B. Sc. (Honours School) Chemistry

SRI GURU GRANTH SAHIB WORLD UNIVERSITY

FATEHGARH SAHIB

Faculty of Basic and Applied Sciences

DEPARTMENT OF CHEMISTRY

Syllabi and outline of Examination

for

B.Sc. (Honours School) Chemistry
(Semester I - VI)

(Under Credit Based Choice System, CBCS)

EXAMINATION: 2018-2021, 2019-2022

SRI GURU GRANTH SAHIB WORLD UNIVERSITY
FATEHGARH SAHIB

ORDINANCES

For B.Sc. (Hons. School) (Semester System)

(UNDER THE +3 SCHEME)

Notwithstanding the integrated nature of a course spread over more than one academic year, the ordinances in force at the time a student joins a course shall hold good only for the examination held during or at the end of that academic year. Nothing in these Ordinances shall be deemed to debar the University from amending the ordinances subsequently and the amended ordinances, if any, shall be applicable to all the students whether old or new.

1 B.Sc. (Hons. School) course comprises of three years, each year will consist of two semesters. The university examination will be held at the end of every semester in the months of November/December (for semester I, III & V) and May/June (for semester II, IV & VI) or as fixed by the Academic Council.

2 A candidate must complete and pass the whole course of three years within a maximum period of five years from the date of admission in B.Sc. (Hons.School) first semester.

3 The outlines of tests and syllabi shall be such as prescribed by the Academic Council from time to time.

4 A candidate will be eligible to join 1st semester of B.Sc. (Hons. school) course, only if he/she has passed +2 examination (Medical/Non-Medical) without reappear of Punjab School Education Board, or any other examination recognized as equivalent there to with 50 percent marks.

5 Semester examination will be open to regular candidates who have been on the rolls of the department and meet the attendance and other requirements as prescribed in the Ordinance No.7 below.

6(a) Subject to fulfillment of requirement of mid semester examinations and the attendance requirements, there will be no condition of passing minimum no. of papers for promotion from odd semester to even semester in an Academic Session.

(b) To qualify for admission to 2nd year (3^{rd} Sem) of the Course, the candidate must have earned 50% of the total credits of the two semesters of the 1st year. Similarly, to qualify for admission to 3rd year (5^{th} Sem) of the course, the candidate should have earned 50% of total credits of four semesters of the earlier two years.

(c) A candidate placed under reappear in any paper, will be allowed two chances to clear the reappear, which should be availed within consecutive two years/chances i.e. to pass in a paper, the candidate will have a total of three chances, one as regular candidate and two as reappear candidate.

Reappear/improvement exams will be conducted along with the scheduled exams of the coming batches i.e re-appear exams of odd semester will be conducted along with the regular exams of odd semester, and reappear exams of even semester will be conducted along with the regular exams of even semester. However for the student of 6th semester

only, the reappear exams for the two odd semesters immediately proceeding the final semester i.e 3rd and 5th semester will be conducted along with the end semester examinations of the 6th semester. Such student will submit the reappear examination form along with special examination fee as notified by the university from time to time. The chance(s) so availed by the student will be counted towards the total number of chances available to the student for clearing a paper.

(d) Subject to provisions laid down in the statutes and the ordinances, the controller of examinations shall be responsible for all arrangements connected with the conduct of examination and all matters connected there with.

7 **Attendance Requirements**

A candidate will be required to attend a minimum of 75% lectures delivered to that class in each paper as well as 75% of the laboratory work, seminars etc. separately. Provided that a deficiency in attendance may be condoned for special reasons, as per the relevant ordinances on the subject. The attendance of students admitted to 1st semester will be counted from the date of admission.

8 **Private Candidates**: A candidate, who has completed the prescribed course of instructions for a semester but has not appeared in the examination or having appeared, has failed in the examination, may appear as a private candidate within the prescribed period.

9 The pass and reappear students of B.Sc. (Hons. School) from any recognized university shall be treated at par with the corresponding students of this University. But in case such a student is admitted in B.Sc. (Hons School) semester III/V in this University, he/she will be required to clear the deficient papers, if any and submit the required migration certificate.

10 Amount of examination fee to be paid by a candidate for each semester shall be as fixed by the University from time to time.

11 Applications for admission to the examination shall be made on the prescribed form attested by the competent authority as per University rules. The last date by which admission forms and fees must reach the Registrar shall be notified from time to time.

12 The general rules and conditions of the University for the award of medal/prizes etc. will be applicable to the topper of this examination. A candidate will be eligible for the award of a medal or a prize, if he/she:

(i) Secures highest CGPA among all the students of that programme/branch; and

(ii) Passes all the examination of the programme in minimum stipulated duration of the course and in the first attempt available to him/her.

13 The medium of instructions and examination will be English except for the non English subjects.

14 Subject to the restrictions contained in the Ordinances, a candidate for B.Sc. (Hons School) Scheme shall be required to take up the papers as per the syllabus prescribed by the university.

15 Elementary Punjabi in lieu of Punjabi compulsory shall be allowed to the following categories of candidates:

1. Candidates who have passed their Matriculation examination from a School located outside the State of Punjab.

2. Candidates who have passed their Matriculation examination from a School located in the State of Punjab will not be allowed to take up the subject of Elementary Punjabi in lieu of Punjabi Compulsory. This clause will not apply to students covered by clause No. 3 given below.

3. Children of Defence personnel/Para military personnel (serving as well as retired) will be allowed to take up the subject of elementary Punjabi, provided the father or the mother/guardian (in case father is deceased) of the candidate gives an affidavit that the candidate has not studied Punjabi at the School level.

16. **A Candidate shall be allowed to join:**

(i) **First Semester:**

Provided that he/she has passed at least, one academic year previously, the +2 examination (without reappear) of Punjab School Education Board, or any other examination recognized as equivalent thereto.

(ii) **Second Semester:**

Provided that he/she has undergone a regular course of studies of first semester as provided under the ordinances.

(iii) **Third Semester:**

Provided that he/she has undergone a regular course of studies of First and Second semesters as provided under the regulations in sequential order and fulfils the conditions as laid in ordinance 6(b).

(iv) **Fourth Semester:**

Provided that he/she has undergone a regular course of studies of First, Second and Third semesters as provided under the ordinances in sequential order.

(v) **Fifth Semester:**

Provided that he/she has undergone a regular course of studies of First, Second, Third and Fourth semesters as provided under the regulations in sequential order and fulfils the conditions as laid in ordinance 6(b).

(vi) **Sixth Semester:**

Provided that he/she has undergone a regular course of studies of First, Second, Third, Fourth and Fifth semesters as provided under the ordinances in sequential order.

17 Three weeks after the termination of examination or as soon thereafter as possible, the Registrar shall publish the result of the candidates. Each candidate shall receive a certificate indicating details of marks obtained in each examination. At the end of Semester-VI examination, the Successful candidates shall receive a degree stating the division according to **ordinance 18.**

18 The successful candidates shall be classified on the basis of aggregate marks secured in all the six semesters of B.Sc. taken together as under:

(a) 75% or more with Distinction.

(b) 60% or more in the First division.

(c) 50% or more but less than 60% in the Second division.

(d) below 50% in the Third division.

19 A candidate who has passed B.Sc. (Hons. School) examination from this University shall have two chances within a period of two years after passing the examination to improve division or to obtain 55% marks as a private candidate. Improvement shall be allowed in not more than 50% of total theory papers offered in 1st to 6th Sem examination. However, previous marks of Practical/Project will be carried forward in the paper(s) in which he/she appears for improvement. A candidate who has passed an examination higher than M.Sc shall not be allowed to improve his performance in B.Sc.

20. Candidate obtaining pass grades as prescribed in each subject offered in 1st to 6th semester shall be granted a certificate.

21. The Candidate shall be entitled to grace marks as admissible under the ordinances relating to the 'Grace Marks.'

22. The student shall be awarded letter grades in each subject/paper as per the seven point scheme. Each letter grade indicates the level of performance in a subject/paper and has a grade point for the purposes of the computing the CGPA,as given in table below:

Letter Grade	Performance	Grade Point	Percentage Equivalent
A^+	Outstanding	8.50-10.00	85-100
A	Very Good	7.00-8.49	70-84.9
B	Good	6.00-6.99	60-69.9
C	Average	5.00-5.99	50-59.9
D	Below Average	4.00-4.99	40-49.9
E	Poor	2.50-3.99	25-39.9
F	Very Poor	0.00-2.49	0-24.9

23. To pass in a subject/paper a candidate is required to obtain a minimum of D grade in internal assessment and external examination separately.

