 | |

**B.Sc. Degree Programme in Polymer Chemistry**
**Table I: Course Structure, Scheme of Instruction and Evaluation**

| Semester | Course Code | Study Component | Instructional Hours/Weeks | | Credits | Duration of Uty Exam | Evaluation (Marks) | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|
| | | | T | P | | | CE | ESE | |
| V | PO 1541 | Core Course V | 3 | | 3 | 3 hours | 20 | 80 | 18 |
| | PO 1542 | Core Course VI | 4 | | 4 | 3 hours | 20 | 80 | |
| | PO 1543 | Core Course VII | 4 | | 4 | 3 hours | 20 | 80 | |
| | PO 1544 | Core Course VIII Lab III | | 6 | 3 | 3 hours | 20 | 80 | |
| | PO1545 | Core Course IX Lab -IV | | 3 | 2 | 3 hours | 20 | 80 | |
| | PO 1551 | Open Course | 3 | | 2 | 3 hours | 20 | 80 | |
| | | Project | | 2 | – | – | – | – | |
| VI | PO 1641 | Core Course X | 3 | | 3 | 3 hours | 20 | 80 | 24 |
| | PO 1642 | Core Course XI | 4 | | 4 | 3 hours | 20 | 80 | |
| | PO1643 | Core Course XII | 4 | | 4 | 3 hours | 20 | 80 | |
| | PO1644 | Core Course XIII Lab V | | 2 | 3 | 3 hours | 20 | 80 | |
| | PO 1645 | Core Course XIV Lab VI | | 6 | 4 | 3 hours | 20 | 80 | |
| | PO 1661 | Elective Course | 3 | | 2 | 3 hours | 20 | 80 | |
| | PO 1646 | Project and Factory Visit | | 3 | 4 | Viva-voce | – | 100 | |

A) Language Courses = 9, B) Foundation Courses = 2
C) Complimentary Courses =9, D) Core Courses =14, E) Open Course =1
F) Elective Course = 1, G) Project = 1
Total Courses = 9+2+9+14+1+1+1 = 37,
Total Credit = 18+18+18+24+18+24 = 120.

## GENERAL ASPECTS OF EVALUATION

### MODE OF EVALUATION

Evaluation of each course shall consist of two parts:

1) Continuous Evaluation (CE), and
2) End Semester Evaluation (ESE)

The CE to ESE ratio shall be 1:4 for both Courses with or without practical. There shall be a maximum of 80 marks for ESE and maximum of 20 marks for CE. A system of performance based, indirect grading will be used. For all courses (Theory and Practical), grades are given on a 7-point scale based on the total percentage of mark (CE+ESE) as given below:

**Criteria for Grading**

| Percentage of marks | CCPA | Letter Grade |
|---|---|---|
| 90 and above | 9and above | A+ Outstanding |
| 80 to <90 | 8 to < 9 | A Excellent |
| 70 to < 80 | 7 to < 8 | B Very Good |
| 60 to < 70 | 6 to < 7 | C Good |
| 50 to < 60 | 5 to < 6 | D Satisfactory |
| 40 to < 50 | 4 to < 5 | E Adequate |
| Below 40 | < 4 | F Failure |

## I.1. CONTINUOUS EVALUATION FOR LECTURE COURSES

The continuous evaluation will be done continuously during the semester. CE components are

(i) Attendance(5 marks)
(ii) Assignments/seminar (5 marks) and
(iii) Test(10 marks)

### 1.1.1 ATTENDANCE:

The allotment of marks for attendance shall be as follows:

| | |
|---|---|
| Attendance less than 75% | 0mark |
| 75%& less than 80 % | 1 mark |
| 80%& less than 85 % | 2marks |
| 85%& less than 90 % | 3marks |
| 90% &less than 95% | 4marks |
| 95% & above | 5 marks |

### 1.1.2 EVALUATION OF THE ASSIGNMENTS/SEMINAR

Each student shall be required to do one assignment or one seminar for each Course. Seminar for each course shall be organized by the course teacher and assessed by a group of teachers in the Department. The topic selection by the student for assignments/seminar shall be with the approval of the course teacher. The assignment typed/written on A4 size paper shall be 4 – 6 pages. The minimum duration of the seminar shall be fifteen minutes and the mode of delivery may use audio–visual aids if available. Both the assignment and the seminar shall be evaluated by giving marks based on each of the four components shown in table 1.1.2.1. The seminar is to be conducted within the contact hours allotted for the course.

#### 1.1.2.1 Mode of Assignments/Seminar Evaluation (maximum 5 marks)

| No | Components | Marks |
|---|---|---|
| 1 | Adherence to overall structure & submission deadline | **2** |
| 2 | Content & grasp of the topic | **1** |
| 3 | Lucidity/clarity of presentation | **1** |
| 4 | References, interaction/overall effort | **1** |

The explanatory guidelines in Table I.1.2.2.are suggested (tentatively) for the assessment of each of the above main components:

| **I.1.2.2 Guidelines for Assignments/Seminar Evaluation** | | |
|---|---|---|
| No | Main Component | Sub –Components |
| 1 | Adherence to overall structure & submission deadline | i. Punctual submission<br>ii. Adequate length/duration<br>iii. Inclusion of introduction, discussion & summary sections<br>iv. Absence of errors/mistakes |
| 2 | Content & grasp of the topic | 1. Coverage of topic<br>2. Understanding of topic<br>3. Logical organization<br>4. Originality (No copying from a source or plagiarism) |
| 3. | Lucidity/Clarity | i. Clarity<br>ii. Effective presentation/delivery<br>iii. Neatness of presentation<br>iv. Inclusion of appropriate diagrams/equations/structures etc. |
| 4 | References/Interaction/Overall effort | 1. Listing of references<br>2. Use of more than one reference source/Use of Web resource<br>3. Correct response to quiz/questions<br>4. Overall effort in preparing assignment/seminar |

### I.1.3. DETAILS OF THE CLASS TEST

For each course there shall be one class test /model test.

1. The duration of the test shall be 3 hours.
2. Each question paper shall have four parts: A,B,C and D (marks as shown in Table I.1.3.1)
3. Part A shall contain10 questions of 1 mark each. The length of the answers to these questions may range from one word to a maximum of 2 sentences.
4. Part B shall contain12 short answer type questions. Out of these, the students have to answer 8 questions. The length of each of these answers shall not exceed one paragraph. Each question carries2 marks.
5. Part C shall contain9 short essay type questions of which the candidate has to answer 6 questions. Each question carries 4 marks. The answers to each of these should not exceed 120 words.
6. Part D shall contain4 questions of which the candidate has to answer 2. Each of these long essay type questionscarries15 marks.
7. Total marks for the entire questions to be answered are 80.
8. Convert the marks obtained out of 80 to marks out of 10

### I.1.3.1 Question Paper Pattern for Test

| Question type | Total number of questions | Number of Questions to be answered | Marks for each question | Total marks |
|---|---|---|---|---|
| Very short answer type (one word to maximum of 2 sentences) | 10 | 10 | 1 | 10 |
| Short answer (not to exceed one paragraph) | 12 | 8 | 2 | 16 |
| Short Essay (not to exceed 120 words) | 9 | 6 | 4 | 24 |
| Long essay | 4 | 2 | 15 | 30 |
| **Total** | **35** | **26** | | **80** |

The marks of CE shall be consolidated by adding the marks of attendance, assignment/seminar and test paper respectively for a course as:

| | | |
|---|---|---|
| a | Attendance | 5 marks |
| b | Assignment/Seminar | 5 marks |
| c | Test Paper | 10 marks |

## I.2. CONTINUOUS EAVALUATION FOR LABORATORY COURSES

The CE components are: (i) Attendance for laboratory sessions, (ii) Experiment (Lab) report on completion of each set of experiments, (iii) Laboratory skill and (iv) Quiz/test.

The marks for the components of practical for continuous evaluation shall be as shown below:

| | | |
|---|---|---|
| 1 | Attendance | 5 marks |
| 2 | Record (lab report) | 5 marks |
| 3 | Test | 5 marks |
| 4 | Performance, punctuality and skill | 5 marks |

## I.2. Components of CE for Lab Courses

### 1.2.1 Attendance:

The allotment of marks for attendance shall be as follows:

| | |
|---|---|
| Attendance less than 75% | 0mark |
| 75%& less than 80 % | 1 mark |
| 80%& less than 85 % | 2marks |
| 85%& less than 90 % | 3marks |
| 90% & less than 95% | 4 marks |
| 95% & above | 5 marks |

The guidelines for evaluating the three main components 2-4 using sub-components are presented below.

## I.2.2 EVALUATION OF THE EXPERIMENT (LAB) REPORT

On completion of each experiment, a report shall be presented to the course teacher. It should be recorded in a bound note-book (not on sheets of paper). The experimental description shall include aim, principle, materials/apparatus required/used, method/procedures, tables of data collected, equations, calculations, graphs, other diagrams etc. as necessary and final results. Careless experimentation and tendency to cause accidents due to ignoring safety precautions shall be considered as demerits.

## I.2.2.1 Mode of Experiment (Lab) Report Evaluation

| No | Sub components | Marks |
|---|---|---|
| 1 | Punctual submission and neat presentation | 1 |
| 2 | Inclusion of aim, materials, procedure, etc. | 1 |
| 3 | Calculations and absence of errors/mistakes | 1 |
| 4 | Accuracy of the result | 2 |

## I.2.3. EVALUATION OF THE LAB SKILL

### I.2.3.1 Mode of Lab Skill Evaluation

| No | Sub components | Marks |
|---|---|---|
| 1 | Punctuality and completion of experiment on time | 2 |
| 2 | Lab skill and neat arrangements of table and apparatus in the lab | 1 |
| 3 | Prompt and neat recording of observations in the lab note book | 1 |
| 4 | Experimental skill and attention to safety | 1 |

### I.2.3. EVALUATION OF THE LAB QUIZ/TEST

For each lab course there shall be one lab test during a semester. The test for a lab course may be in the form of a quiz /University practical examination. Two teachers (one of the teachers should be the course teacher) shall conduct the quiz/test within the assigned lab contact hours. The marks obtained should be converted to 5 marks for consolidating the CE.

### II.1. END SEMESTER EVALUATION FOR LECTURE COURSES

The end semester evaluation conducted by the University at the end of the semester shall have80 marks. The end semester University theory examination shall be of 3 hours duration. Grades A+ to F shall be awarded as per the regulations and the general aspects of evaluation.

## II.1.1. END SEMESTER QUESTION PAPER PATTERN

1. The duration of the test shall be 3 hours.
2. Each question paper shall have four parts: A,B,C and D (marks as shown in Table I.1.3.1)
3. Part A shall contain 10 questions of 1 mark each. The length of the answers to these questions may range from one word to a maximum of 2 sentences.
4. Part B shall contain 12 short answer type questions. Out of these, the students have to answer 8 questions. The length of each of these answers shall not exceed one paragraph. Each question carries 2 marks.
5. Part C shall contain 9 short essay type questions of which the candidate has to answer 6 questions. Each question carries 4 marks. The answers to each of these shall not exceed 120 words.
6. Part D shall contain 4 questions of which the candidate has to answer 2. Each of these long essay type questions carries 15 marks.
7. Total marks for the entire questions to be answered are 80.

## II.2. END SEMESTER EVALUATION FOR LABORATORY COURSES

The scheme of valuation of ESE of Lab courses and their marks are discussed along with the syllabi for each of such laboratory courses in the subsequent sections. The University practical examination will be of 6 hours duration. Total marks for the ESE of each practical course are80.

## II.3. CONSOLIDATION OF MARKS

The marks of a course are consolidated by combining the marks of ESE and CE (80+20)

A minimum of 40% marks is required for passing a course with a separate minimum of 40% for CE and ESE.

## III. Project/Dissertation, Factory/R&D Institute Visit and Project based Viva-voce

### Evaluation of the Project & Factory/Research institution visit report

### (Semester VI, PO – 1646)

The Project work may be conducted individually or by a group comprising of a maximum of 5 students during the semesters V and VI. The work of each student/group shall be guided by one faculty member. After the completion of the work, the student shall prepare 2 copies of the project report. The copies certified by the concerned guide & the Head of the Department shall be submitted prior to the completion of the sixth semester.

The typed copy of the report may have a minimum of 25 pages comprising the title page, introduction, literature review, result and discussion and references. These reports shall be evaluated by a board of two examiners appointed by the University. The examiners shall affix their dated signatures in the facing sheet of the project report. The evaluation/viva voce of the project report shall be conducted on a separate day. The number of students may be a maximum of 16 per day or as per regulations and the general aspects of project evaluation. The students have to present their work individually before the examiners on the day of the viva-voce. The examiners shall consult each other and award grades based on the various components given in the Table below. There shall be no continuous assessment for the dissertation/project work.

The Factory/research institution visit report shall be submitted during the lab course examination/viva voce. The examiners who evaluate the report (of 16 students per day) shall affix their dated signatures in the facing sheet.