24. The cumulative grade point average (CGPA) is the weighted average of all the grades awarded to a student since his/her entry into the course, upto and including the latest semester. CGPA is calculated on the basis of all the papers the student has passed at the given time as epr the formula below:

$$CGPA = \sum C_i G_i \; / \; \sum C_i$$

C_i is the credit of ith paper/subject and G_i the grade point for the ith paper/subject. For each particular semester, the semester grade point average (SGPA) can be calculated on the basis of papers cleared for that particular semester only.

25. The subject(s)/ paper(s) in which the student has earned 'E' or 'F'grade in the external examination, will be termed as re-appear subject(s)/ Paper(s).

B. Sc. (Honours School) Chemistry

SCHEME OF TEACHING AND EXAMINATION

Theory Papers

External Theory Examination = 75 marks

Instructions for paper setters: The external question paper will carry 75 marks and will be of 3 hrs duration. It will consists of three sections named A, B and C. Section A will be compulsory and will have 10 short answer type questions of 2 marks each covering the whole syllabus of the subject. Section B will consist of eight questions of 6 marks each and candidates are required to answer any five questions. Section C will consist of four long answer type questions of 12.5 marks each. Candidate will be required to attempt any 2 questions.

Internal Assessment Theory Exam = 25 marks

Components of internal assessment:

a) First Mid Semester Tests = 15 marks
b) Assignments/Class Tests/Presentations/Quiz = 7 marks
c) Attendance and class behavior = 3 marks

Practical Lab Examination

External Lab Examination = 75 marks
Internal Assessment Lab Exam = 25 marks

Components of internal assessment:

a) Practical notebook = 7.5 marks
b) Seminars/Lab Performance/Viva = 12.5 marks
c) Lab attendance and behavior = 5 marks

B. Sc. (Honours School) Chemistry

Outline of Examination

Semester	Core Course (14)	Ability Enhancement Compulsory course (AECC) (2)	Ability Enhancement Elective Course (AEEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) (4)
I	Organic Chemistry I: Basics & Hydrocarbons (4+2)	English Communication			Mathematics-I Physics-I
	Physical Chemistry I: States of Matter & Ionic Equilibrium (4+2)				
II	Inorganic Chemistry I: Atomic Structure & Chemical Bonding (4+4)	Punjabi			Mathematics-II Physics-II
	Physical Chemistry II: Chemical Thermodynamics & equilibrium (4+4)				
III	Inorganic Chemistry II: s and p Block Elements (4+4)		SEC-1		Mathematics-III Physics-III
	Organic Chemistry II: Functional Groups-I (4+4)				
	Physical Chemistry III: Phase Equilibria & Chemical Kinetics (4+4)				
IV	Inorganic Chemistry III: d and f block elements (4+4)		SEC-2		Mathematics-IV Physics-IV
	Organic Chemistry III: Functional Groups-II (4+4)				
	Physical Chemistry IV: Electrochemistry (4+4)				

V	Organic Chemistry IV: Organic Spectroscopy (4+4)			DSE-1	
	Physical Chemistry V: Quantum Chemistry & Photochemistry (4+4)			DSE-2 (Environmental Studies)	
VI	Inorganic Chemistry IV: Organometallic Chemistry (4+4)			DSE-3	
	Organic Chemistry V: Biomolecules (4+4)			DSE-4	

Core Papers (C): (Credit: 06 each) (1 period/week for tutorials or 4 periods/week for practical)

1. Organic Chemistry I: Basics and Hydrocarbons (4 + 4)
2. Physical Chemistry I: States of Matter & Ionic Equilibrium (4 + 4).
3. Inorganic Chemistry I: Atomic Structure & Chemical Bonding (4 + 4)
4. Physical Chemistry II: Chemical Thermodynamics and equilibrium (4 + 4)
5. Inorganic Chemistry II: s- and p-Block Elements (4 + 4)
6. Organic Chemistry II: Functional Groups-I (4 + 4)
7. Physical Chemistry III: Phase Equilibria and Chemical Kinetics (4 + 4)
8. Inorganic Chemistry III: d and f block elements (4 + 4)
9. Organic Chemistry III: Functional Groups-II (4 + 4)
10. Physical Chemistry IV: Electrochemistry (4 + 4)
11. Organic Chemistry IV: Organic Spectroscopy (4 + 4)
12. Physical Chemistry V: Quantum Chemistry & Spectroscopy (4 + 4)
13. Inorganic Chemistry IV: Organometallic Chemistry (4 + 4)
14. Organic Chemistry V: Biomolecules (4 + 4)

Discipline Specific Elective Papers: (Credit: 06 each) (4 papers to be selected)- DSE 1-4

1. Co-ordination Chemistry (4) + Lab (4)
2. Environmental Studies (4) + Lab (4)
3. Molecular Spectroscopy (4) + Lab (4)
4. Analytical Methods in Chemistry (4) + Lab (4)
5. Applications of Computers in Chemistry (4) + Lab (4)
6. Novel Inorganic Solids (4) + Tutorials (1)
7. Polymer Chemistry (4) + Lab (4)
8. Research Methodology for Chemists (4) + Lab (4)
9. Green Methods in Chemistry (4) + Lab (4)
10. Industrial Chemistry (4) + Lab (4)
11. Dissertation

Other Discipline (Four papers of any one discipline)- GE 1 to GE 4

1. Mathematics (4) + Tut (1)
2. Physics (4) + Lab (4)

Skill Enhancement Courses (02 to 04 papers) (Credit: 02 each)- SEC1 to SEC4

1. Basic Analytical Chemistry
2. Analytical Clinical Biochemistry
3. Green Methods in Chemistry
4. Fuel Chemistry
5. Intellectual Property Rights

B. Sc. (Honours School) Chemistry

SEMESTER: I

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-101	Basics & Hydrocarbons	3	1	-	4	25	75
BSCH-102	States of Matter & Ionic Equilibrium	3	1	-	4	25	75
BSCH-103	Physics-I	3	1	-	4	25	75
BSCH-104 A (N. Med.) BSCH-104 B (Med.)	Mathematics-I	3	1	-	4	25	75
BSCH-105	Communication Skills	-	-	4	2	25	75
BSCH-106L	Chemistry Lab- I **Inorganic and Organic Chemistry Lab**	-	-	4	2	25	75
BSCH-107L	General Elective I Lab **Physics Lab**	-	-	4	2	25	75
	TOTAL	12	4	12	22	175	525

B. Sc. (Honours School) Chemistry

SEMESTER: II

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-201	Atomic Structure & Chemical Bonding	3	1	-	4	25	75
BSCH-202	Chemical Thermodynamics & equilibrium	3	1	-	4	25	75
BSCH-203	Physics-II	3	1	-	4	25	75
BSCH-204 A (N. Med.) BSCH-204 B (Med.)	Mathematics-II	3	1	-	4	25	75
BSCH-205	Punjabi	2	-	-	2	25	75
BSCH-206L	Chemistry Lab-II **Inorganic & Physical Chemistry Lab**	-	-	4	2	25	75
BSCH-207L	General Elective II Lab **Physics Lab**	-	-	4	2	25	75
	TOTAL	17	5	12	22	175	525

B. Sc. (Honours School) Chemistry

SEMESTER: III

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-301	Representative elements and Inorganic Polymers	3	1	-	4	25	75
BSCH-302	Functional Groups-I	3	1	-	4	25	75
BSCH-303	Phase Equilibria & Chemical Kinetics	3	1	-	4	25	75
BSCH-304 A (N. Med.) BSCH-304 B (Med.)	Mathematics-III	3	1	-	4	25	75
BSCH-305	Physics-III	3	1		4	25	75
BSCH-306	SEC-1	2			2	15	35
BSCH-307L	Chemistry Lab-III **Organic and Physical Chemistry Lab**	-	-	4	2	25	75
BSCH-308L	General Elective III Lab (Physics Lab)	-	-	4	2	25	75
	TOTAL	17	5	8	26	190	560

B. Sc. (Honours School) Chemistry

SEMESTER: IV

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-401	d and f block elements	3	1	-	4	25	75
BSCH-402	Functional Groups-II	3	1	-	4	25	75
BSCH-403	Electrochemistry	3	1	-	4	25	75
BSCH-404 A (N. Med.) BSCH-404 B (Med.)	Mathematics-IV	3	1	-	4	25	75
BSCH-405	Physics-IV	3	1	-	4	25	75
BSCH-406	SEC 2	2			2	15	35
BSCH-407L	Chemistry Lab-IV **Inorganic and Organic Chemistry Lab**	-	-	4	2	25	75
BSCH-408L	General Elective lab IV (Physics Lab)	-	-	4	2	25	75
	TOTAL	17	5	8	26	190	560

BSCH-101: Basics and Hydrocarbons **(45 Hrs.)**

M. Marks: 100 (75+25)

UNIT - I **(20 Hrs.)**

Organic Compounds: Classification and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

Electronic Displacements: Inductive, Electromeric, Resonance and Mesomeric effects, Hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples. Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and relative stability of Carbocations, Carbanions, Free radicals, Carbenes, Arynes and Nitrenes.