**The total marks for study tour report and the project is 100.**

**Evaluation of the Project**

| No | Main Component | Marks | Sub-components |
|---|---|---|---|
| 1 | Dissertation | 50 | i. Background/review and objectives<br>ii. Materials and methods<br>iii. Results and discussion<br>iv. Summary/Conclusion and references |
| 2 | Project Presentation | 15 | i. Clarity and understanding<br>ii. Effective presentation and delivery<br>iii. Content and neatness of presentation<br>iv. Time management and interaction |
| 3 | Viva-voce | 15 | i. Understanding of project objectives<br>ii. Familiarization with methods/procedures<br>iii. Background knowledge of Project & Subject<br>iv. Correct and clear answers |
| 4 | Report of visit to Res. Institution/Factory | 20 | i. Brief description of the Institute/Factory<br>ii. Details of Instruments/Manufacturing facility<br>iii. Figures, flowcharts, pictures& diagrams<br>iv. Neat presentation and summary |

## IV. GENERAL ASPECTS OF COURSE AND CREDIT TRANSFER

As per Regulations, students from other institutions may be admitted in the 3rd and 5th semesters by transfer subject to conditions prescribed by the University. Such transfers to a B.Sc. Polymer Chemistry Programme can be permitted only from a similar semester based three year degree programme with Polymer Chemistry as the major and Mathematics as a compulsory complementary course and physics as a desirable complementary course. The requirements of the language, foundation and elective courses will be decided as per the views of the concerned BoS.

For core course transfers, the transferable credit per course is limited to 4 (as this is at present the highest credit per course in the University of Kerala) even if the source Institution awards a credit >4. If, however, a core course with comparable content, contact hours and mode of evaluation has a credit <4 at the source Institution, then the transferee may be awarded a credit at par with the similar course at this University.

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**Core Course No. – I. Course Code– PO1141.**
**Semester – I. Credits-4.**
**Inorganic Chemistry– I**
**(2018 admission onwards)**

***36 hours***

**COURSE OBJECTIVE**

The objective of this course is to teach the students the principles of modern theory of atomic structure, periodic properties of elements, occurrence and isolation of elements, chemical bonding, nuclear chemistry and environmental chemistry (air, water and soil pollution).

**COURSE TRANSACTION FORMAT**

Lecture-Tutorial-Lab: **2-0-2** hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 36 hours lecture and 36 hours lab instruction.

**COURSE SYNOPSIS**

Introduction to atomic structure, electronic configuration and periodic properties; Types of bonds-introduction to V.B., M.O. and VSEPR Theories, Introduction to nuclear chemistry, Basic idea of occurrence and isolation of elements, Environmental chemistry (air, water and soil pollution).

**COURSE CONTENT**

**Module I (Modern theory of atomic structure)** *6 hours*

Introduction to wave mechanics: Dual nature of electron, Heisenberg's uncertainty principle and its significance, Schrodinger wave equation for a particle in one dimensional box and its solution (no derivation), Radial and angular function, significance of and, orbital concept, Pauli's exclusion principle, Aufbau principle, extra stability of filled and half-filled orbital, shapes of orbital, classification of elements into s, p, d and f blocks

**Module II (Periodic properties, occurrence and isolation of elements)** *6 hours*

Size of atoms & ions, ionization energies, electron affinity, Fajan's rule, electronegativity – Pauling, Mulliken, Allred & Rochow scale, horizontal vertical and diagonal relationship in the periodic table.
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.

**Module III (Chemical bonding I)** *6 hours*

Types of bonds, transition between the main types of bonding, General properties ionically& covalently bonded compounds, lattice energy, Born — Haber cycle, Fajan's rule, partial covalent

character of ionic bond.

Secondary bond forces - Van der Waal's forces, ion—dipole, dipole—dipole, ion—induced dipole and dipole - induced dipole interactions, Hydrogen bonds and their consequences, dipole moment and its application.

**Module IV (Chemical bonding II)** *6 hours*

Covalent bond - Lewis theory, Sidgwick - Powell theory, VSEPR theory, V.B. theory (qualitative idea taking hydrogen as example), Hybridisation (explanation of structures of molecules such as $SF4$, $ClF_3$, IF7, $XeF_4$ &$XeF_6$).
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, rules of LCAO, M.O. configuration of $H_2^+$, $He_2^+$,$Li^{2+}$, $C_2$, $N_2$, $O_2$, $O_2^-$, $F_2$, NO and CO, bond order, M.O. treatment involving delocalized pi bonding—resonance.
Metallic bonding - general properties, qualitative idea of theories of bonding in metals - free electron theory, V.B. theory, and band theory.

**Module V (Nuclear chemistry)** *6 hours*

Structure of nucleus - liquid drop model, shell model, forces in the nucleus, stability, ratio of neutrons to protons, modes of decay, gamma radiation, half-life period, binding energy & nuclear stability –alpha decay, radioactive decay series, induced nuclear reactions –nuclear fission &nuclear fusion, atomic bomb, moderators. Types of reactor (general idea ) HTR, water cooled thermal reactor, fast breeder reactors, application of radioactive isotopes-radio carbon dating, rock dating, neutron activation analysis, solubility of sparingly soluble salt.

**Module VI - Environmental Chemistry (Air, Water and Soil Pollution** *6 hours*

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.

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.

Soil pollution - Pesticides, Fertilizers, Industrial waste, plastics - Control of pollution

***References:***


1. *1. J. D. Lee ,Concise inorganic chemistry , Blackwell science limited*
2. *Sathya Prakash, G. D. Tuli, Basu S. K. & Madan R. D., Advanced Inorganic Chemistry, (Vol. I ) ,S .Chand & Com .Ltd., New Delhi .*

3. *F .A .Cotton,P. L. Gaus & G. Wilkinson, Basic Inorganic Chemistry, John Wiley & Sons.*
4. *B. R. Puri, L. R. Sharma & K .C .Kalia, Principles of Inorganic Chemistry, Vallabh Publications, New Delhi*
5. *D. F. Shriver, P .W. Atkins &C. H. Langford, Inorganic Chemistry, Oxford Univ. Press*
6. *M. C. Day & Selbin, Theoretical Inorganic Chemistry*
7. *R .D. Madan, Modern Inorganic Chemistry, S. Chand & Company Ltd. New Delhi*
8. *S. K. Banerji, Environmental Chemistry.*
9. *A. K. De, Environmental Chemistry - An introduction.*
10. *B. K. Sharma, Air Pollution.*
11. *V. K. Ahluwalia, Environmental Chemistry.*
12. *G.W. vanLoon and S. J. Duffy, Environmental Chemistry: A global perspective.*

**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 I COURSE CODE - PO1141*
### *INORGANIC CHEMISTRY - I*

***Time: 3 hours*** ***Maximum marks: 80***

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

1. The quantum numbers n =3, l=1 correspond to which orbital?

2. State Pauli's exclusion principle.

3. Which has higher electron gain enthalpy-Fluorine or Chlorine?

4. What is the hybridization of Xe in $XeF_4$ molecule?

5. How lattice energy is related to solubility of an ionic crystal?

6. Based on VSEPR theory, predict the shape of $NH_3$ molecule

7. Name a naturally occurring radioactive element

8. Define binding energy

9 Write the reason for eutrophication?

10. In the stratosphere, fluorine from the CFC's change to which compound.

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

11. Distinguish between angular probability function and radial probability function
12. What do you understand by a node? How many nodes are there for a 3S orbital?
13. Write the actual electronic configuration of copper. Give reason
14. The size of inert gas atoms is larger than the corresponding halogen atoms. Why?
15. What is Mullikan's scale of electronegativity?
16. Explain diagonal relationship with an example
17. What is bond order? Calculate the bond order of $O_2^-$
18. Name the energy changes to be considered in the formation of an ionic bond
19. Sketch the atomic and molecular orbitals of NO molecule
20. What are bonding and anti-bonding orbitals?
21. Explain the structure of $ClF_3$ molecule
22. Write a note on greenhouse effect.

## Section –C

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

23. State Schrodinger equation and explain the terms in it and also bring out the significance of $\Psi$and $\Psi^2$
24. comment on the extra stability of filled and half-filled orbital's
25. Account for the fact that there is a decrease in first ionization energy from Be to B and Mg to Al
26. Explain the principle involved in the electrolytic and chemical reduction methods in the isolation of elements
27. State and explain Fajan's rule
28. Define dipole moment .How is it helpful in predicting the geometry of molecules?

29. Mention the rules governing in the linear combination of atomic orbital

30. A freshly cut piece of wood gives 16100 counts of β ray emission per minute per Kg and an old wooden bowl gives 13200 counts per minute per Kg. Calculate the age of wooden bowl. Half-life period of carbon is 5568 years.

31. What is smog? What are the different types of smog?

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

32. (a) Discuss the arrangement of the elements in the periodic table

(b) State and explain VSEPR Theory. What are its limitations?

33. (a) Explain H- bonding. What are its consequences?

(b) Explain resonance by taking $CO_3^{2-}$ and $O_3$ as examples

34. (a) Discuss the application of radioactive isotope in neutron activation analysis and solubility Of sparingly soluble salt

(b) Briefly discuss about the various air pollutants

35. (a) Explain nuclear fission and nuclear fusion

(b) Write a note on Ozone depletion

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**COURSE PO1221: FOUNDATION COURSE II (METHODOLOGY & INFORMATICS)**

**Foundation Course No. – 1. Course Code– PO 1221.**
**Semester – II.Credits-3.**

***72 hours***

**COURSE OBJECTIVE**

One of the objectives of this course is to teach the students the principles of science and its methods, experimentation and data handling in Science. The course also aims at teaching the evolution of chemistry as a discipline of science, giving an overview of information technology, introducing cheminformatics and analytical chemistry.

**COURSE TRANSACTION FORMAT**

Lecture-Tutorial-Lab: **2-0-2** hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 36 hours lecture and 36 hours lab instruction.

**COURSE SYNOPSIS**

Overall structure of science; role of experimentation and observation; data gathering, analysis and presentation; evolution of chemistry, informatics tools, analytical chemistry.

**COURSE CONTENT**

**PART A. LECTURES**

***Module I Science and its Methods*** *12 hours*

Theories and laws of science, Basis for scientific laws and factual truths, Science and technology, Scientific temper, empiricism and the vocabulary of science, Hypothesis, observations and proofs, Formulation of hypothesis, its verification (proving), corroboration and falsification (disproving), Revision of scientific theories and laws, Importance of models, simulations and virtual testing.

***Module II Experimentation and Data Handling in Science*** *12 hours*

Design of an experiment, observation, data collection, interpretation and deduction, repeatability and replication, Documentation of experiments, Planning of experiments-Design, selection of controls, choice and selection of instruments, Data interpretation, significance of statistical tools in data interpretation, errors and in accuracies, Data presentation. Graphics, tables, histograms and pi diagrams, Accuracy and precision.

***Module III Evolution of chemistry as a discipline of science*** *12 hours*

Ancient speculations on the nature of matter, alchemy- early form of chemistry, Robert Boyle and the origins of modern chemistry, Antoine Lavoisier and the revolution in chemistry, Chemical atomism- John Dalton, Atom model- J.J. Thomson, Ruther Ford and Bohr.

Major contributions of Friedrich Wohler, Dmitri Mendeleev, Michael Faraday and Marie Sklodowska- Curie. Structure of chemical science: scope of chemical science, branches of chemistry.

Evolution of nanoscience and its basic aspects, Carbon nanotubes and fullerenes, Applications– in electronics, robotics, sensors, medicine.

Introduction to green chemistry - basic aspects of atom economy calculations (simple reactions).

***Module IV Over view of information technology*** *12 hours*

Personal computer and its peripherals, computer networks & internet, wireless technology, introduction to mobile phone technology overview of operating systems & major application software.

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.

Basic concepts of IPR, copyrights and patents, plagiarism.

IT in teaching and learning, educational software, academic services-INFLIBNET, NICNET, BRNET, Virtual labs.

***Module V Introduction to Cheminformatics*** *12 hours*

Basics of cheminformatics, applications of cheminformatics, storage & retrieval, file formats-MOL, SDF, CML, PDB formats, SYBYL Line Notation, SMILES of simple molecules like methane, ethyl alcohol, benzene, cyclohexane etc., Molecular visualization tools, Chemical Data basis, Chemical safety, Toxicology information- material safety data sheets.

**Module VI (Analytical principles)** *12 hours*

Qualitative analysis - Principles of elimination of interfering anions, principles involved in the precipitation of compounds of cation, Volumetric analysis, acid–base, redox, precipitation & complex metric titrations, Indicators– acid –base redox & adsorption indicators, Gravimetric analysis - factors affecting the solubility of precipitates - co-precipitation & errors due to co-precipitation, Colorimetric methods - theory & application.