Stereochemistry: Concept of isomerism. Types of Isomerism; Fischer Projection, Newman and Sawhorse Projection formulae and their interconversions; Geometrical isomerism: cis-trans and, syn-anti isomerism, E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with two or more chiral-center's, Diastereoisomers, meso structures, Racemic mixture and Resolution. Relative and absolute configuration: D/L and R/S designations.

UNIT - II **(25 Hrs.)**

Saturated Hydrocarbons: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reaction, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Unsaturated Hydrocarbons: Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Alkenes: Electrophilic additions their mechanisms (Markovnikov/ Anti Markovnikov addition), mechanism of oxymercuration-demercuration, hydroboration-oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism.

Alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

SUGGESTED BOOKS

1. Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd.

(Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
4. Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

BSCH -102: States of Matter and Ionic Equilibrium **(45 Hrs.)**

M. Marks: 100 (75+25)

UNIT - I (23 Hrs.)

Gaseous state: Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases; relation between mean free path and coefficient of viscosity, variation of viscosity with temperature; Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities;

Behaviour of real gases: Deviations from ideal gas behaviour; compressibility factor Z, and its variation with pressure for different gases; Causes of deviation from ideal behaviour; Vander Waals equation of state, its application in explaining real gas behaviour, Other equations of state (Berthelot, Dietrici, Virial equation of state); Vander Waals equation expressed in Virial form and calculation of Boyle temperature; Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states.

Liquid state: Qualitative treatment of the structure of the liquid state; Radial distribution function; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases; Qualitative discussion of structure of water.

UNIT - II (22 Hrs.)

Solid state: Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, qualitative idea of point and space groups, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals. Glasses and liquid crystals.

Ionic equilibria: Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono-, di- and triprotic acids (exact treatment)

Salt hydrolysis; Calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry. Solubility and solubility product of sparingly soluble salts; applications of solubility product principle; Qualitative treatment of acid-base titration curves (calculation of pH at various stages). Theory of acid–base indicators; selection of indicators and their limitations; Multi-stage equilibria in polyelectrolyte systems; hydrolysis and hydrolysis constants.

SUGGESTED BOOKS

1. Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press (2006).
2. Ball, D. W. Physical Chemistry, Thomson Press, India (2007).
3. Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004).
4. Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: Noida, UP (2009).

BSCH-103: Physics - I **(Mechanics)** **(45 Hrs.)**

M. Marks: 100 (75+25)

UNIT-I **(**22 Hrs)

Coordinate Systems: Cartesian and spherical polar co-ordinate systems, area, volume, displacement, velocity and acceleration in these systems, Solid angle. Reference frames. Inertial frames; Galilean transformations and invariance. Centre of Mass. Relationship of conservation laws and symmetries of space and time.

Work and Energy: Work and Kinetic Energy Theorem. Conservative and nonconservative forces. Force as gradient of potential energy. Work done by non-conservative forces. Law of conservation of Energy.

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Rotational Dynamics: Angular momentum of a particle and system of particles. Principle of conservation of angular momentum. Rigid body. Rotation of the rigid body about a fixed axis. Angular momentum of rigid body about the principal axes. Kinetic energy of rotation of rigid body around principal axes. Euler's equations.

UNIT-II **(**23 Hrs)

Central Force Motion: Central force. Equation of motion under central forcefield. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness.

Non-Inertial Systems: Non-inertial frames and fictitious forces. Centrifugal force. Coriolis force and its applications.

Special Theory of Relativity: Postulates of Special Theory of Relativity. Michelson-Morley experiment and its physical significance. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity: velocity addition theorem. Variation of mass with velocity. Mass-energy Equivalence. Relativistic Doppler Effect. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

Recommended Textbooks

- An introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, Vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G. R. Fowles and G. L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

BSCH-104 A (Non-Medical): MATHEMATICS - I **(45 lectures)**
M. Marks: 100 (75+25)

Unit-I **(**22 Hrs)

Matrix Algebra: Matrices, Algebra of matrices, Type of matrices, Elementary operation on matrices. Inverse of a matrix using Gauss Jordan Method. Linear independence of row and column vectors, Row rank and Column rank and their equivalence. Application of matrices to a system of linear (homogeneous and non-homogeneous) equations.

Eigen values and Eigen vectors: Characteristic equation of a matrix. Properties of Eigen values for special type of matrices, Cayley-Hamilton theorem. Diagonalization of matrices. Trace of matrices.

Conjugate of matrix. Some special types of matrices. Hermitian, Skew-Hermitian, Orthogonal and Unitary matrices and orthogonal matrices. And their Eigen values.

Unit-II **(**23 Hrs)

Functions of Complex variables: De-Moivre's theorem and roots of complex numbers. Euler's theorem. Logarithmic Functions. Circular and Hyperbolic Functions and their inverses.

Complex plane: Stereographic projection. Riemann sphere. Limits and continuity. Differentiability and analytics functions. Cauchy Riemann equations. Sufficient condition for analytic function. Harmonic functions.

Recommended Textbooks

1. R.K. Jain, S.R.K. Iyengar: Advanced Engineering Mathematics. Narosa Publishing House (2014).
2. P. B. Bhattacharya and S. K. Jain: First Course in Linear Algebra. New Age International (2000).
3. S. Narayan and P. K. Mittal: A textbook of matrices. S. Chand & Company (2000).
4. Dennis G. Zill, Patrick `QsD. Shanahan: A First Course in Complex Analysis with Applications. Jones & Bartlett Publishers (2008).
5. Pater D. Lax: Linear Algebra and Its Applications. 2nd Ed. (2007).
6. Mathematical Physics: H. K. Dass (S. Chand Publication, 6th Ed. 2011).
7. Babu Ram: Advanced Engineering Mathematics. Pearson Education (2010).

BSCH-104 B (Medical) MATHEMATICS - I **(45 lectures)**
M. Marks: 100 (75+25)

Unit-I **(**23 Hrs)

Trigonometry: T-ratios, addition and subtraction formulae, multiple angles, sub-multiple angles, trigonometric equations, inverse trigonometrical functions (proofs of articles are not required).

Algebra: Fundamental principle of counting, Permutation and Combination with simple applications. Principle of mathematical induction, statement of Binomial Theorem and its applications.

Unit-II **(**22 Hrs)

Co-ordinate Geometry: Cartesian & Polar co-ordinates in plane, different forms of straight lines. Angle between two straight lines. Conditions of parallelism and perpendicularity. Standard equations of circle.

Conic Section: Standard equations of parabola, ellipse and hyperbola and simple problems.

Recommended Books:

1. NCERT, Mathematics text book for class 11th.
2. NCERT, Mathematics text book for class 12th.
3. Loney, S. L., Plane Trigonometry Part-I, A.I.T.B.S. Publishers, India, Reprint-2009.
4. Jain, P. K., Ahmad, K.: Textbook of Analytical Geometry, New Age International (P) Limited, Second Edition, 2005.