***References:***


1. *Newton R. G. The Truth of Science : New Delhi, 2nd edition*
2. *The Golem: What everyone should know about science, Collins and Pinch. Cambridge Univ 1993*
3. *Contemporary Science Teaching, Dr. Soti Sivendra Chandra*
4. *The Story of Chemistry, N.C. Datta, University Press*
5. *Alexis Leon & Mathews Leon, Computers Today, Leon Vikas*
6. *Alexis & Mathews Leon, Fundamentals and Information Technology. Leon Vikas ISBN 08125907890.*
7. *Ramesh Bangia, 'Learning Computer Fundamentals, Khanna Book Publishers, ISBN 818752252b*
8. *Barbara Wilson, Information Technology, the Basics, Thomas Learning.*
9. *Teaching of information Technology, R T Mishra*
10. *Methods of Teaching Chemistry, Kolasani Sunil Kumar, K Ramakrishna and D.B. Rao*
11. *Introduction to Information Technology, Prentice Hall, V. Rajaraman*
12. *Introduction to Cheminformatics, Andrew. R. Leach & V. J. Gillet*
13. *Principles of Nano science and nanotechnology, M A Shah, Tokeer Ahmed, Narosa Publishing House*
14. *T. Pradeep, "NANO: The Essentials", 'McGraw-Hill Education'*
15. *Anastas. P.T; Warner, J.C, "Green Chemistry; Theory and Practice", Oxford University Press; Oxford, U.K., 1998.*
16. *Green Chemistry; An introductory text, Lancaster. M, Royal society of chemistry, Cambridge, UK, 2003.*
17. *Vogel, "Text book of Quantitative Inorganic Analysis".*
18. *Day & Underwood "Quantitative analysis: laboratory manual"*

*19. Comprehensive Practical organic chemistry by A.H Ahluwalia, Renu Aggarwal, 2000, universities press.*

**Weightage of marks:**

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

## PART B. LABORATORY

## COMPUTER LABORATORY

[No ESA for this component]

Computer Lab based instruction on the use of IT in learning. Use of educational - softwares, information mining from internet and using INFLIBNET/NICNET, Word processing and document preparation, Data handling and presentation, Introduction to Scilab\Matlab.

## MODEL QUESTION PAPER

**B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER II EXAMINATION**

**COURSE PO1221: F OUNDATION COURSE II (M ETHODOLOGY &INFORMATICS)**

**Time: 3 hours** **Max marks: 80**

**Section A, Marks 1**

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……..

## 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?

## 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 pi -diagram in presenting the results of a typical experiment.
30. Write a note on applications of nanotechnology.
31. How can atom economy be calculated?

## 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 (10Marks)

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
35. Explain (i) Use of IT in teaching & learning, (ii) Revision of scientific theories and laws

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER – III. CREDITS - 3**
**CORE COURSE- II. COURSE CODE- PO 1341**
**PHYSICAL CHEMISTRY-I**
**(2018 admission onwards)**

***54 hours***

## COURSE OBJECTIVES

The objectives of the course are to provide the student with a deep understanding on the principles and application of thermodynamics, chemical kinetics, chemical and ionic equilibria and properties of binary liquid mixtures. On course completion, the student will appreciate the great significance of the laws of thermodynamics. She/he will also become familiar with the laws that govern and theories that explain the kinetics of chemical reactions, ionic equilibria and binary systems of liquids.

## COURSE TRANSACTION FORMAT

Lecture-Tutorial-Lab: **3-0-2** hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 54 hours lecture and 36 hours lab instruction.

## COURSE SYNOPSIS

Laws of thermodynamics, Statistical Thermodynamics, Chemical and ionic equilibrium, Types and characteristics of chemical reactions, Theories of chemical reactivity, Properties of liquid - liquid systems.

## COURSE CONTENT

### *LECTURES*

***Module 1 Chemical Thermodynamics-1 9 hours***

Terminology of thermodynamics: System, surroundings, types of systems. Extensive and intensive properties. State and path functions. Types of processes- Zeroth law of thermodynamics.

First law of thermodynamics: Definition of Internal energy and Enthalpy. Statement of first law. Heat capacities at constant volume (Cv) and at constant pressure (Cp).Thermodynamic derivation of the relation between Cp and Cv. Reversible process and maximum work. Calculation of work, heat, internal energy change and enthalpy change for the expansion of ideal gases under reversible, isothermal and adiabatic conditions. The Joule-Thomson effect. Derivation of the expression for Joule-Thomson coefficient. Sign and magnitude of Joule-Thomson coefficient, inversion temperature.

Thermo chemistry: Heat of reaction at constant pressure (Qp), at constant volume (Q v) and their relationship. Enthalpies of formation, combustion and neutralisation.Integral and differential enthalpies of solution. Hess's law and its application. Kirchoff's equation.

***Module II Chemical Thermodynamics- 11*** ***9 hours***

Second law of thermodynamics: Need for II law. Different statements of second law- The Carnot cycle and its efficiency. Carnot's theorem and its proof.
Concept of entropy: Definition and physical significance. Entropy change for reversible and irreversible processes and in phase changes. Dependence of entropy on T, P and V.
Gibb's and Helmholtz free energies and their significances. Criteria of equilibrium and spontaneity. Gibb's- Helmholtz equation. Dependence of Gibb's free energy change on temperature, volume and pressure. Clausius – Clapeyron equation and its applications. Maxwell's relations.
Partial molar quantities: Chemical potential. Gibb's - Duhem equation. Concept of fugacity. Determination of fugacity of a gas by graphical method.

***Module III Thermodynamics-III and Statistical Thermodynamics*** ***9 hours***

Nernst heat theorem, proof and its consequences. Statement of third law-Planck's statement, Lewis Randall statement. Concept of perfect crystal. Determination of absolute entropies of solid, liquid and gas. Exception to third law with reference to examples- CO, NO, $N_2O$ and $H_2O$.
Statistical Thermodynamics: Phase space, system, assembly and ensemble. Types of ensembles. Thermodynamic probability. Boltzmann distribution law (no derivation): Entropy and probability. Partition function and its physical significance. Partition functions and thermodynamic properties – Internal energy, enthalpy, heat capacity, pressure, work function, Gibb's free energy and chemical potential.

***Module IV Chemical and Ionic Equilibria*** ***9 hours***

Thermodynamic derivation of law of mass action. Relation between Kp, Kc and Kx. Vant Hoff reaction isotherm. Variation of equilibrium constant (Kp & Kc) with temperature – The Vant Hoff equation.

Ionic equilibrium: Ionic product of water. Effect of solvents on ionic strength. Levelling effect. Ionization of weak acids and bases. pKa and pKb values. Solubility product and common ion effect and their applications, pH and its determination by indicator methods. Buffers and calculation of their pH - Henderson'sequation. Hydrolysis of salts of all types. Degree of hydrolysis and hydrolysis constant. Relation between hydrolysis constant and ionic product of water.

***Module V Chemical kinetics*** ***9 hours***

Order and molecularity of reaction. Derivation of integrated rate equation of zero, first, second, third and nth order reactions and examples. Determination of order of reactions- Graphical and

analytical methods using integrated rate equations. Fractional life method. Differential rate equation method. Isolation method.

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.

Influence of temperature on the rate of reactions. Arrhenius equation. Determination of Arrhenius parameter. Energy of activation and its significance. Collision theory. Derivation of rate equation for a second order reaction based on collision theory. Collision theory of unimolecular reactions. Lindeman mechanism. Steady state approximation. Theory of absolute reaction rate.

***Module VI Binary Liquid Systems*** ***9 hours***

Liquid-liquid system: Completely miscible, ideal and non-ideal mixtures. Raoult's law. Vapour pressure–composition and temperature-composition curves. Fractional distillation. Deviation from Raoult's law.
Azeotropic mixtures. Partially miscible liquid systems: Critical solution temperature. Conjugate layers. Examples for upper, lower and upper cum lower CST. Immiscible liquid pairs. Theory of steam distillation. Distribution law - Its thermodynamic derivation. Limitations of distribution law. Applications of distribution law to the study of association and dissociation of molecules. Solvent extraction. Equilibrium constant of $KI + I_2 \leftrightarrows KI_3$.

***About 150 problems to be worked out.***

***References:***
1. Glasstone & Lewis, "Elementary Physical Chemistry", Longman.
2. Kundu & Jain, "Physical Chemistry", Chand.
3. Kapoor, "Elements of Physical Chemistry", Macmillan
4. Barrow, "Physical Chemistry".6th edn. The McGraw -Hill.
5. Alberty & Silbey, "Physical Chemistry", John Wiley & Sons.
6. Castellan, "Physical chemistry", Narosa Publishing House. New Delhi
7. Atkins, "Physical Chemistry", Longman.
8. Glasstone, "Thermodynamics for Chemists".
9. Rastogi & Misra, "An Introduction to Chemical thermodynamics", Vikas.
10. Puri, Sharma & Pathania, "Principles of Physical Chemistry", Vishal.
11. Gurdeep Raj, "Advanced Physical Chemistry", Goel.

**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 III EXAMINATION**
**COURSE CODE- PO1341: 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

(10x1=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 $2.18 \times 10^{-3}$ $sec^{-1}$. 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?

(8x2 =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 $5.70 \times 10^{-5}$ $dm^3$ $mol^{-1}$ $S^{-1}$ at $25^0$c and $1.64 \times 10^{-4} dm^3 mol^{-1} S^{-1}$ at 400c. Calculate the activation energy and the Arrhenius - pre exponential factor

(6x4 =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

(2x15 =30 marks)

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

## Syllabus for B.Sc. Degree Programme in Polymer Chemistry

**SEMESTER – 1V.CREDITS – 3.**
**CORE COURSE- III COURSE CODE- PO 1441**
**ORGANIC CHEMISTRY-I**
**(2018 admission onwards)**

***54 hours***

**COURSE OBJECTIVES**

1. To introduce the concepts of reaction mechanism, conformational analysis and stereochemistry of simple organic compounds.
2. To impart knowledge about the preparation, reactivity and properties of hydrocarbons and halogen and oxygen containing organic molecules.

The course will enable the student to assimilate the chemistry of carbon based molecules, their structural aspects, reactivity and the related aspects of conformational analysis and

stereochemistry of organic compounds. S/he will appreciate the vastness of the area of the chemistry of carbon compounds, the intricacies of their structure and the details of their reactivity.

**COURSE TRANSACTION FORMAT**

Lecture-Tutorial-Lab: **3-0-2** hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 54 hours lecture and 36 hours lab instruction.

***COURSE SYNOPSIS***

Electronic effects in organic chemistry. Chemistry of alkanes, cycloalkanes and conformational analysis. Organic stereochemistry and mechanism of organic reactions. Structure, preparation and reactivity of halogen and oxygen containing organic compounds such as halocarbons, alcohols, ethers, phenols, aldehydes, ketones and carboxylic acid derivatives.

***COURSE CONTENT***

**Module I Introduction to Reaction Mechanisms and Hydrocarbons:** *9 hours*

(a) Electron displacement effect - inductive, electromeric, resonance, hyper conjugation and steric effects. Homolytic and heterolytic fission of bonds. Reactive intermediates – carbocations, carbanions, free radicals, carbenes, nitrenes and benzyne.
(b) Hydrocarbons - Alkanes: Methods of preparation (Wurtz reaction, Kolbe reaction and Decarboxylation reaction) physical and chemical properties and commercial importance. Alkenes –two methods of preparation(Decarboxylation and Dehalogenation) - Addition to conjugated dienes, 1, 4-addition and Diels-Alder reaction.
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.

**Module II Organic Reaction Mechanisms:** *9 hours*
Types of organic reaction – substitutions (in aliphatic and aromatic) SN1, SN2 and SN1 reactions and mechanisms. 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. Elimination reactions - E1 & E2.Stereochemistry of the above reactions. Saytzeff's and Hofmann's rules. Competition between elimination and substitution.

**Module III Cycloalkanes and Conformations:** *9hours*

Cycloalkanes: Nomenclature, methods of formation (from halides, Simmons-Smith reaction) and reactions. 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.

Conformations: Conformational analysis of ethane, n-butane, cyclohexane and mono substituted cyclohexanes. Fisher Newman, saw-horse and wedge projections. Introduction to polycyclic alkanes: decalin, cubane, prismane and adamantane.
Large ring compounds: Muscone and civetone.

**Module IV Stereochemistry of organic compounds:** *9 hours*

Elements of symmetry, chirality, stereogenic centre, enantiomers, chiral and achiral molecules with two stereogenic centres, diastereoisomers, meso compounds, resolution, inversion and racemization.Absolute and relative configuration, D-L, R-S systems of nomenclature, Priority and sequence rules. Asymmetric synthesis. Geometrical isomerism: E-Z systems of nomenclature. Geometric isomerism of maleic and fumaric acid andbutadiene.

**Module V Halogen Compounds, Alcohols, Phenols and Ethers:** *9 hours*

Halogen compounds: methods of preparation (from alcohol and alkene) and properties, synthetic uses of vinylchloride, chloroform, carbon tetrachloride, chloroprene, Freon-12, DDT, BHC.
Alcohols, phenols and ethers: Methods of preparation (hydroboration & hydration of alkene) Specialemphasis to oxy-mercuration, demercuration, hydroboration, oxidation and anti hydroboration, crown ethers.
Preparation, properties and industrial applications of ethylene glycol and glycerol. Pinacol-pinacolone rearrangement. Mechanisms - Reimer-Tiemann reaction, Kolbe reaction. Fries and Claisen rearrangements and their mechanisms. Phthalein reaction. Preparation and properties of catechol, resorcinol, quinol, andnaphthols. Ziesel's method of estimation of alkoxy group.