BSCH-105: Communication Skills in English **(45 lectures)**
M. Marks: 100 (75+25)

UNIT-1 STUDY OF SHORT STORIES: Contact Hours: 40

Popular short Stories, Oxford University press, 1989. Rpt. 2008. The following short stories from this anthology are prescribed:

1. A Cup Of tea
2. The open Window
3. The Necklace
4. The Gateman's Gift
5. Living or dead?

GRAMMAR AND VOCABULARY:

Use of Tenses

1. Change of Voice
2. Change of Narration
3. Use of Conjunctions
4. Use of prepositions
5. One word substitution
6. Words often confused and misspelt
7. Common errors in the usage of English Language

UNIT- 2: COMPOSITION: Contact Hours: 10

1. Paragraph writing
2. Writing a review of a TV Serial
3. Translation of News item/ Article in newspaper / excerpt from Short Story into Punjabi or Hindi.
4. Expansion of a given concept into a paragraph
5. Picture Caption Writing

PRESCRIBED BOOKS:

1. Best, Wilfred D. *The Student's Companion*, New Delhi: Rupa& Co., 1958. 29th impression, 1994
2. *Short Plays*, edited by JagdishChander, Oxford, 21st impression,2001.
3. *Popular short Stories*, Oxford University press, 1989. Rpt. 2008.
4. Singh, Achhru, *University English Grammar and Vocabulary Study*, Chandigarh: Unistar Publishers.
5. Frank, O'Holo, *Writer's work: A Guide to Effective Composition*, Prentice Hall, New Delhi, 1976.
6. Sanyal, Mukti& Prasad, Tulika, *Fluency in English*, Macmillan
7. Sharma, S.C., Sharma, Pankaj, *A textbook of grammar and composition*, Mcmillan

BSCH -106L: CHEMISTRY LAB-I **(Inorganic Chemistry Lab)**
M. Marks: 100 (75+25)

(A) Titrimetric Analysis

1. Calibration and use of apparatus
2. Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

3. Estimation of carbonate and hydroxide present together in mixture.
4. Estimation of carbonate and bicarbonate present together in a mixture.
5. Estimation of free alkali present in different soaps/detergents

(C) Redox Titrations

6. Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
7. Estimation of oxalic acid and sodium oxalate in a given mixture.
8. Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

BSCH -106L: CHEMISTRY LAB-II **(Organic Chemistry Lab)**
M. Marks: 100 (75+25)

Melting and Boiling point

1. Checking the calibration of the thermometer
2. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
3. Effect of impurities on the melting point: mixed melting point of two unknown organic compounds
4. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)

Purification of organic compounds by crystallization using the following solvents:

5. a) Water b) Alcohol c) Alcohol-Water

Chromatography

6. Separation of a mixture of two amino acids by paper chromatography.
7. Determination of R_f value and purity of organic compounds by use of thin layer chromatography.
8. Separation of a mixture of two sugars by ascending paper chromatography.
9. Separation of a mixture of o-and p-nitrophenol/ o-and p-aminophenol by thin layer chromatography (TLC).
10. Separation of mixture of o-nitroaniline and p-nitroaniline by column Chromatography.

SUGGESTED BOOKS

1. Mann, F. G.; Saunders, B. C. Practical Organic Chemistry, Pearson Education (2009).
2. Furniss, B. S.; Hannaford, A. J.; Smith, P. W. G.; Tatchell, A. R. Practical Organic Chemistry, 5th Ed., Pearson (2012).

BSCH -107L: PHYSICS LAB-I

M. Marks: 100 (75+25)

LABORATORY EXPERIMENTS / PRACTICAL COURSE

1. To find the least count of vernier caliper, Travelling microscope and screw.
2. To find the thickness of a given slab using and diameter of a wire using vernier caliper and screw gauge.
3. To study the random error in observations.
4. To determine the height of a building using a Sextant.
5. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
6. To plot a graph between the distances of the knife edges from the centre of gravity and the time period of a compound pendulum from the graph find:

   (a) The acceleration due to gravity.

   (b) The radius of gyration & moment of inertia.
7. To determine the value of g using Kater's Pendulum.
8. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

Recommended Textbooks

1. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

B. Sc. (Honours School) Chemistry

SEMESTER: II

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-201	Atomic Structure & Chemical Bonding	3	1	-	4	25	75
BSCH-202	Chemical Thermodynamics & equilibrium	3	1	-	4	25	75
BSCH-203	Physics-II	3	1	-	4	25	75
BSCH-204 A (N. Med.) BSCH-204 B (Med.)	Mathematics-II	3	1	-	4	25	75
BSCH-205	Punjabi	2	-	-	2	25	75
BSCH-206L	Chemistry Lab-II **Inorganic & Physical Chemistry Lab**	-	-	4	2	25	75
BSCH-207L	General Elective II Lab **Physics Lab**	-	-	4	2	25	75
	TOTAL	17	5	12	22	175	525

BSCH-201: Atomic Structure & Chemical Bonding **(45 Hrs.)**

M. Marks: 100 (75+25)

UNIT - I **(20 Hrs.)**

Atomic Structure: Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of s, p, d and f orbitals. Contour boundary and probability diagrams Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number

Periodicity of Elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-block:

(a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table.

(b) Atomic radii (van der Waals)

(c) Ionic and crystal radii.

(d) Covalent radii (octahedral and tetrahedral)

(e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy

(f) Electron gain enthalpy, trends of electron gain enthalpy

(g) Electronegativity, Pauling's/ Mulliken's/ Allred Rachow's/ and Mulliken-Jaffe's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity. Sanderson's electron density ratio

Unit - II **(25 Hrs.)**

Chemical Bonding-I:

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy. Madelung constant, Born-Haber cycle and its application, Solvation energy Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors an insulators, defects in solids Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process

Chemical bonding-II: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair

repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, σ bond and π bond, multiple bonding Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference.

SUGGESTED BOOKS

1. Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
2. Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
3. Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
4. Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

BSCH-202: Chemical Thermodynamics & Equilibrium **(45 Hrs.)**

M. Marks: 100 (75+25)

UNIT - I (25 Hrs.)

Thermodynamics-I: Definition of Thermodynamic terms: system, surrounding etc. Intensive and extensive variables; state and path functions; isolated, closed and open systems. **First law:** Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions, Joule-Thomson Effect, Zeroth law of Thermodynamics.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature, Hess's law and its applications.

Thermodynamics-II: Second Law: Limitations of first law and need for second law, Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes, entropy as a criteria of spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases.

Third Law of Thermodynamics: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules. Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

UNIT - II (20 Hrs.)

Chemical Equilibrium: Criteria of thermodynamic equilibrium, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants Kp, Kc and Kx. Le Chatelier principle (quantitative treatment); Law of mass action, Le-Chatelier Principle and its applications to physical equilibria.

Solutions and Colligative Properties: Binary liquid solutions and its important terms (molarity, molality, mole-fraction, normality), Raoult's law, ideal and non-ideal solutions, lowering of vapour pressure, Raoult's and Henry's Laws and their applications.

Partial molar properties: Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

SUGGESTED BOOKS

1. Peter, A. & Paula, J. de. *Physical Chemistry* 9^{th} *Ed.*, Oxford University Press (2011).
2. Castellan, G. W. *Physical Chemistry* 4^{th} *Ed.*, Narosa (2004).
3. Engel, T. & Reid, P. *Physical Chemistry* 3^{rd} *Ed.*, Prentice-Hall (2012).
4. McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
5. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S.
6. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
7. Levine, I .N. *Physical Chemistry* 6 Ed., Tata Mc Graw Hill (2010).

B. Sc. (Honours School) Chemistry

BSCH-203: Physics - II **(Waves and Optics)** **(45 Hrs.)**

M. Marks: 100 (75+25)

UNIT-I (22 Hrs.)

Superposition of Collinear Harmonic Oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N-collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Wave Motion: Plane and Spherical Waves. Transverse and longitudinal waves Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Gravity Waves

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

UNIT-II (23 Hrs.)

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Interference: Division of amplitude and wavefront. Young's double slit experiment. Phase change on reflection: Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Michelson & Febry-Perot Interferometer.

Diffraction: Introduction, Division of amplitude and division of wavefront. Single slit diffraction. Diffraction grating. Resolving power of grating.

Fresnel diffraction: Fresnel's Half-Period Zones for Plane Wave, Theory of a Zone Plate: Comparison of a Zone plate with a Convex lens. Fresnel diffraction pattern due to (1) a straight edge and (2) a rectangular aperture (slit), and (3) an opaque circular disc.

Recommended Textbooks

- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill.
- Principles of Optics, Max Born and Emil Wolf, 7th Edn.1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill.
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

BSCH-204 B (Medical) MATHEMATICS – II **(45 lectures)**

M. Marks: 100 (75+25)

Unit-I **(**23 Hrs)

Differential Calculus: Lagrange's Mean Value Theorem, Cauchy Mean Value Theorem and General Mean Value Theorem. Taylor's and Maclaurin's series. Successive differentiation. Leibnitz's rule and its applications.

Vector Differential Calculus: Ordinary and partial derivatives of vector function. Gradient of scalar field and physical interpretation. Directional derivatives. Divergence and Curl of a vector function and their physical interpretation. Del and Laplacian operators.

Unit-II **(**22 Hrs)

Vector Integral Calculus: Ordinary Integrals of vectors. Line Integral. Work done by force. Surface integral. Volume integrals. Gauss's Divergence theorem (proof only), Green's theorem, Stokes' theorem and their applications.

Ordinary Differential Equations of First Order: Order and degree of a differential equation. Solution of first order ODE: Integrating factor method, Variable separable method, Homogeneous differential equations, Equations reducible to homogeneous differential equations. Bernoulli's equation. Exact differential equations. Orthogonal trajectories.