**Module VI Aldehydes, Ketones and Carboxylic Acids:** *9 hours*

Aldehydes and Ketones: - General methods of preparation: Grignard reaction; oxidation reaction. Generalchemical reactions. Reduction using $LiAlH_4$, Sodium borohydride and Aluminum isopropoxide – comparative study. Mechanism of Wolff-Kishner reduction, Clemmenson reduction, Aldol condensation and Benzoincondensation. Preparation and uses of crotonaldehyde, mesityl oxides, cinnamaldehyde, salicylaldehyde and vanillin. Carboxylic acids and their derivatives: - Preparation and properties of aliphatic and aromatic carboxylic acids. Ascent and descent series in aliphatic carboxylic acids. Mechanism of Cannizarro reaction and Beckmann rearrangement.

***References:***

1. K. S. Tewari, S.N. Mehrotra and N.K. Vishnoi, "A Text Book of Organic Chemistry", Vikas
2. I. L. Finar, "Organic Chemistry" Vol 1 &2, Longman.
3. R. T. Morrison and R. T. Boyd, "Organic Chemistry", Prentice-Hall.
4. F. Carey, "Organic Chemistry". McGraw Hill
5. P. Y. Bruice "Organic Chemistry",
6. P. Sykes, "Guide Book to Mechanism in Organic Chemistry", Orient Longman.
7. S. M. Mukherji and S. P. Singh, "Reaction Mechanisms of Organic Chemistry", Macmillan.

8. M. K. Jain, “A Text Book of Organic Chemistry”.
9. Bahl and Bahl, “Advanced Organic Chemistry”.
10. P. S. Kalsi, “Stereochemistry and Mechanism through Solved Problems”, New Age.
11. P. S Kalsi, “Organic Reactions and Their Mechanisms”, New Age.
12. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, McMillan

***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 IV EXAMINATION

### COURSE CODE- PO1441: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. $CH_3^-$ is — stable than $(CH_3)_3\bar{C}$
4. Pyrole is —basic than pyridine
5. The Hybridisation of carbon atom in Benzyne is — and —
6. Haloalkanes react with aqueous alkali to form—
7. Schiff’s bases are obtained by reaction of ketones with —
8. The reducing agent in Clemmensen reduction is —
9. Picric acid is —
10. Lucas reagent is —

**[10x1=10]**

## SECTION B

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

11. What are the conformations of cyclohexanes? Diagrammatically show and label the C-H bonds in these.

12. Depict the structure of muscone and civetone

13. What is the directive effect of a methyl group in aromatic electrophilic substitution?

14. How is diethyl ether prepared? Why is it more volatile than ethanol?

15. The peroxide effect is observed only in the addition of HBr and not HCl or HI. Why?

16. What is nitrene? Illustrate its formation in a reaction

17. State and explain Huckel's rule

18. Arrange in the increasing order of acid strength: propionic acid, formic acid, acetic acid. Give reason.

19. Tertiary alcohols are more reactive than primary and secondary alcohols towards Lucas reagent. Why?
20. What is aldol condensation?
21. How will you distinguish acetaldehyde and acetone?
22. Starting from phenol how 2-hydroxy benzaldehyde is prepared?

**[8X2=16]**

## SECTION C

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

23State and explain Baeyer's strain theory

24. How are 1- naphthol, 2-naphthol and BHC prepared?

25.How will you synthesise glycerol from propene?

26.Give an account of resolution

27.Give an account of non-benzenoid aromatics

28.Illustrate asymmetric synthesis

29. Discuss the reduction of carbonyl compounds with $LiAlH_4$ and $NaBH_4$

30. What is the mechanism of SNi reaction? Illustrate with an example

31.Write a note on the directive influence of OH and $NO_2$ groups

**[6x4=24]**

## 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

Alkenes.
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 **[2X15=30]**

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER I, III & IV**
(Lab Course 1 & II of PO1141, PO1341, PO1441)
**Six hours examination in semester IV.**
**Course Code PO 1442.**
**Core course – IV. Credits - 2.**
**Inorganic Qualitative and Volumetric Analysis**
**(2018 admission onwards)**

**Total 36+36+36 hrs.of lab instructionin Semester I, III &IV**

This laboratory based course reinforces the qualitative and quantitative chemical analysis that the student has learned in the I, III and IV semesters.

## COURSE OBJECTIVES

To equip the students with skill in qualitative and quantitative chemical analysis of inorganic materials.

After the course completion, the student will have the necessary training required for laboratory based wetchemical analysis.

## I. INORGANIC QUALITATIVE ANALYSIS

### *COURSE CONTENT*

Hands-on, wet chemistry study of the reactions of the following cationic and anionic radicals for identification and confirmation of identity. Cations: Ag, Hg, Pb, Cu, Bi, Cd, As, Sn, Sb, Fe, Al, Cr, Zn, Mn, Co, Ni, Ca, Sr, Ba, Mg, Na, K and $NH_4$.

Anions: $CO_3$, S, $SO_4$, $NO_3$, F, Cl, Br, I, $BO_3$, Acetate, Oxalate, Tartarate, $AsO_3$, $AsO_4$, $CrO_4$ and $PO_4$.
Systematic qualitative analysis by semi micro methods of a mixture containing two acidic and two basic radicals from the above list. (Not more than one interfering radical).

## II. INORGANIC VOLUMETRIC ANALYSIS

Inorganic analysis based on quantitative volumetry.

***COURSE CONTENT***

**Module 1.Acidimetry and Alkalimetry**

a. Strong acid – Strong base; b. Strong base – Weak acid; c. Strong acid – Weak base; d. Determination of$Na_2CO_3$ and $NaHCO_3$ in a mixture; e. Estimation of $NH_3$ in an ammonium salt by direct and indirect methods.

**Module 2.Dichrometry**

a. Determination of ferrous iron using internal indicator; b. Determination of ferric iron via reduction with $SnCl_2$; c. The above exercise using external indicator.

**Module 3.Permanganometry**

Determination of ferrous iron, Sodium oxalate, Hydrogen peroxide, calcium nitrite and $MnO_2$ in pyrolusite.

**Module 4.Iodometry**

Standardisation of thiosulphate using $KIO_3$, electrolytic copper and potassium dichromate. Determination of$As_2O_3$,arsenite, hypochlorite, bleaching powder and Cu in a salt.

**Module 5. Precipitation methods**

Determination of Chloride in neutral medium (Mohr's method)

**Module 6.Complexometry**

a. Standardization of EDTA solution using ZnSO4. b. Determination of Zn and Mg using EDTA.

***Reference:***

1. A. I. Vogel, "A text book of Qualitative Analysis including semi micro methods" Longmans.
2. V. V. Ramanujam, "Semi micro Qualitative Analysis"
3. E. S. Gilreath "Qualitative Analysis using semi micro method" McGraw Hill
4. A. I. Vogel, "A text book of Qualitative Inorganic Analysis" Longmass
5.A.I. Vogel , "A Text Book of Quantitative Inorganic Analysis".

# UNIVERSITY OF KERALA

**B.Sc. Degree Programme in Polymer Chemistry**

**SEMESTER – IV. (Core Course)**

**PO1442 LAB COURSE-I & II (PRACTICAL)**

**Inorganic qualitative and volumetric analysis**

**SCHEME OF VALUATION**

**Time: 6 hours** **Maximum marks: 80**

**Table 1.**

| Main components for ESE for lab course – Inorganic qualitative analysis | | |
|---|---|---|
| No. | Main components in general | Marks |
| 1 | Lab record | 10 |
| 2 | Anions (identification, confirmation, and chemistry) | 8 |
| 3 | Cations (identification, confirmation, and chemistry) | 8 |
| 4 | Systematic recording | 6 |
| 5 | Viva | 5 |
| 6 | Performance | 2 |
| 7 | Neatness | 1 |
| | Total | 40 |

**Table 2.**

| Main components for ESE for lab course – Inorganic volumetric analysis | | |
|---|---|---|
| No. | Main components in general | Marks |
| 1 | Lab record | 10 |
| 2 | Procedure with principle and equation | 4 |
| 3 | Accuracy (up to 1% - 15mark, error > 3% - grace mark -4) | 15 |
| 4 | Two step calculation | 2 |
| 5 | Neat tabulation and recording | 2 |
| 6 | Viva | 5 |
| 7 | Performance | 2 |
| | Total | 40 |

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**

**SEMESTER –V CREDITS - 3**

**CORE COURSE- V. COURSE CODE- PO 1541**

**ORGANIC CHEMISTRY-II**

**(2018 admission onwards)**

***54 hours.***

.

## *COURSE OBJECTIVES*

The objective of the course is to introduce the chemistry of acyclic and cyclic organic compounds containing hetero atoms, organometallic compounds, phytochemicals and secondary metabolites, dyes and drugs. The course will enable the student to further appreciate the rich chemistry of carbon based molecules, especially of natural origin.

## *COURSE TRANSACTION FORMAT*

Lecture-Tutorial-Lab: 3-0-0 hours per week; eighteen 5-day weeks per semester.Contact hours per semester: 54 hours lectures.

## *COURSE SYNOPSIS*

Chemistry of amino, mercapto and sulfur-oxygen compounds.Heterocyclic chemistry. Organometalliccompounds. Chemistry of carbohydrates, alkaloids, terpenes, steroids and vitamins.Chemistry of dyes anddrugs.Bioorganic chemistry of amino acids, peptides and nucleic acids.

## *COURSE CONTENT*

### Module I. Nitrogen and Sulphur Compounds *9 hours*

Methods of preparation of aliphatic (reaction of alkyl halide or alcohol with ammonia) and aromatic(reduction, Hoffmann degradation) amines. Methods of separation of amine mixtures Hoffmann and Hinsbergmethods. Hoffman exhaustive methylation. Preparation and uses of benzene diazonium salts. Benzidine rearrangement and its mechanism. Preparation, structure and properties of urea. Methods of preparation of mercaptans, sulphoxides, sulphones, sulphonic acid, sulphanilic acid and sulphanilamide.

### Module II. Carbohydrates *9 hours*

Classification and nomenclature of monosaccharides, configuration of monosaccharides Epimerization, mutarotation and anomers. Elucidation of structures of glucose and fructose. Chair conformation of D-glucopyranose. Occurrence and chemical properties of disaccharides. Elucidation of structure of sucrose.
Starch and cellulose (brief study). Industrial application of cellulose.

**Module III. Heterocyclic and Organometallic Compounds** *9 hours*

Heterocyclic compounds: Introduction, classification and nomenclature. Aromaticity in heterocyclic compounds. General methods of preparation and properties of furan, thiophene, pyrrole, indole, pyridine, quinoline and isoquinoline. Importance of heterocyclic compounds. Organometallic compounds: Preparation, reactions and synthetic uses of Grignard reagent, organo zinc and organo lithium compounds. Reformatsky reaction. Synthetic reagents: Ethyl acetoacetate - synthesis, structure, tautomerism and synthetic applications.
Diethyl malonate –synthesis and synthetic application.

**Module IV Alkaloids, Terpenes, Dyes:** *9 hours*

Alkaloids: Introduction, extraction and general properties. Elucidation of structures of coniine and nicotine. Importance of alkaloids. Terpenoids: Introduction - Isoprene and special isoprene rules. Isolation of terpenoids. Structure of citral and geraniol (structure elucidation not required).Importance of menthol, alphapinene and camphor. Dyes: Classification. Witt's theory. Synthesis of the following dyes: Methyl orange, congo red, Bismarck brown, malachite green, rosaniline, indigotin and alizarin.

***Module V Steroids, Vitamins and Drugs:*** *9 hours*

Steroids: Introduction. Diel's hydrocarbon. General nature of steroids. General idea of structure of cholesterol (elucidation not required). Sex hormones - examples and functions (Structure not expected).Importance of androgen, estrogen and cortisone. 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. Drugs: Classification of various types of drugs with examples. Sulphonamides, antimalarials and chemotherapy.

***Module VI Bioorganic Chemistry -Amino acids, Proteins and Nucleic Acids.*** *9 hours*

Amino acids: - Classification, structure and stereochemistry of amino acids –two methods of preparation, reactions of a-amino acids - essential and non-essential amino acids, zwitter ion, isoelectric point. Peptides: structure and synthesis (Carbobenzoxy method, Sheehan method only). Proteins: Structure of proteins, denaturation and colour reactions. Enzymes: General nature and classification, specificity of enzymes. Nucleicacids: Classification and structure of DNA and RNA. Replication of DNA, Genetic Codes.

Oils and Fats: -Occurrence and extraction. Common fatty acids, soap, saponification value, iodine value, acid value, synthetic detergents and detergent action, alkyl and aryl sulphonates.

***References:***
1. K. S. Tewari, S.N. Mehrotra and N.K. Vishnoi, "A Text Book of Organic Chemistry", Vikas
2. I. L. Finar, "Organic Chemistry" Vol 1 &2, Longman.
3. R. T. Morrison and R.T. Boyd, "Organic Chemistry", Prentice-Hall.
4. T. W. Graham Solomons, "Organic Chemistry". John Wiley & Sons.
5. S. H. Pine, "Organic Chemistry", Prentice Hall.

6. M. K. Jain, “A Text Book of Organic Chemistry”.
7. Bahl and Bahl, “Advanced Organic Chemistry”.

**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 EXAMINATION

### COURSE CODE- PO1541:ORGANIC CHEMISTRY – II

Time: 3 hours Maximum marks:80

**SECTION A**

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

**[10x1=10]**

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 —

**SECTION B**

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

**[8X2=16]**

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

## SECTION C

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

**[6X4=24]**

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.

## SECTION D

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

**[2X15=30]**

32. a) How willyou separatea 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)

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER –V.CREDITS – 4.**
**CORE COURSE- VI.COURSE CODE- PO 1542.**
**PHYSICAL CHEMISTRY-II**
**(2018 admission onwards)**

72 hours

## COURSE OBJECTIVES

The objectives of the course are:
1. To master the laws that governs the physical and chemical behaviour of chemical substances in the gaseous, liquid, solution and solid states.
2. To understand how the different phases of matter exist in equilibrium
3. To enable the student to understand and appreciate the theories and practice of electrochemistry.

On course completion, the student will understand the equilibria between phases, the laws that govern the various states of matter and the theories of electrochemistry.

## COURSE TRANSACTION FORMAT

Lecture-Tutorial-Lab: 4-0-0 hours per week; eighteen 5-day weeks per semester.
Contact hours per semester: 72 hours lecture.

## COURSE SYNOPSIS

Properties of materials in the gaseous, liquid, solution and solid state. Introduction to equilibria between phases, and electrochemistry

## COURSE CONTENT

***Module 1.Gaseous State*** ***12 hours***

Types of molecular velocities 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. Collision frequency, collision number, collision diameter and mean free path. Ideal gas equation. Behaviour of real gases. Deviation of real gases from ideal behaviour. Compressibility factor, Boyle temperature- Van der Waals' equation of state- derivation and importance. Virial equation of state. Determination of molar mass by limiting density method.

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.

.

***Module II Liquid state and Dilute solutions*** ***12 hours***

Properties of liquids: Surface tension- measurement by capillary rise method and stalagmometer method, factors affecting surface tension. Viscosity-Poisuelle equation, Determination of viscosity by Ostwald's viscometer. Refractive index and its determination by Abbe's refractometer.

Dilute solutions: Molality, molarity, normality and mole fraction. Colligative properties. Thermodynamic derivation of $\Delta T_b = K_b$ x m and $\Delta T_f = K_f$ x m . Osmotic pressure: Laws of osmotic pressure.-Van't Hoff equation. 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.

***Module III Solid state*** ***12 hours***

Isotropy and anisotropy, space lattice and Unit cell. Elements of symmetry of crystal. Crystal systems, Bravais lattices. Laws of crystallography, Miller indices, Representation of lattice planes of cubic crystals. 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. Defects in crystals - Schottky and Frenkel defects. Liquid crystals: Types of liquid crystals- smectic, nematic and cholesteric. Molecular arrangements in various states of liquid crystals, uses of liquid crystals.

***Module IV Phase Equilibria*** ***12 hours***

Phase equilibria-Terminology-The Phase rule, Thermodynamic derivation of phase rule and its application to (a) Water system (b) Sulphur system(c) Solid-liquid equilibria involving simple eutectic system such as Pb-Ag system, Thermal analysis and desilverisation of lead . KI-water system and Freezing mixtures.(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.(e) Solid –Gas system – decomposition of $CaCO_3$ and dehydration of $CuSO_4$ -$5H_2O$.Efflorescence and Deliquescence.

***Module V Electrical Conductance*** ***12 hours***

Conductance: Arrhenius theory .Variation of conductance with dilution of strong and weak electrolyte. Debye- Huckel theory of inter ionic attraction. Debye–Huckel–Onsagar equation (only qualitative treatment).Activity and activity coefficient of electrolytes.Kohlrausch's law and its application.Wieneffect. Debye–Falkenhagen effect. Walden's rule.

Ionic mobilities: Transference number and its determination by Hittorff's and moving boundary methods. Abnormal transference number. Applications of conductivity measurements: Determination of degree of dissociation of weak electrolytes, degree of hydrolysis, solubility of sparingly soluble salts, conductometric titrations involving strong acid - strong base, strong acid – weak base, weak acid – strong base, weak acid – weak base and precipitation.

***Module VI Electromotive Force*** ***12 hours***

Electrochemical cells (brief explanation). Types of electrodes – Metallic electrodes, gas electrodes, anion reversible electrodes and redox electrodes. Reference electrodes– standard hydrogen and calomel electrodes. Electrode reactions and cell reactions.Derivation of Nernst equation for electrode potential and cell potential. Gibbs-Helmholtz equation and EMF of a cell. Calculation of $\Delta G$, $\Delta H$, $\Delta S$ and equilibrium constant from EMF data. 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.
Fuel cells: Principle, $H_2$-$O_2$ and hydrocarbon-$O_2$ fuel cells. Over voltage. Applications of potential measurements: Determination of ionic product of water, hydrolysis constant and solubility product. pH value using quinhydrone and glass electrodes. Potentiometric titrations of acid – base and redox reactions.

***About 150 problems to be worked out.***

***References:***


1. S. Glasstone & Lewis, "Elementary Physical Chemistry", Longman.
2. N. Kundu and S. K. Jain, "Physical Chemistry", S Chand.
3. K. L. Kapoor, "Elements of Physical Chemistry", Macmillan
4. G. M. Barrow, "Physical Chemistry", 6thedn, McGraw-Hill.
5. R. A. Alberty& R. J. Silbey, "Physical Chemistry", John Wiley.
6. G. W. Castellan, "Physical chemistry", Narosa.
7. P. W. Atkins, "Physical Chemistry", Longman.
8. Puri, Sharma &Pathania, "Principles of Physical Chemistry"
9. Glasstone, Physical Chemistry, Macmillan


**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 EXAMINATION**
**COURSE CODE- PO1542: 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 $^0$c 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

(10x1=10 marks)

## Section B

***(Answer any eight 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 (8x2 =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 $-0.42^0$c. Calculate the molar mass of solute. Molar heat of fusion of ice at $0^0$c is 6.025 KJ and R =8.314 J $K^{-1}$ $mol^{-1}$

(6x4 =24 marks)

## Section D

***(Answer any two 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

(2x15 =30 marks)

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

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER –V. CREDITS – 4.**
**CORE COURSE- VII. COURSE CODE- PO 1543**
**POLYMER CHEMISTRY-I**
**(2018 admission onwards)**

*72 hours*

## COURSE OBJECTIVES

The objectives of the course are:
1. To introduce the specialized subject of the chemistry of polymers,
2. To familiarize the students with the types of polymers, the significance and determination of their molecular mass and
3. To understand in detail the mechanisms of the reactions that lead to the formation of polymers.

## COURSE TRANSACTION FORMAT

Lecture-Tutorial-Lab: 4-0-0 hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 72 hours lecture.

## COURSE SYNOPSIS

Basic principles of polymer chemistry, inorganic polymers, molecular mass & size, mechanism & kinetics of free radical, ionic & condensation polymerization

## COURSE CONTENT

**Module 1-Basic principles of polymer chemistry** 12 hours

Historical development of polymer chemistry. Monomers, polymers, repeating units, functionality. Nomenclature of polymers. Importance and applications of polymers –acrylic, vinyl, cellulose, fluorinated, poly ethylene, & SAN copolymer. Classification of polymers. Ladder and spiral polymers. Cis- trans configuration. DL isomers and tacticity. Inorganic polymers- importance, advantages and applications- structure, preparation and properties of silicones and polyphosphazenes. Comparison with organic polymers.

**Module II– Free radical addition polymerization** 12 hours

Chain growth polymerization. Mechanism of chain growth polymerization. Initiation, propagation and termination. Types of free radical initiators (peroxo, azo and redox initiators).Initiator efficiency. Inhibitors and retarders – functions and examples. Chain transfer reactions. Kinetics of chain growth polymerization. Kinetic chain length. Auto acceleration, thermal &electrochemical polymerization.

**Module III Ionic & stereoregular polymerization** 12 hours

Ionic polymerization – anionic and cationic catalysts, Solvent effects in ionic polymerizations. Mechanism and kinetics of anionic and cationic polymerizations. Counter ions. Termination modes. Living polymers. Coordination polymerization: stereo regularity, Ziegler-Natta catalysts. Metallocene catalysts. Bimetallic and monometallic mechanisms.

**Module IV – Condensation or step growth polymerization** 12 hours

Step growth polymerization,-Average functionality, basic characteristics, extent of reaction, degree of polymerization, Carother's equation. Gel and gel point. Mechanism of self-catalysed and non- catalysed esterification. Ring-opening & interfacial polymerization, Copolymerization: random, alternate, block and graft. Copolymerization involving two monomers(free radical mechanism). Reactivity ratio, its determination. Q-e scheme. Polymerisation techniques (bulk, solution, suspension and emulsion). Melt, solution and interfacial condensation.

**Module V - Molecular mass and size of polymers** 12 hours

Degree of polymerization and molecular weight. Practical significance of molecular weight. Threshold molecular weight. 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. Molecular mass distribution curve. Polydispersity and polydispersity index of polymers. Examples of monodispersed and polydispersed polymers. Molecular mass & mechanical properties. Size of polymer molecules.

**Module VI – Determination of molecular mass of polymers** 12 hours

Absolute and relative methods of molecular mass determination. Determination of No. average molecular mass – end group analysis, cryoscopy & vapourphase osmometry, Weight average molecular mass- ultracentrifugation (principle only), Light scattering method (No experimental details expected), viscosity average molecular mass, Gel permeation chromatography.

**References:**


1. *Malcon P. Steves, Polymer chemistry-An introduction, 3rd edition, Oxford University Press.*
2. *F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley &Sons*
3. *V. R. Gowariker, N. V. Viswanathan&J. Sreedhar, Polymer Science, New Age International Publishers.*
4. *P. Bahadur&N. V. Sastry, Principles of Polymer Science, Narrora Publishing House, 2nd Edition, New Delhi.*

5. *PremamoyGhosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi.*
6. *G. Odian, Principles of polymerization, 3rd edition, John Wiley &Sons.*
7. *G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi*
8. *V. K. Ahluwalia& A. Misra, Polymer Science-A Text Book, AneBooks, India, New Delhi.*
9. *J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi.*

***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 EXAMINATION
### COURSE CODE- PO1543. 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) polymethylmethacrylate (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 autoaccelaration?
8. If the degree of polymerization of polyethylene is 100. What is its molecular mass?
9. Write the expression for Z– average molecular mass

***Section B***

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

10. Write the structure of AIBN
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

## *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

## *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

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER V**
**Organic Chemistry Experiments (Chemistry Lab Course No-III)**
**Course Code PO 1544. Credits – 3.**
**Core Course VIII.**

**Three hours examination in semester V*.**

**(2018 admission onwards)**

108 hours

**COURSE OBJECTIVES**

The objective of this course is to train the students in qualitative and quantitative chemical analysis of organic materials. On completion, the student will have the necessary expertise in laboratory based organic analysis

**COURSE TRANSACTION FORMAT**

Lecture-Tutorial-Lab: 0-0-6 hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 108 hours lab instruction.

## COURSE SYNOPSIS

Laboratory based qualitative and quantitative analysis of organic materials.

## COURSE CONTENT

*Module 1.*Elemental tests for Nitrogen, Halogens and Sulphur.

*Module 2.*Determination of physical constants.

*Module 3.*Study of the reactions of common functional groups using known organic compounds.

*Module 4.*Qualitative analysis with a view to characterization of functional groups and identification of the following compounds:- Naphthalene, Anthracene, Chlorobenzene, Benzyl chloride, p-Dichlorobenzene, Benzyl alcohol, Phenol, o-, m- and p-Cresols, 1- and 2-Naphthols, Resorcinol, Benzaldehyde, Acetophenone, Benzophenone, Benzoic, Phthalic, Cinnamic and Salicylic acids, Ethyl benzoate, Methyl salicylate, benzamide, Urea, Aniline, o-, m- and p-Toluidines, Dimethyl aniline, Nitrobenzene, o- and p-Nitrotoluenes, m-Dinitrobenzene, and Glucose.

*Module 5.***Organic preparations** involving Halogenation, Nitration, Oxidation, Reduction, Acetylation, Benzoylation, Hydrolysis and Diazotisation.

*Module 6.* **Chromatography**. Thin layer chromatographic separation of mixture of Nitro anilines, and Dyes byColumn Chromatography.

*Module 7.***Organic Estimations**. Molecular mass determination of an acid by titration method..Determination of the equivalent of an Ester. Determination of Phenol or Anilineby bromate- bromide method.

1. A.I. Vogel , "A Text Book of Quantitative Organic Analysis".
2. V. K. Ahluwalia and R. Aggarwal, "Comprehensive Practical Organic Chemistry" Vol 1 & 2, University Press.