Recommended books

1. R.K. Jain, S.R.K. Iyengar: Advanced Engineering Mathematics. Narosa Publishing House (2014).
2. B. S. Grewal: Higher Engineering Mathematics: Khanna Publishers 40th Ed.
3. H. K. Dass: Mathematical Physics. S. Chand Publication, 6th Ed. 2011.
4. Murray Spiegel and Seymour Lipschutz: Schaum's Outline of Vector Analysis: (McGraw-Hill, 2009).
5. Richard Bronson: Schaum's Outline of Theory and Problems of Differential Equations. McGraw-Hill, 1994.

B. Sc. (Honours School) Chemistry

BSCH-204 B (Medical) MATHEMATICS – II **(45 lectures)**

M. Marks: 100 (75+25)

Unit-I **(**24 Hrs)

Function, Limit and Continuity: Functions and graphs, Domain and Co-Domain, range, Inverse Functions, Exponential and Logarithmic Functions, limit of Functions, Algebraic Computations of limits, Continuity of Functions at a point, Continuity of Functions in interval.

Differential Calculus I: An Introduction to the Derivative, Differentiation of standard Functions, Formulae on derivative of sum, difference, product and quotient of functions, chain rule.

Differential Calculus II: Derivative of Trigonometric functions, Inverse Trigonometric functions, Exponential and Logarithmic Functions, Differentiation of implicit functions, Derivative of functions expressed in parametric form, derivative of higher order, Increasing and decreasing functions, Sign of derivative, Maxima and Minima of a single variable. Partial differentiation. Homogeneous function, Euler's theorem of homogeneous function.

Unit-II **(2**1 Hrs)

Ordinary Differential equations: Leibnitz linear equations, exact equation, linear differential equation of higher order with constant coefficients, Method of variation of parameters.

Integral Calculus: Integration as inverse of differentiation, Integration by substitution, by partial fractions and Integration by parts, Definite Integral and its properties. Areas of bounded regions, the definition of integral of real value functions of real variable as a limit of sum motivated by determination of area.

Recommended Books:

1. NCERT, Mathematics text book for class 11th and 12th.
2. Narayan, S., Mittal, P. K.: Differential Calculus, S. Chand & Co., 2005.
3. Narayan, S., Mittal, P. K.: Integral Calculus, S. Chand & Co., 2005.
4. Grewal, B. S.: Elementary Engineering Mathematics. Khanna Publishers, 15th Ed.
5. Dence, J. B.: Mathematical Techniques in Chemistry, Wiley, 1975.

BSCH-206L Chemistry Lab-III (Inorganic Chemistry)

Time: 8 Hours/week MM: 100(25+75)

I. Qualitative Analysis

Analysis of inorganic mixture for acidic and basic radicals including interfering radicals like Phosphate, Tartrate, oxalate and similar radicals

II. Gravimetric Methods

1. To estimation of Barium as Barium sulphate in the solution of Barium chloride.
2. To estimate Nickel as nickel dimethylglyoxime complex in nickel salt solution.
3. To estimate lead as lead chromate in the given solution of lead nitrate.
4. Estimation of Chromium (III) as its Lead Chromate.
5. To estimate ferrous as ferric oxide in a solution of ferrous ammonium sulphate.
6. Estimation of Cu^{2+} using Ammonium/Sodium Thiocyanate.

SUGGESTED BOOKS

1. Svehla, G & Sivasankar, B. Vogel's Qualitative Inorganic Analysis.
2. Agarwala, S. K.; Lal, K. Advanced Inorganic Analysis.

BSCH-206L Chemistry Lab-IV (Physical Chemistry Lab)

Time: 6 Hours/week MM: 100

I. Viscosity measurements

1. To determine the coefficient of viscosity of a given liquid by Ostwald's viscometer.
2. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.
3. Study the variation of viscosity of sucrose solution with the concentration of solute.
4. To determine the viscosity of different mixtures of benzene and nitrobenzene, (i) Test the validity of J. Kendall's equation and; (ii) determine the composition of mixture of the two liquids.
5. Determination of molecular weight of high polymer by viscosity measurements.
6. To study the variation of viscosity of a liquid with temperature.
7. To study the variation of viscosity with composition of mixture of liquids.

II. Surface tension measurement

8. Determination of surface tension of a given liquid by drop number method using Stalagmometer.
9. To determine the unknown composition of a given mixture of two liquids by surface tension measurements.
10. To determine the critical micelle concentration of a soap (sodium laureate) by surface tension measurements.
11. Determination of surface tension of a given liquid by drop weight method.
12. Determination of surface tension of a mixture of two miscible liquids and hence the parachor of the mixture.

VII. pH Metry

13. To determine the strength of given acid pH metrically.
14. To determine the pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of the acid.
15. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.
16. Preparation of buffer solutions of different pH
    i. Sodium acetate-acetic acid
    ii. Ammonium chloride-ammonium hydroxide
17. pH metric titration of
    (i) strong acid vs. strong base
    (ii) weak acid vs. strong base.
18. Determination of dissociation constant of a weak acid.

SUGGESTED BOOKS

1. Vogel's Quantitative Chemical Analysis, J. Mendham, Pearson Education, 2009.
2. Vogels Qualitative Inorganic Analysis, G. Svehla, Pearson Education, 2012.
3. Experiments in Applied Chemistry, Sunita Rattan, S. K. Kataria & Sons, 2012.

4. Advanced Practical Physical Chemistry, J. B. Yadav, Krishna Prakashan Media (P) Ltd., 2012.
5. Khosla, B. D.; Garg, V. C.; Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
6. Garland, C. W.; Nibler, J. W.; Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
7. Halpern, A. M.; McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W. H. Freeman & Co.: New York (2003).

BSCH-207L Physics Lab-II (Physical Chemistry Lab)

LABORATORY EXPERIMENTS / PRACTICAL COURSE

1. To determine the velocity of ultrasonic waves in organic liquid.

2. Find the frequency of A.C. mains using electrical vibrator.

3. To determine the frequency of tuning fork using sonometer.

4. To determine the frequency of A. C. mains using a sonometer & an electromagnet.

5. To investigate the motion of coupled oscillators.

6. To study Lissajous Figures.

7. To determine the specific rotation of sugar using Laurent's half-shade polarimeter.

8. To plot a graph between the concentration and rotation for various strengths of sugar solution and hence find the (a) specific rotation and (b) concentration of the given sugar solution

B. Sc. (Honours School) Chemistry
SEMESTER: III

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-301	s and p Block Elements	3	1	-	4	25	75
BSCH-302	Organic Functional Groups-I	3	1	-	4	25	75
BSCH-303	Physics-III	3	1	-	4	25	75
BSCH-304 A (N. Med.) BSCH-304 B (Med.)	Mathematics-III	3	1	-	4	25	75
BSCH-305	Phase Equilibria & Chemical Kinetics	3	1	-	4	25	75
BSCH-306	SEC-1	2	-	-	2	15	35
BSCH-307L	Chemistry Lab-V Organic and Physical Chemistry Lab	-	-	4	2	25	75
BSCH-308L	General Elective III Lab (Physics Lab)	-	-	4	2	25	75
	TOTAL	17	5	8	26	190	560

B. Sc. (Honours School) Chemistry

BSCH-301: s and p Block Elements

(45 Hrs.)
M. Marks: 100 (75+25)

UNIT- I **(22 Hrs.)**

Chemistry of Group 1 and 2 Elements: Comparative study, Diagonal relationships, salient features of hydrides, solvation and complexation tendencies, comparison of solubility products of hydroxides and sulphates, Role of Na^+, K^+, Mg^{2+} and Ca^{2+} in biosystems. Hydrides and their classification-ionic, covalent and interstitial. Structure and bonding in basic beryllium acetate and nitrate.

Chemistry of Group 13, 14 and 15 Elements: Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of *p* block elements.

Study of the compounds with emphasis on structure, bonding, preparation, properties and uses: Boric acid and borates, boron nitrides, borohydrides (diborane) and graphitic compounds, silanes, Oxides and oxoacids of nitrogen and phosphorus.

Unit II **(23 Hrs.)**

Chemistry of Group 16 and 17 Elements

Study of the compounds with emphasis on structure, bonding, preparation, properties and uses: Oxides and oxoacids of chlorine, Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

Chemistry of Group 18 Elements

Occurrence and uses, rationalization of inertness of noble gases, Clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Structure and shape of xenon compounds: XeF_2, XeF_4, XeF_6, $XeOF_2$, $XeOF_4$, XeO_2F_2, XeO_2F_4.

Inorganic Polymers: Types of inorganic polymers, comparison with organic polymers; Synthesis, structural aspects and applications of silicones and siloxanes, Borazines, silicates and polysulphates.

Acids and Bases: Bronsted-Lowry concept, Lux-flood concept, Solvent-system concept of acid-base reactions; solvated proton, Relative strength of acids and bases; types of acid-base reactions, levelling solvents, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB) Application of HSAB principle,

SUGGESTED BOOKS

1. Lee, J.D. *Concise Inorganic Chemistry*, ELBS, 1991.
2. Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
3. Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth-Heinemann. 1997.
4. Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, VCH, 1999.
5. Miessler, G. L. & Donald, A. Tarr. *Inorganic Chemistry 4th Ed.*, Pearson, 2010.
6. Shriver & Atkins, *Inorganic Chemistry 5th Ed.*

BSCH-302: Organic Functional Groups-I **(45 Hrs.)**

M. Marks: 100 (75+25)

Unit I **(20 Hrs.)**

Arenes and Aromaticity: Nomenclature of benzene derivatives. The aryl group. Aromatic nucleus and side chain. Structure of benzene: Molecular formula and Kekule structure. Stability and carbon-carbon bond lengths of benzene, resonance structure, MO picture.

Aromaticity: The Huckel rule, aromatic ions, Aromatic electrophilic substitution -general pattern of mechanism, role of sigma and pi complexes. Mechanism of nitration, halogenation, sulphonation, mercuration and Friedel-Crafts reaction. Activating and deactivating substituents, orientation and ortho/para ratio. Side chain reactions of benzene derivatives. Birch reduction. Methods of formation and chemical reactions of alkylbenzenes, alkynylbenzenes and biphenyl.

Polynuclear Compounds: Reactions of naphthalene, phenanthrene and anthracene, Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene;

Alkyl and Aryl Halides: Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms of nuclephilic substitution reactions of alkyl halides, SN2, SN1 and SNi reactions with energy profile diagrams. Polyhalogen compounds: chloroform, carbon tetrachloride.

Aryl Halides: Methods of formation of aryl halides, nuclear and side chain reactions. nucleophilic aromatic substitution; SNAr, Benzyne mechanism; Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions. Synthesis and uses of DDT and BHC.

Unit II **(25 Hrs.)**

Alcohols and Phenols: preparation, properties and relative reactivity of 1º, 2º, 3º alcohols, Bouvaelt-Blanc Reduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, Pinacol-Pinacolone rearrangement;

Phenols: Preparation and properties; Acidity and factors effecting it, Ring substitution reactions, Reimer-Tiemann and Kolbe-Schmidt Reactions, Fries and Claisen rearrangements with mechanism.

Ethers, Epoxides and Sulphides: Nomenclature of ethers, epoxides and sulphides. Structure and bonding in ethers and epoxides. Physical properties of ethers, Preparation of ethers. The Williamson synthesis, Acid catalyzed cleavage of ethers. Preparation of epoxides, Conversion of vicinal halohydrins to epoxides, Reactions of epoxides: Nucleophilic ring opening, acid-catalyzed ring opening. Ziesel's method. Reactions of Grignard and organolithium reagents with epoxides.

Sulphur containing compounds: Preparation and reactions of thiols, thio ethers and sulphonic acids, Preparation of sulphides, oxidation and alkylation of sulphides. Cleavage and autoxidation.

SUGGESTED BOOKS

1. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.

BSCH-303: Physics-III **(Thermal Physics)**

(45 lectures)

B. Sc. (Honours School) Chemistry

M. Marks: 100 (75+25)

UNIT – I (22 Lectures)

Kinetic Theory of Gases: Basic assumptions of kinetic theory of gases. Kinetic interpretation of temperature. Degrees of freedom. Law of equipartition of energy. Maxwell-Boltzmann distribution law of molecular speeds and useful deductions: average speed, most probable speed, root mean square speed of molecules. Experimental Verification of Maxwell's distribution law.

Molecular Collisions: Mean free path, Zeroth order approximation: expression for mean free path. Collision probability. Transport phenomena in ideal gases: viscosity, thermal conductivity, diffusion and Brownian motion.

Zeroth and First Law of Thermodynamics: Thermodynamical system: state of system and Thermodynamical variables. Concept of thermodynamical equilibrium. Zeroth law of thermodynamics and concept of Thermal equilibrium. The internal energy and differential form of first law of thermodynamics. Work Done during Isothermal expansion and Adiabatic expansion. Specific heats of gases. Compressibility and Coefficient of expansivity.

UNIT – II (23 Lectures)

Entropy and Second Law of Thermodynamics: Kelvin-Planck and Clausius statements of second law of thermodynamics. Heat engines and Carnot's cycle. The efficiency of Carnot's heat engine. Carnot's cycle as refrigerator. Definition of Entropy. Reversible and Irreversible processes. The Clausius inequality. Thermodynamic potentials: Internal energy U, Enthalpy H, Free energy A, and Gibb's free energy G. Derivation of four Maxwell's relations. The TdS equations. The heat energy equations.

Behavior of Real Gases: Van der Waal's Equation of State (EOS) for Real Gases. Virial coefficients. Limitations of Van der Waal's EOS. Critical constants. Phase transition phenomena: First and second order phase transitions.

Cooling of gases: Adiabatic cooling. Joule –Thomson expansion for ideal and real gases. Joule-Kelvin coefficient. Cooling by adiabatic demagnetization. The third law of thermodynamics.

SUGGESTED BOOKS

1. Thermal Physics: S. C. Garg, R. M. Bansal and C. K. Ghosh, Tata McGraw-Hill (1993).
2. Statistical Physics, Thermodynamics & Kinetic Theory: V. S. Bhatia, Vishal Publishing Co., Jalandhar (2012).
3. Heat and Thermodynamics: Mark W. Zemansky and Richard H. Dittman, McGraw-Hill (7^{th} Edition, 2007).

B. Sc. (Honours School) Chemistry

BSCH-304A (Non-medical)- MATHEMATICS – III **(45 lectures)**

M. Marks: 100 (75+25)

UNIT-I

Laplace Transforms: Existence condition, Laplace transform of standard functions. Properties of L.T.s Convolution theorem. Change of scale Theorem. Shifting Theorem. Inverse Laplace transform of functions using partial fractions. L.T. of unit step function, Periodic function and Dirac Delta function.

Fourier Series: Euler's Formulae. Fourier expansion of periodic function and determination of Fourier coefficients. Fourier expansion of even and odd functions. Half range series.

Fourier Transform: Fourier Integral Theorem and Fourier Transform. Fourier Sine and Cosine transforms. Convolution theorem. Properties of Fourier transform: translation, change of scale, complex conjugation etc.

UNIT-II

Partial Differential Equation: Solution to linear partial differential equations. Homogeneous partial differential equations with constant coefficients.

Application of partial differential equations: Wave equation and its solution for vibrating string. Heat flow equation in one dimension. Solution by method of separation of variables.

Special Integral Functions: Beta and Gamma Functions and Relation between them. Expression of integrals in terms of Gamma functions. Error Functions (Probability Integral).

Recommended Textbooks

1. Babu Ram: Advanced Engineering Mathematics. Pearson Education (2010).
2. R.K. Jain, S.R.K. Iyengar: Advanced Engineering Mathematics. Narosa Publishing House (2014).
3. E. Kresyzig: Advanced Engineering Mathematics. Jon Wiley & Sons.
4. H. K. Dass: Mathematical Physics. S. Chand Publication, 6th Ed. 2011.

B. Sc. (Honours School) Chemistry

BSCH-304B (Medical)- MATHEMATICS – III **(45 lectures)**

M. Marks: 100 (75+25)

Unit I **2**1 Hrs

Matrices, algebra of matrices, types of matrices, elementary operations on matrices, inverse of a matrix, Determinant, Properties of Determinant, Application of matrices of system of linear (both homogenous and non-homogenous) equations.

Row rank, column rank, Rank of a matrix, row rank, column rank, Gauss-Jordan method, Normal form of vectors.

Unit II 24 Hrs

Eigen values and eigen vectors of a matrix, algebraic and geometric multiplicity of an eigen value and eigen vectors, Cayley-Hamilton theorem and its application to find the inverse of a matrix.

Conjugate of a matrix, some special types of matrices and their eigen values: symmetric, skew-symmetric, Hermitian, skew-Hermitian, unitary and orthogonal matrices, diagonalization of a matrix, similar matrices.

Text Books

1. Narayan, S., Mittal, P. K.: A textbook of Matrices, S. Chand & Company Ltd. Edition, 2001.
2. Seymour, L., Marc, L. L.: Linear Algebra, Schaum's outline Series, 2013.