# UNIVERSITY OF KERALA

**B.Sc. Degree Programme in Polymer Chemistry**

**(CORE Course No. VIII)**

**SEMESTER V**

**PO1544 CHEMISTRY LAB COURSE- III (PRACTICAL)**

**ORGANIC CHEMISTRY EXPERIMENTS**

**SCHEME OF VALUATION**

**Time: 3hours** **Maximum marks: 80**

**Components for End semester valuation of organic Chemistry experiments**

| Sl No | Components | Marks |
|---|---|---|
| 1 | **Organic Preparation(14marks)** | |
| | a) Equation and procedure for preparation of compound | 6 |
| | b) Quantity of the compound | 2 |
| | c) Quality of the compound | 2 |
| | d) Recrystallised sample | 4 |
| 11 | **Qualitative Analysis(46)** | |
| | a) Preliminary examination | 4 |
| | b) Elemental analysis | 4 |
| | c) Aromatic or aliphatic | 4 |
| | d) Saturated or unsaturated | 6 |
| | e) Identification and confirmation of functional group | 8 |
| | f) Systematic recording | 4 |
| | g) Suggestion and preparation of derivative | 4 |
| | h) Display of organic derivative | 2 |
| | i) Viva voce | 10 |
| 111 | **Lab record** | 20 |

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER V**
**Course Code PO 1545**
**Core course - IX.Credits - 2.**
**Polymer Chemistry Experiments. (Chemistry Lab Course No-1V)**
**Three hours examination in semester V.**
**(2018 admission onwards)**

***COURSE OBJECTIVES***

The objective of this course is to equip the students with skill in polymer related laboratory work

***COURSE TRANSACTION FORMAT***

Lecture-Tutorial-Lab: 0-0-3 hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 54 hours lab instruction.

**COURSE SYNOPSIS**

1. Laboratory based qualitative and quantitative analysis of polymeric materials.
2.Preparation of polymers

**COURSE CONTENT**

**Module 1**

Determination of: 1. ammonia content 2. total solid content 3. dry rubber content 4. KOH number.
5. acid value 6. iodine value 7. estimation of hydroxyl groups 8. estimation of nitrogen in polymeric and related samples.

**Module II**

Determination of: 1.ash content; 2. volatile matter and 3. Metal (Cu, Fe and Th) content of dry rubber.

**Module III**

Qualitative analysis of plastics and rubbers

**Module IV**

Synthesis of different polymers involving various polymerization processes and techniques.

***References***

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

# UNIVERSITY OF KERALA

**B.Sc. Degree Programme in Polymer Chemistry**

**(CORE COURSE)**

**SEMESTER - V**

**PO- 1545 CHEMISTRY LAB COURSE-1V (PRACTICAL)**

**POLYMER CHEMISTRY EXPERIMENTS**

**SCHEME OF VALUATION**

**Time: 3hoursMaximum marks: 80**

**Components for end semester valuation of Polymer Chemistry experiments**

| Sl No | Components | Marks |
|---|---|---|
| 1 | Quantitative analysis of polymer(30 marks)<br>a)Principle, equation and procedure for polymer estimation<br>b)Performance<br>c)Neat tabulation<br>d)correct calculation<br>e)Quality and thickness<br>f) Accuracy up to 2% 8marks, 2.1 to2.4 % 6marks,2.5 to2.9% 4marks, 3 to 3.4% 2 marks and above 3.5% 1 mark | <br>5<br>5<br>5<br>5<br>2<br>8 |
| 2 | Qualitative analysis of polymer (20 marks)<br>a) Preliminary experiments<br>b) Elemental analysis<br>c) Group identification<br>d) Identification and confirmation of sample<br>e) Systematic recording<br>f) Viva voce | <br>4<br>4<br>2<br>4<br>2<br>4 |
| 3 | Polymer preparation(10 marks)<br>a)Equation and procedure for polymer preparation<br>b)quantity of sample<br>c)quality of sample<br>d) Display | <br>5<br>2<br>2<br>1 |
| 4 | Record | 20 |

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMESTER –V.OPEN COURSE**
**COURSE CODE- PO 1551.CREDITS – 2.**
**CHEMISTRY IN EVERY DAY LIFE**
**(2018 admission onwards)**

***54 hours***

**COURSE OBJECTIVES**

The objective of this course is to make the students aware of the contributions of chemistry in making our life pleasant and comfortable. Harmful effects of chemicals and the recent developments too are discussed.

**COURSE TRANSACTION FORMAT**

Lecture-Tutorial-Lab: 3-0-0 hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 54 hours lecture.

**COURSE SYNOPSIS**

Basic concept of chemistry , fundamentals of biochemistry, idea about drugs, dyes, soaps & detergents, polymers, silicates, environmental chemistry, nano technology & green chemistry.

**COURSE CONTENT**

**Module 1 (Basic concept of chemistry)** 9 hours

Importance of chemistry, subatomic particles-proton, electron, neutron, Bohr model of Atom, Dual behaviour , Heisenberg's uncertainty principle, orbital concept, Aufbau principle, Hunds rule, Pauli's exclusion principle, electronic configuration, Modern periodic table, types of elements, chemical bonding – energetic of bond formation, ionic & covalent bond, H-bond, effect of H- bonding on physical properties

**Module 2(Fundamentals of Biochemistry)** 9 hours

Biochemistry, elements in living organism, Carbohydrates – definition, classification based on taste, functions. 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.

Enzymes – Definition, characteristics, function, coenzymes (papain)

Nucleic acids – Definition, biological functions of DNA & RNA, genetic code, mutation (only brief idea). Vitamins – Definition, classification, physiological functions, important vitamins, their sources& deficiency diseases (vitamin A, B1, C, D, E, K, & H )

Lipids – Definition, classification, fatty acids, fat, oil, waxes

Hormones- definition, function, classification & sources (androgen, oestrogen, progesterone, testosterone)

**Module 3 Chemistry in action** 9 hours

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.

Dyes- definition, classification based on application, uses & examples.

Soaps & Detergents: Hard & soft soaps, cleaning action of soap, preparation. Detergents- cationic, anionic & non- ionic detergents, superiority of detergents over soaps.

Antioxidants, artificial sweetening agents, carotenoid, flavonoids& food preservatives (brief idea)

**Module 4Chemistry& Industry** 9 hours

Polymers- Preparation, uses & application of PE, PS, PVC,PTFE, Polyvinyl acetate, Nylon 6, Nylon 66, cellulose acetate, viscose rayon, silicone rubber.

Advanced materials- carbon fibres- CFRP & CFRC, advantages& application.

Silicates – General idea& application of cement, ceramics & glass.

**Module 5 –Environmental Chemistry** 9 hours

Pollution- types of pollution, air pollution, air pollutants, acid rain, photochemical smog, particulates, ozone layer depletion, air pollution control.

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.

Soil pollution- sources of soil pollution, effects of soil pollutants, control.

Nuclear hazards- sources of radioactive pollution, damages to biological systems, hazards & control

**Module 6 -Frontiers in chemistry** 9 hours

Nano chemistry –Basic concept, classification, fullerene nano particle, carbon nano tube, quantum Dot, application of nanotechnology in drug delivery, fluorescent biological labels, colorimetric assay, dendrimers, Nano robots& biosensors ( Brief idea only ).

Green chemistry –Role of chemical industries in polluting the environment , waste management in our city, polymer recycling, biodegradable polymers, introduction to the principles of green chemistry, basic aspects of atom economy calculations.

**References:**


1. J. D. Lee, Concise Inorganic Chemistry, Black Well Science
2. John McMurry Fay & Robert C. Fay, Chemistry 4th edition, Pearson.
3. ArunBahl& B.S. Bahl , A Text book of Organic Chemistry, S. Chand
4. PremamoyGhosh, Polumer Science & Technology, Tata McGraw
5. S. P. Bhutani, Chemistry of biomolecules, Ane Books.
6. S. Shanmugham, Nanotechnology, www.mjp Publishers
7. Dominic W. S.Wong Mechanism & Theory in food chemistry, CBS Publishers
8. Dr.S. S. Dara, Dr.D. D. Misra, A Text book of environmental Chemistry& Pollution control.
9. Anastas,P.T., Warner, J.C.,Green Chemistry-Theory & Practice, Oxford Univ. Press.


**Distribution 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 Departmentcan 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***
***CHEMISTRYIN 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?

## 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

## 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

## Section D

**(Answer any 2 questions. Each question carries 6 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

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**Semester – VI.Course Code– PO 1641.**
**Core Course No – X. Credits – 3.**
**Inorganic Chemistry II**
**(2018 admission onwards)**

***54 hours.***

***COURSE OBJECTIVES***

1. To understand the electronic configuration and general properties of transition metals, lanthanides and actinides
2. To enable the students to learn about the bonding in co-ordination and organometallic compounds.
3. To grasp the concepts of symmetry and its applications in inorganic structural chemistry
4. To learn about the compounds of non-transition elements, non-aqueous solvents and bioinorganic chemistry

***COURSE TRANSACTION FORMAT***

Lecture-**Tutorial-Lab: 3-0-0**hours per week; eighteen 5-day weeks per semester.
Contact hours per semester: 54 hours lecture.

**COURSE SYNOPSIS**

Transition metals, Lanthanides & Actinides, Coordination chemistry, Introduction to Group theory, Chemistry &applications of organo metallic compounds, structure & properties of compounds of non-transition elements, non –aqueous solvents, structure, properties & applications of metal ions in biological systems, metallo enzymes & photosynthesis.

**COURSE CONTENT**

**Module I -Transition & Inner Transition elements** 9 hours

Transition elements –Electronic configuration& general characteristics, abundance, difference between the$I^{st}$ row and the other two rows.
Lanthanides – Electronic configuration &general properties, occurrence, separation – chemical &ion exchange methods, lanthanide contraction & its consequences, magnetic properties &complex formation behaviour.
Actinides - Electronic configuration& position in periodic table oxidation state, occurrence, Trans actinides – Names &symbol.

***Module II -Coordination Chemistry -I*** 9 hours

Double salts & coordination compounds, nomenclature, Werner's theory, EAN rule, shapes of d orbitals, bonding in transition metal complexes, V. B. Theory, Crystal field theory - explanation of magnetic properties, geometry, colour, electronic spectra of $d^1$& $d^9$ systems,

spectrochemical series, effects of crystal field splitting, Jahn – Teller distortion, M. O. theory, chelates – application.

**Module III -Coordination chemistry II& Group theory** 9 hours

Isomerism & stability of complexes, factors affecting stability, geometry of different coordination numbers, application of complexes in qualitative& quantitative analysis.
Group theory – elements of symmetry, proper & improper axis of symm, plane of symm, centre of symm .& identity element. Combination of symm, elements, point groups ($C_{2v}$&$C_{3v}$). Schoenflies symbol of simple molecules like $H_2O$, $NH_3$& $BF_3$.

**Module IV -Organometallic Compounds** 9 hours

Definition, nomenclature & classification, 18 electron rule, metal carbonyls (mono nuclear & poly nuclear - examples of carbonyls of Fe, Co, & Ni ), preparation & properties of carbonyls of Fe & Ni, structure & nature of metal –carbonyl bonding in mononuclear Ni carbonyls , bonding in ferrocene, structure & application of Ziese's salt , Wilkinson's catalyst. Application of organo metallic compounds.

**Module V – Compounds of non-transition elements &non –aqueous solvents** 9 hours

Preparation, properties & structural aspects of following: boron nitrides, borazole, boron hydrides.
Preparation & properties of hypohalous acids, per halic acid &pseudo halogens, chemistry of cement, glass, ceramics & Xenon compounds.
Non – aqueous solvents – Classification of solvents, characteristics of common solvents, protic & aprotic solvents, liquid ammonia solutions of alkali metals, reactions in liquid $SO_2$& liquid HF.

**Module VI Bioinorganic chemistry** 9 hours

Role of alkali & alkaline earth metal ions in biological systems, biological functions, excess &deficiency diseases of Cr, Mn, Cu, Fe, Ni &Co. Toxicity of meta l ions(Pd, As, Cd, Mg),oxygen carriers, haemoglobin & myoglobin - structure & mechanism of action, cooperative effect in Hb, biochemistry of iron, biological role of Mg & Ca ions, elementary idea of cytochromes, ferretin & ferredoxines, Metallo enzymes –carbonic anhydrase& peroxidase, photosynthesis, principle & mechanism.

**References:**

1. J. D. Lee, Concise inorganic chemistry, Blackwell science limited
2. SathyaPrakash, G. D. Tuli, S. K.Basu& R. D.Madan, Advanced Inorganic Chemistry, (Vol. I ) ,S .Chand &Com .Ltd .,New Delhi .
3. F .A .Cotton,P. L .Gaus& G. Wilkinson , Basic Inorganic Chemistry ,John Wiley & Sons.
4. B. R. Puri, L. R. Sharma & K .C .Kalia, Principles of Inorganic Chemistry, Vallabh Publications, New Delhi

5 .D . F. Shriver, P .W. Atkins &C .H .Langford, Inorganic Chemistry, Oxford Univ. Press
6 .M .C. Day &J .Selbin, Theoretical Inorganic Chemistry, East west press pvt.Ltd.
7. R .D .Madan, ModernInorganic Chemistry, S. Chand &Company Ltd .New Delhi
8. SathyaPrakash, G. D. Tuli, Basu S. K. &Madan R. D. , Advanced Inorganic Chemistry, (Vol.II), S .Chand &Com .Ltd, New Delhi
9. W .U .Malik, G. D. Tuli& R. D. Madan, Selected Topics in inorganic chemistry, S.Chand&Co .Ltd, New Delhi
10. M .N. Hughes,The Inorganic chemistry of biological processes,John Wiley.