Reference Books

3. Datta K. B., Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd., New Delhi, 2000.
4. Bhattacharya P. B. Jain S.K., Nagpaul S. R.: First course in Linear Algebra, Wiley Eastern, New Delhi (1983).
5. Lax. P: Linear Algebra, John Wiley & Sons, New York. Indian, 1997.
6. Hoffman, K., Kunje. R,: Linear Algebra, Prentice-Hall of India, 2nd Edition, 1989.

BSCH-305: Phase Equilibria and Chemical Kinetics **(45 Hrs)**

M. Marks: 100 (75+25)

Unit I (24 Hrs.)

Phase Equilibria: Concept of phases, components and degrees of freedom, Gibbs-Phase rule, derivation of Gibbs Phase Rule, phase diagram for one component systems- water and sulphur system. Phase diagrams for two component system-solid-liquid equilibria, involving simple eutectic Pb-Ag system, desilverisation of lead.

Solid solutions: compound formation with congruent melting points (Mg-Zn and $FeCl_3$-H_2O) and incongruent melting point NaCl-H_2O. Freezing mixtures (acetone-dry ice).

Binary solutions: Gibbs-Duhem equation, Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, lever rule, partial miscibility of liquids (Phenol-water, Triethylamine-water, Nicotine-Water), CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit II (21 Hrs.)

Chemical Kinetics: Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, Half-life time of a reaction, Methods for the determination of the order of a reaction, kinetics of complex reactions (integrated rate expressions up to first order only): (i) parallel reactions and and their differential rate equations (steady-state approximation in reaction mechanisms) (ii) chain reactions. Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates.

Catalysis: Catalysis and general characteristics of catalytic reactions, Homogeneous catalysis, acid-base catalysis, Heterogeneous catalysis, mechanisms of catalyzed reactions at solid surfaces; Enzyme catalysis, Michaelis-Menten mechanism.

Polymers: Polymers and nomenclature of polymers, various types of polymerization, mechanism of polymerization, preparation properties and technical applications of thermo-plastics (PVC,PVA), thermosets (PF, UF), and elastomers (GR-S, GR-A, GR-M), Silicones, Introduction to polymeric composites, Molecular weight of polymer, vulcanization of rubber.

SUGGESTED BOOKS

1. Peter Atkins & Julio De Paula, *Physical Chemistry 9th Ed.,* Oxford University Press (2010).
2. Castellan, G. W. *Physical Chemistry*, 4th Ed., Narosa (2004).
3. McQuarrie, D. A. & Simon, J. D., *Molecular Thermodynamics*, Viva Books Pvt. Ltd.: New Delhi (2004).
4. Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).

BSCH-307L: CHEMISTRY LAB-V **(Organic and Physical Chemistry Lab)**
M. Marks: 100 (75+25)

I. Elemental detection

1. Test for elements (other than C, H, O)

II. Qualitative Analysis (Functional group and Melting point determination)

2. To perform qualitative analysis of single organic compound (hydrocarbons, aldehydes, ketones, phenols, carboxylic acids/derivatives, amines, amides, nitro compounds and carbohydrates).

III. Thermochemistry

1. Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).
2. Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Calculation of the enthalpy of ionization of ethanoic acid.
4. Determination of enthalpy of hydration of copper sulphate.
5. Study of the solubility of benzoic acid in water and determination of ΔH.
6. Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.
7. Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.
8. Determination of heat of neutralization of sulphuric acid using Dewar flask
9. Determination of heat of ionization of weak base calorimetrically.
10. Determination of heat of neutralization of two acids and hence their relative strength.

IV. Phase equilibrium / Distribution law

19. To determine the distribution coefficient of Iodine (I_2) between CCl_4 and water.
20. To determine the distribution coefficient of benzoic acid between benzene and water hence shows that benzoic acid dimerises in benzene.
21. To determine the equilibrium constant of the reaction $KI + I_2 = KI_3$by distribution method.
22. To determine the mutual solubility curve of phenol and water and hence the consolute point.
23. To determine the critical solution temperature of phenol and water in presence of (i) 1% NaCl; (ii) 0.5 % naphthalene; (iii) 1 5 succinic acid.

SUGGESTED BOOKS

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).
3. Experiments in Applied Chemistry, Sunita Rattan, S. K. Kataria& Sons, 2012.
4. Advanced Practical Physical Chemistry, J. B. Yadav, Krishna Prakashan Media (P) Ltd., 2012.

BSCH-308-L **Title: Physics Lab-III**

LABORATORY EXPERIMENTS / PRACTICAL COURSE

1. To study Hall Effect & to determine the (1) Hall Voltage V_H (2) Hall Coefficient $R_{H.}$
2. Find the frequency of A.C. mains using electrical vibrator.
3. To study the variation of magnetic field with distance along the axis of circular coil Carrying Current.
4. To plot a graph between current & frequency in a series L.C.R circuit & to find the resonant frequency.

a. (a)to find the quality factor & band width.

5. To plot a graph between current and frequency in a parallel L.C.R circuit and find the resonant frequency.
6. To determine the frequency of tuning fork using sonometer.
7. To determine the frequency of A. C. mains using a sonometer& an electromagnet.
8. To find the low resistance using a Carey-Foster bridge without calibrating the bridge wire.

B. Sc. (Honour School) Chemistry

SEMESTER: IV

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-401	d and f block elements	3	1	-	4	25	75
BSCH-402	Organic Functional Groups-II	3	1	-	4	25	75
BSCH-403	Physics-IV	3	1	-	4	25	75
BSCH-404 A (N. Med.) BSCH-404 B (Med.)	Mathematics-IV	3	1	-	4	25	75
BSCH-405	Electrochemistry	3	1	-	4	25	75
BSCH-406	SEC 2	2			2	15	35
BSCH-407L	Chemistry Lab-VI **Inorganic and Organic Chemistry Lab**	-	-	4	2	25	75
BSCH-408L	General Elective lab IV (Physics Lab)	-	-	4	2	25	75
	TOTAL	17	5	8	26	190	560

BSCH-401: d and f block elements **(45 Hrs.)**

M. Marks: 100 (75+25)

Unit I **(20 Hrs.)**

Chemistry of Ist row d block elements Definition of d-block elements, electronic configuration of atoms and ions, general characteristic properties of transition elements: atomic radii, ionic radii, density, melting and boiling point, ionisation energy, reducing character, metallic character, reactivity, oxidation states, formation of colored ions, magnetic properties, tendency to form complexes, formation of interstitial compounds, catalytic properties, alloy formation. Compound and complexes: aqueous chemistry and complexes of Ti(III). Isolation of Cr from its chromite ore. Chemistry of Chromium(II); binuclear compounds, Chemistry of Cr(III) complexes; Chemistry of Cr (VI) chromates, Dichromates and peroxo complexes of Cr(IV), Cr(V) and Cr(V).Chemistry of Mn (II) and Mn (III) complexes.

Chemistry of 2nd and 3rd row d block elements: Comparison of the chemistry of elements of second and third row series with that of elements of first transition series. Aqueous chemistry of Zr(IV), Chemistry of Nb(V). Dinitrogen complexes of molybdenum. Mo-Mo and Re-Re quadrupole bonds, Chemistry of complexes of Rh(III), Pt(II) and Pd(II).

Unit II **(25 Hrs.)**

Lanthanides: General characteristics of lanthanides: electronic structure and position, physical properties, oxidation states, color and spectral properties, magnetic properties, lanthanide contraction, similarity among lanthanides, basic differences, reactivity of lanthanides, solubility of compounds, tendency to form complexes, double salt formation; extraction of lanthanide from monazite; Isolation of lanthanides; Compound of lanthanides: oxides, hydroxides, halides, nitrides, oxosalts, double salts of lanthanides.

Actinides: Electronic configuration, Chemistry of thorium and uranium

Bioinorganic Chemistry: Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

SUGGESTED BOOKS

1. Purcell, K.F & Kotz, J.C. Inorganic Chemistry W.B. Saunders Co, 1977.
2. Huheey, J.E., Inorganic Chemistry, Prentice Hall, 1993.
3. Lippard, S.J. & Berg, J.M. Principles of Bioinorganic Chemistry Panima Publishing Company 1994.
4. Cotton, F.A. & Wilkinson, G, Advanced Inorganic Chemistry. Wiley-VCH, 1999
5. Basolo, F, and Pearson, R.C., Mechanisms of Inorganic Chemistry, John Wiley & Sons, NY, 1967.
6. Greenwood, N. N. & Earnshaw A., Chemistry of the Elements, Butterworth Heinemann, 1997.