**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 VICOURSE CODE - PO1641***

***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

## 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

## 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 V.B.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

**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

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**Semester – VI Core Course No - XI**
**Course Code– PO1642.Credits – 4.**
**Physical Chemistry III**
**(2018 admission onwards)**

***72 hours.***

***COURSE OBJECTIVES***

1. To introduce the concepts of quantum mechanics.
2. To familiarize the students with the theory, instrumentation and application, at an introductory level, of
the various spectroscopic methods in chemistry.
3. To learn the chemical behaviour of substance in the colloidal state, the physicochemical aspects of photochemical, catalytic and adsorption phenomena
Upon finishing the course, the student is expected to gain introductory level knowledge of QM and
Spectroscopy with relevance to chemical systems, and will understand colloidal state of chemical substance, the theories of photochemistry, catalysis and adsorption

***COURSE TRANSACTION FORMAT***

Lecture-Tutorial-Lab: 4-0-0 hours per week; eighteen 5-day weeks per semester.Contact hours per semester: 72 hours lecture.

***COURSE SYNOPSIS***

Preliminary quantum mechanics. Theory and applications of rotational, vibrational, electronic and Raman spectroscopy. Introductory NMR, ESR and EIMS spectroscopy. Colloidal state of chemical substance, theories of adsorption, photochemistry and catalysis

***COURSE CONTENT***

***LECTURES***

***Module I Development of Quantum Mechanics 12 hours***

Radiation phenomena: Black body radiation. Planck's quantum theory, Photoelectric effect, Compton effect and atomic spectra. 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.

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). 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)

.

***Module II Rotational and Vibrational Spectroscopy 12 hours***

Regions of electromagnetic spectrum. Different units of energy (erg, Joule, calorie, $cm^{-1}$, Hz, $A^o$ and eV) and their interconversions. Interaction of radiations with matter. Various types of molecular spectra. Born-Oppenheimer approximation.

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.

Vibrational spectroscopy: Harmonic oscillator. IR spectra of diatomic molecules. Energy expression. Selection rules. Frequency of separation. Calculation of force constant.Anharmonic oscillators.

Morse equation. Fundamental and overtone transitions. Combination bands and hot bands. Degree of freedom of polyatomic molecules. Group frequencies and application of IR spectra.

***Module III Raman, UV-VIS and NMR Spectroscopy 12 hours***

Raman spectroscopy: Stokes and antistoke's lines. Quantum and classical theory of Raman effect. Rotational Ramanspectrum. Selection rule. Frequency of separation. Vibrational Ramanspectrum. Mutual exclusion principle. Advantages of Raman Spectroscopy.

Electronic spectroscopy: Electronic spectra of diatomic molecules. Franck-Condon principle. Singlet and triplet states. Dissociation and predissociation. Dissociation energy. Selection rules. Electronic spectra of polyatomic molecules (qualitative idea only).

NMR spectroscopy: Principle of NMR, Nuclear spin. Interaction of nuclear magnet with external magnet. Precession. Relaxation. Shielding and deshielding effect. Chemical shift. Delta and tau scales. Spin – spin coupling. Low and high resolution spectra. Interpretation of PMR spectra of simple molecules such as ethyl bromide, ethanol, acetaldehyde, ethyl acetate, toluene and acetone.

***Module IV ESR, EIMS and Non Spectral methods*** ***12 hours***

Electron spin resonance spectroscopy: Principle. Types of substances with unpaired electrons. Interaction of electron magnet with external magnet. Energy level splitting. Lande splitting factor. Presentation of ESR spectrum. The normal and derivative spectra. Hyperfine splitting. Simple examples like hydrogen atom, methyl and benzene radicals.

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.

Non-spectral methods: Dipole moment. Debye equation and Clausius–Mosottiequation. Measurement of dipole moment by temperature method. Dipole moment and molecular structure. Diamagnetism and paramagnetism. Magnetic Susceptibility and unpaired electrons. Measurement of magnetic susceptibility. Molar refraction and molecular structure. Atomic refractions. Optical exaltation. Parachor and atomic equivalent of parachor.

***Module V Photochemistry and Catalysis*** ***12 hours***

Beer-Lambert Law, Grotthus -Draper law and Stark- Einstein Law of Photochemical Equivalence. Quantum Yield, Reason for very low and very high quantum yields. Kinetics of decomposition of HI. Qualitative treatment of $H_2$-$Cl_2$ reaction. Fluorescence and phosphorescence. Photosensitisation and chemiluminescence. Explanation and examples.

Catalysis: Theories of catalysis, Intermediate formation theory, steady state method, Enzyme Catalysis-mechanism. Effect of temperature on enzyme catalysis.Michaelis-Menten equation.

***Module VI Colloids and Adsorption*** ***12 hours***

Colloidal state: Purification of colloidal solutions –dialysis and ultra-filtration. Kinetic, electrical and optical properties of colloidal systems-Ultra microscope, Electrical double layer and zeta potential.
Coagulation of colloids, Hardy-Schulz rule and gold number. Gels: elastic and non-elastic gels, imbibition, synergesis. Surfactants -micelles, critical micelle concentration, sedimentation and

streaming potential. Application of colloids-Cottrell precipitator-sewage disposal-formation of deltas.

Adsorption: Physical and chemical adsorption, Freundlich adsorption isotherm. Derivation of Langmuir adsorption isotherm, Statement and explanation of BET and Gibbs isotherms. Determination of surface area of adsorbents by Langmuir equation. Applications of adsorption.

**About 150 problems to be worked out.**

***References:***


1. S. Glasstone& Lewis, "Elementary Physical Chemistry", Longman.
2. N. Kundu and S. K. Jain, "Physical Chemistry", S Chand.
3. K. L. Kapoor, "Elements of Physical Chemistry", Macmillan
4. G. M. Barrow, "Physical Chemistry", 6thedn, McGraw-Hill.
5. R. A. Alberty& R. J. Silbey, "Physical Chemistry", John Wiley.
6. G. W. Castellan, "Physical chemistry", Narosa.
7. P. W. Atkins, "Physical Chemistry", Longman.
8. M. Chanda, "Atomic Structure & Chemical Bond Including Molecular Spectroscopy", Tata McGraw Hill.
9. C. N. Banwell, "Fundamentals of Molecular Spectroscopy", Tata McGraw Hill.
10. M. C. Gupta, "Atomic and Molecular Spectroscopy", New Age.
11. P. S. Sindhu, "Fundamentals of Molecular spectroscopy", New Age International.
12. R. K. Prasad, "Quantum Chemistry", New Age International.
13. Puri, Sharma &Pathania, "Principles of Physical Chemistry"


**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 VICOURSE CODE - PO1642***
***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 e.s.r spectra
5. Predict the number of lines in the e.s.r 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

(10x1=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 e.s.r?
19. Distinguish between chemical and physical adsorption
20 Convert 15000$cm^{-1}$to frequency and wavelength
21. What are fundamental bands and overtones?
22. Explain the terms singlet and triplet states (8x2 =16 marks)

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

23. What are the methods by which ions are produced in mass spectrometer?
24. Explain mutual exclusion principle and how is it useful in structure elucidation
25. What is Debye equation? Explain its significance
26. Discuss harmonic and anharmonic oscillator
27. Explain Franck- Condon principle
28. Explain the terms fluorescence and phosphorescence

29. What are the postulates of quantum mechanics? Explain
30. Explain spin –spin coupling and high resolution spectra in nmr with an example
31. The fundamental vibrational frequency of carbon monoxide molecule is 2170 $cm^{-1}$. Calculate the force constant of the molecule.

(6x4 =24 marks)

**Section D**

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

32 a) Derive Langmuir adsorption isotherm

b) Explain the determination of surface area of a solid by Langmuir adsorption isotherm

33. Derive

a) The expression for the kinetics of decomposition of HI

(b) Michaelis – Menten equation

34. 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

35. 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

(2x15 =30 marks)

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

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**Core Course No – XII. Course Code– PO1643**
**Semester – VI.Credits – 4.**
**Polymer Chemistry II**
**(2018 admission onwards)**

***72 hours***

***COURSE OBJECTIVES***

1. To introduce different levels of polymer structure and the critical importance of Tg and Tm.
2. To provide an overview of polymer reactions and reactivity of polymers.
3. To understand factors that influences the degradation of polymers.
4. To learn about the properties of polymers in solution and biopolymers

## COURSE TRANSACTION FORMAT

Lecture-Tutorial-Lab: 4-0-0 hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 72 hours lecture.

## COURSE SYNOPSIS

Molecular forces & bonding in polymers, crystalline state, $T_g$, polymer reactions, functional polymer solution nature, size &shape of macro molecules, polymer degradation, biopolymers, biodegradable polymers &polymer recycling.

### *COURSE CONTENT*
### LCECTURES

***Module I – Molecular forces and bonding in polymers*** ***12 hours***

Primary structure – polarity of monomers. Secondary structure – conformation and configuration. Tertiary structure – crystalline and amorphous polymers. Polar and non-polar interactions. Segmental mobility and total mobility of polymer chains. Solid, liquid, glassy and rubbery states. Amorphous and crystalline behaviours. $T_g$ and $T_m$. Viscoelastic deformation. Determination of $T_g$. Factors influencing $T_g$(molecular geometry, molecular mass, plasticisers, copolymerization) relationship between $T_g$ and $T_m$. Importance of $T_g$. Factors influencing crystalline state, polymer single crystals, spherulites.

**Module II – Polymer reactions-I** ***12 hours***

Reactions involving hydroxyl, aldehydic, ketonic, carboxylic and amino groups. Hydrolysis, acidolysis, oxidation, hydrogenation, addition and substitution reactions. Cyclisation reactions of PVA and PAN. Prepolymers and curatives. Illustrations of curing of unsaturated polyesters with styrene, thiols with $PbO_2$ or epoxide or diamine. Cyclisation of natural rubber in acid medium, cross linking- photo chemical, through labile intermediate, vulcanization using peroxide, sulphur, sulphur compounds, mechanism of sulphur vulcanization.

**Module III– Polymer reactions-II** ***12 hours***

Preparation of block and graft copolymers. Preparation, properties and applications of ion exchange resins. Structure and applications of: conducting polymers, photoconducting polymers, Polymer drugs. Polymer supported reactions, advantages. Merrifield's solid phase peptide synthesis, dendritic polymers (brief idea)

**Module IV – Polymer solution** ***12 hours***

Difference of polymer solution from that of low molecular mass solutes. Swelling and formation of ellipsoid. Viscosity changes. Gel-sol systems. Good and poor solvents. Fractionation of polymers: fractional precipitations, gradient illusion and gel permeation chromatography.

Cohesive dispersion forces. Cohesive energy density (CED). Solubility parameter. Thermodynamics of polymer dissolution. Nature, size and shape of macromolecules in solution. End to end distance and radius of gyration. Perturbed and unperturbed dimensions. θ-Solvent and θ-temperature

**Module V – Polymer degradation** ***12 hours***

Process of degradation. Random and chain end degradation. Methods of degradation: thermal degradation – factors affecting thermal stability; mechanical degradation – milling and mastication; photodegradation – photostabilisers; oxidative degradation – oxidants and antioxidants; hydrolytic degradation; degradation by high energy radiation, chemical degradation .Polymer waste management.

**Module VI- Biopolymers and biodegradable polymers** ***12 hours***

DNA and RNA – structure and functions. Structure of proteins, Preparation, properties and applications of cellulose derivatives: cotton and rayon: cellulose plastics: cellulose acetate, cellulose nitrate & regenerated cellulose. Structure and applications of starch, shellac, chitin and chitosan. Commercial applications of natural polymers-lignin, kerogen, amber, asphaltenes. Biodegradable polymers, examples. Biomedical applications of polymers.

**References:**


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


**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 VI COURSE CODE - PO1643***
***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.

***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.

***Section –C***
***(Answer any 6 questions. Each question carries4 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

***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 ofpolymers.

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMSTER – VI. Course Code PO – 1644.**
**Core Course No. 13. Credits – 3.**
**Chemistry Lab Course No. –V (Gravimetry)**
**Three hours examination in semester VI**
**(2018 admission onwards)**

36 hours

***COURSE OBJECTIVES***

To equip the students with skill in the chemical analysis and synthesis of polymeric materials.

***COURSE TRANSACTION FORMAT***

Lecture-Tutorial-Lab: 0-0-2 hours per week; eighteen 5-day weeks per semester.
Contact hours per semester: 36 hours lab instruction.

**COURSE CONTENT**

The following determinations are to be done using silica crucible

Gravimetric estimation of
1) Barium as $BaSO_4$,
2) Sulphate as BaSO4,

3) Iron as $Fe_2O_3$,
4) Calcium as $CaCO_3$,

The following determinations are to be done using sintered crucible

1) Magnesium as oxinate,
2) Nickel as dimethyl glyoxime complex,
3) Copper as CuCNS and
4) Silver as AgCl.

***Reference:***

1. A.I. Vogel, "A Text Book of Quantitative Inorganic Analysis".

**UNIVERSITY OF KERALA**
**B.Sc. Degree Programme in Polymer Chemistry**
**PO1644 LAB COURSE-V (PRACTICAL)**
**GRAVIMETRY**
**SCHEME OF VALUATION**

**Time: 3Hours** **Maximum marks: 80**

| Main components for ESE for lab course – Inorganic gravimetric analysis | | |
|---|---|---|
| No. | Main components in general | Marks |
| 1 | Lab record | 20 |
| 2 | Procedure with principle and equation | 10 |
| 3 | Accuracy (up to 1% - 25 marks, error > 3% - grace mark -8) | 25 |
| 4 | calculation | 5 |
| 5 | Neat tabulation and recording | 5 |
| 6 | Viva | 10 |
| 7 | Performance | 5 |
| | Total | 80 |

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**SEMSTER – VI. Course Code PO – 1645.**
**Core Course No. XIV. Credits – 4.**
**Chemistry Lab Course No-VI.**
**Physical Chemistry Experiments**
**Three hours examination in semester VI#**
**(2018 admission onwards)**

108 hours

## COURSE OBJECTIVES

To impart better understanding of the theoretical principles of physical chemistry that the student has learned through experimentation.

## COURSE TRANSACTION FORMAT

Lecture-Tutorial-Lab: 0-0-6 hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 108 hours lab instruction.

## COURSE TRANSACTION FORMAT

Lecture-Tutorial-Lab: 0-0-6 hours per week; eighteen 5-day weeks per semester.
Contact hours per semester: 108 hours lab instruction.

## COURSE SYNOPSIS

Laboratory experiments with emphasis on physical chemistry.

## COURSE CONTENT

### *Module 1*. Phase Rule

Distribution Law. Partition coefficient of iodine between water and carbon tetrachloride. Partition coefficient of benzoic acid between toluene and water.

### *Module 2*. Dilute Solution

Transition temperature of a salt hydrate. Determination molar mass of a solute using transition point depression of a salt hydrate. Depression in freezing point. Molar mass of a solute using depression in freezing point of a solid solvent by cooling curve method.

### *Module 3*.Partially miscible liquids.

Critical Solution temperature of phenol-water system. Influence of impurities (KCl or NaCl) on

miscibility temperature of phenol-water system. Influence of succinic acid on the miscibility temperature of phenol-water system.

***Module 4*. Physical properties of liquids**

Viscosity of simple liquids. Surface tension of simple liquids and determination of parachor. Refractive index of simple liquids and determination of molar refraction.

***Module 5*. Thermochemistry and Chemical kinetics**

Determination of water equivalent of a calorimeter. Heat of neutralization of a strong acid by a strong base. Kinetics of hydrolysis of an ester. Determination of rate constant.

***Module 6* Electrochemistry**

Conductometric titration of NaOH vs HCl, NaOH vs CH3COOH
Potentiometric titration $Fe^{2+}$vs $Cr_2O_7^{2-}$, KMnO4 vs KI

***References:***

1. Findlay & Kitchener, "Practical Physical Chemistry" Longman.
2. Yadav, "Practical Physical Chemistry"

***Examinations for PO 1544 (lab course III) and PO1545(lab course IV) may be conducted on the same day for 6 hours at a stretch.**

**# Examinations for PO 1644(lab course V) and PO1645(lab course VI) may be conducted on the same day for 6 hours at a stretch.**

**UNIVERSITY OF KERALA**
**B.Sc. Degree Programme in Polymer Chemistry**
**(CORE COURSE), SEMESTER VI**
**PO1645 LAB COURSE-VI (PRACTICAL)**
**PHYSICAL CHEMISTRY EXPERIMENTS**
**SCHEME OF VALUATION**

**Time: 3hours** **Maximum marks: 80**

**Table 1.Components for end semester evaluation of Physical Chemistry experiments**

| Sl. No | Components | Marks |
|---|---|---|
| I. | Lab report:<br>1) 8 experiments& above<br>2)Data and sufficient experimental details<br>3) correctness of the result<br>4)Neatness of presentation | 20 |
| II. | Procedure-<br>1)principle of the expt<br>2)Relevant equation/graph<br>3)materials and apparatus<br>4)experiment | 8 |
| III. | Neat tabulation& systematic recording<br>1)Correct representation of data<br>2)Graphical representation<br>3) satisfactory skill in experimentation<br>4)Neatness of data and result presentation | 8 |
| IV. | Viva | 10 |
| V. | Performance of experiment, calculation and accuracy of the result (accuracy may depend upon the experiment) | 34(details of marks distribution given separately) |

1. Determination of partition coefficient

**Performance, calculation and accuracy (34marks)**

| | | | |
|---|---|---|---|
| a) | Titration of aqueous and organic layer | 6 titre values | 12 marks |
| b) | Calculation(correct equation, substitution, final value | | 4 marks |

| | | | |
|---|---|---|---|
| | and unit) | | |
| c) | Accuracy | up to 6% error | a) 18marks |

2. **Determination of critical solution temperature**

Performance, calculation and accuracy (34 marks)

| Sl No | components | marks |
|---|---|---|
| 1 | Determination of miscibility temperature 6 values and above | 12marks |
| 2 | Graph with 4 points | 4 marks |
| 3 | Accuracy - up to 6% error | 18 marks |

**3. Determination of concentration of KCl**

Performance, calculation and accuracy (34 marks)

| Sl No | components | marks |
|---|---|---|
| 1 | Determination of miscibility temperature 6 values and above | 12marks |
| 2 | Graph with 4 points | 4 marks |
| 3 | Accuracy - up to 6% error | 18 marks |

**4. Determination of concentration of HCl**

Performance, calculation and accuracy (34 marks)

| Sl No | Components | Marks |
|---|---|---|
| a | Measurement of conductance 10 values | 10 marks |
| b | calculation(correct equation, substitution, final value and unit) | 4 marks |
| c | two graphs with minimum 4 points | 4 marks |

| | | |
|---|---|---|
| d | Accuracy (up to 6% error) | 16 arkd |

**5. Determination of molal transition point depression constant & Determination of molecular mass by transition point method**

Performance, calculation and accuracy (34 marks)

| Sl. No. | Components | Marks |
|---|---|---|
| a | Transition point determination- 3 transition temperature | 9 |
| b | Calculation of Kf or molecular mass | 4 marks |
| c | Graph - 3 cooling curve | 6 marks |
| d | Accuracy -up to 6% error | 15 arks |

**6. Determination of concentration of $Fe^{2+}$ /KI potentiometrically**

Performance, calculation and accuracy (34marks)

| Sl. No. | Components | Marks |
|---|---|---|
| a | Measurement of emf 10 values - | 10 marks |
| b | calculation | 4 marks |
| c | graph with six points | 6marks |
| d | Accuracy up to 6% error | 14marks |

Note: If necessary, the schemes given above for lab courses I –VI may be modified by the respective Board of examiners

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**Elective Course. Course Code– PO1661**
**Semester – VI. Credits-2**
**Advanced Polymer Chemistry**
**(2018 admission onwards)**

***54 hours***

***COURSE OBJECTIVES***

1. To introduce processing and technical aspects of polymers.
2. To learn about polymeric materials such as engineering plastics, elastomers and fibres and to understand the characterisation of polymers and
3. To make the students familiar with the properties of macromolecular solutions

***COURSE TRANSACTION FORMAT***

Lecture-Tutorial-Lab: 3-0-0 hours per week; eighteen 5-day weeks per semester. Contact hours per semester: 54 hours lecture.

**COURSE SYNOPSIS**

Characterization of polymers: physical & chemical methods, preparation, structure & properties of plastics, engineering plastics, elastomers & fibers, polymer processing- additives, technology of polymer processing, moulding processes, forming & other techniques.

***COURSE CONTENT***
**LECTURES**

**Module I – Characterization of polymers – I** **9 hours**

Preliminary analysis: solubility, flame test, Lassaigne's test, heating test and melting point test (LDPE and HDPE). Analysis of polystyrene (dye test). Molecular weight (mention any two methods only). Physical properties: stress-strain behavior in tension, fatigue, impact strength, tear resistance, optical properties – transmittance, reflectance; electrical properties – dielectric strength (no experimental details and method of determination).

**Module II - Characterization of polymers – II** **9 hours**

Applications of IR, NMR (proton and C-13) and X-ray diffraction in characterization.Thermal analysis; differential thermal analysis, thermogravimetric analyisis and differential scanning calorimetry.

**Module III – Plastics and engineering plastics** **9 hours**

Preparation, structure and properties of polyolefins (LDPE, HDPE, LLDPE and PP); vinyl polymers (PVC, Polyvinyl acetals and PMMA); Teflon and polyurethanes; Phenol formaldehyde and urea formaldehyde resins; nylons and polyesters (Terylene and Dacron). Engineering plastics, ABS, polyamides, polycarbonates, PPO, PPS, polysulphones, polyimides, polyesters, flouropolymers, ionomers, and liquidcrystalline polymers.

**Module IV – Elastomers and fibres** **9 hours**

Natural rubber, composition, preservation & coagulation of latex, Structure, properties and preparation of synthetic rubbers (PB, SBR, NBR, polychloroprene, polyisobutylene, IIR, EPDM, buna-N, thiacol). Reclaimed rubbers. Thermoplastic elastomers- advantages, polyurethanes. Fibres: natural (structure and properties); synthetic (structure and properties of nylon, polyester and acrylics)

**MODULE V- Polymer processing** **9 hours**

Peculiarities in the properties of elastomeric, fibreforming (tenacity, spirality and crimp) and plastic materials: structure, property, relationship. Compounding: additives and functions. Vulcanizers, hard rubber, ebonite, accelerators, activators, extenders, fillers, antioxidants, antiozonants, UV stabilizers, lubricants, plasticizers, flame retardants and colourants, typical examples. Blending methods: milling and internal mixing.

**MODULE VI- Technology of polymer processing** **9 hours**

Moulding processes: Compression moulding- transfer moulding, injection moulding, blow moulding. Forming techniques- extrusion, spinning, calendaring, and casting. Other techniques- Lamination & reinforcement, foaming, coating, finishing, microencapsulation.

**References:**


1. *Malcon P. Steves, Polymer chemistry-An introduction, 3rd edition, Oxford University Press.*
2. *F. W. Billmayer, Text book of Polymer Science, 3rd edition, John Wiley &Sons*
3. *V. R. Gowariker, N. V. Viswanathan&J. Sreedhar, Polymer Science, New Age International Publishers.*
4. *PremamoyGhosh, Polymer Science & Technology, 3rd edition, Tata McGraw Hill Education Pvt. Ltd., New Delhi*
5. *Siddaramaiah, Practicals in Polymer Science, CBS Publishers & Distributors, New Delhi*
6. *P. Bahadur& N. V. Sastry, Principles of Polymer Science, Narrora Publishing House, 2nd Edition, New Delhi*
7. *G. Odian, Principles of polymerization, 3rd edition, John Wiley &Sons.*

8. *G. S. Misra, Introductory Polymer Chemistry New age International Publishers & Distributors, New Delhi*
9. *V. K. Ahluwalia& A. Misra, Polymer Science-A Text Book, AneBooks, India, New Delhi.*
10. *J. R. Fried, Polymer Science & Technology, Prentice Hall of India Pvt. Ltd, New Delhi*

**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 VICOURSE CODE - PO1661***
***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?

**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 molding?
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. Give the structure of two synthetic rubbers.
22. Write any four advantages of polysulphones.

**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.

**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, $H^1$nmr& $C^{13}$nmr in polymer characterization.

**Syllabus for B.Sc. Degree Programme in Polymer Chemistry**
**Course code - PO1646.**
**Credits -4**
**PROJECTANDFACTORY VISIT**

The course attempts to introduce the student to the preliminaries of conceptualizing a project proposal based on a valid problem in chemistry and related areas, to train in the methodology of collecting background information necessary to solve the problem, to enable designing of experiments to provide an answer to the question posed, to familiarize how to collect and interpret data and to encourage arriving at a conclusion or in an answer to the question posed.

## COURSE OBJECTIVES

The course serves to kindle the research aptitude, provide research skills and inculcate a spirit of enquiry among the students.

## COURSE TRANSACTION FORMAT

Lecture-Tutorial-Lab: 0-0-2 hours per week in semester V and 0-0-3 in semester VI; eighteen 5-day weeks per semester.
Contact hours per semester: 36 hours in semester V and 54 hours in semester VIl at lab and library.
The number of students attached to one supervisor and other modalities of doing the research project will be in accordance with the regulations.

## COURSE CONTENT

The course involves carrying out a small research project that has originality and sound scientific justification and is not meant to do repetitive projects that are mere extensions or copy of those already done. A topic may be chosen in any areas of chemistry that involves theoretical, computational or experimental work. Proper objectives must be identified and on completion, some if not all of these specific objectives must be achieved. Writing a review paper alone does not come under the ambit of a project. The topics shall either be allotted by the supervising teacher or be selected by the students in consultation with the supervising teacher.