BSCH-402: Organic Functional Groups-II **(45 Hrs.)**
M. Marks: 100 (75+25)

Unit I (25Hrs.)

Carbonyl Compounds: Structure, reactivity and preparation; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil-Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α-substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV, PDC and PGC); Addition reactions of unsaturated carbonyl compounds: Michael addition. Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate

Carboxylic Acids and their Derivatives: Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: with special reference to lactic, malic and fumaric acids;
Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann bromamide degradation and Curtius rearrangement.

Unit II (20 Hrs.)

Nitrogen Containing Functional Groups: Preparation and important reactions of nitro and compounds, nitriles and isonitriles, Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1º, 2º and 3º amines with Hinsberg reagent and nitrous acid.
Diazonium Salts: Preparation and their synthetic applications.

Heterocyclic Compounds
Classification and nomenclature, Structure, aromaticity in 5- membered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis, Hantzsch synthesis), Thiophene, Pyridine (Hantzsch synthesis), Pyrimidine, Indole (Fischer indole synthesis and Madelung synthesis)
Structure elucidation and reactions of Furan derivatives namely Furfural and Furoic acid. Structure elucidation of Quinoline and Isoquinoline, Skraup synthesis

SUGGESTED BOOKS

1. Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education)
4. Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
5. Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, JohnWelly& Sons (1976).
6. Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
7. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
8. Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PrajatiParakashan (2010).

BSCH-403: PHYSICS-IV **(Electricity and Magnetism)**

(45 lectures)
M. Marks: 100 (75+25)

Unit-I

Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

Electrostatic energy of system of charges: Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor.

Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

Unit-II

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity **(H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis.

Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Reference Books:

1. Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill.
2. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
3. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.

4. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education.
5. Elements of Electromagnetics, M. N.O. Sadiku, 2010, Oxford University Press.
6. Electricity and Magnetism, J. H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.

BSCH-404 A (Non-medical) MATHEMATICS – IV

Theory-4
(45 lectures)
M. Marks: 100 (75+25)

UNIT-I **22 hours**

Concepts in probability and important definitions (*viz.* Event, trials, sample space, mutually exclusive events). Baye's theorem and its applications. Discrete and continuous random variables. Conditional probability. Probability mass function. Probability density function. Cumulative distribution function.

Mathematical expectation: statistical expectation value, expectation value of random variable. Properties of expectations, variance and covariance. Distribution functions: Discrete and continuous. Probability distribution functions. Binomial and Poisson distributions: their mean and variance. Normal distribution: Important properties of bell shaped normal distribution curve.

UNIT-II **23 hours**

Correlation and Regression: Relation between covariance and correlation. Karl Pearson's coefficient of correlation and Spearman's rank correlation coefficient. Linear regression for two variables: Properties of regression coefficient.

Tests of significance: t-tests for single mean and for the difference of means, paired t-test for difference of means, F-test for equality of two population variances. Chi –square test for goodness of fit and independence of attributes.

Recommended Textbooks

1. Ronald E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye: Probability and Statistics for Engineers and Scientists. Pearson Education India(8th Edition, 2007).
2. S. C. Gupta and V. K. Kapoor: Fundamentals of Mathematical Statistics. S. Chand & Sons (2012).
3. A. M. Goon, B. Dasgupta, M. K. Gupta: Fundamentals of Statistics: Vol. 1. World Press Private Ltd. 1968
4. P. L. Meyer: Introductory Probability and Statistical Applications. Addison Wesley (1970).

BSCH-404 B (Medical) MATHEMATICS – IV

Theory-4
(45 lectures)
M. Marks: 100 (75+25)

UNIT I **22** Hrs

Important concepts in probability: experiment, trial, sample point and sample space, definition of an event, mutually exclusive, exhaustive, independent and equally likely events, conditional probability, Bayes theorem and its applications.

Random Variable**:** definition of discrete random variable, probability mass function, continuous random variable, probability density function, probability distribution function, discrete and continuous probability distributions: Binomial, Poisson and Normal, basic properties of the distributions and their applications, fitting of Binomial and Poisson distributions, curve fitting by method of least squares.

UNIT II **23** Hrs

Statistics: variable, frequency, discrete and continuous frequency distributions, measures of Central tendency: mean, median, mode, harmonic mean, geometric mean, measures of dispersion: range, quartile deviation, mean deviation, standard deviation, coefficient of variation, moments, measures of skewness and kurtosis.

Sampling and Testing of Hypothesis : population, sampling, parameter, statistic, sampling distribution, standard error, null hypothesis, alternate hypothesis, errors in sampling: type-I, type-II , level of significance, critical region, degree of freedom, large sample tests, small sample tests: Student's t-test , Chi-square test for goodness of fit and independence of attributes, F-test or variance ratio test.

Text Books

1. Gupta, S.C. and Kapoor, V. K., Fundamental of Mathematical Statistics, S. Chand and Sons, 2012.
2. Meyer P. L.: Introductory Probability and Statistical Applications, Addison-Wesley, 1970.

Reference Books

1. Goon A. M., Gupta M. K., Dasgupta B.: Fundamental of Statistics, Vol. I, World Press, Calcutta, 1999.
2. Mood A. M., Graybill F. A., Boes D. C.: Introduction to the Theory of Statistics, McGraw Hill, 1974.

BSCH-405: Electrochemistry **(45 Hrs.)**
M. Marks: 100 (75+25)

Unit I **(23 Hrs.)**

Conductance I: Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Huckel-Onsager equation.

Conductance II: Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Electrochemistry I: Rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells.

Electrochemistry II: Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers.Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Unit II **(22 Hrs.)**

Polarography: Principle, residual, Migration, diffusion currents, limiting current, polarographic maximum, Polarogram, concentration polarization, advantages and disadvantages of D.M.E. Reversible & irreversible processes, fundamental equation of polarographic wave. Ilkovic equation half-wave potential, AC polarography, rapid scan polarography, Pulse polarography, Applications of Polarography.

Electroanalytical methods: General principle, Reference electrodes (Calomel, Ag/AgCl Reference electrode), Indicator electrodes, Basic theory and principle of cyclic voltammetry, Potentiometry, Chronopotentiometry, Electrogravimetry.

SUGGESTED BOOKS

1. Atkins, P.W. & Paula, J. D. Physical Chemistry, 9th Ed., Oxford University Press (2011).

2. Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
3. Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: Noida, UP (2009).
4. Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006).
5. Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
6. Rogers, D. W. Concise Physical Chemistry Wiley (2010).
7. Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).

BSCH-407L: Chemistry Lab-VI **(Inorganic and Organic Chemistry)**

Time: 8 Hours/week MM: 100 (25+75)

I. Complexometric Titrations

1. Prepare M/20 magnesium salt standard solution and find out the strength of supplied of the magnesium ion solution using EDTA as an intermediate solution.
2. To determine the temporary and permanent hardness of water sample by Complexometric titration.
3. Determination of Cu^{2+} and Ni^{2+} by using Masking Reagent by EDTA titration.
4. Determination of Ni^{2+} (Back Titration)
5. Determination of Ca^{2+}(Substitution Method)

II. Iodometric-Iodimetric Titrations

6. Prepare N/20 Potassium dichromate standard solution and find out the strength of supplied Potassium dichromate solution using sodium thiosulphate solution as an intermediate solution.
7. To determine the percentage of available chlorine in a sample of bleaching powder.
8. Prepare N/20 arsenious oxide standard solution and find out the strength of supplied arsenious oxide solution using iodine solution as an intermediate solution.
9. To estimate the percentage purity of the given sample of sodium sulphite using iodine and 0.1 N sodium thiosulphate solution.
10. Prepare N/20 I_2 standard solution and find out the strength of supplied I_2 solution using Sodium Thiosulphate as an intermediate solution.
11. Prepare N/20 $CuSO_4$ standard solution and find out the strength of supplied $CuSO_4$ solution using Sodium Thiosulphate as an intermediate solution.
12. To determine the percentage of available Cl_2 in given sample of Bleaching powder ($CaOCl_2.H_2O$).

III. **Precipitation titrations**

SUGGESTED BOOKS

1. Vogel's Quantitative Chemical Analysis, J. Mendham, Pearson Education, 2009.
2. Vogel’s Qualitative Inorganic Analysis, G. Svehla, Pearson Education, 2012.

(Organic Chemistry Lab)

I. Aromatic electrophilic substitution

1. Preparation of m-dinitrobenzene from nitrobenzene.
2. Preparation of p-nitroacetanilide from acetanilide.
3. Preparation of p-bromoacetanilide from acetanilide.
4. Preparation of 2,4,6-tribromophenol from phenol
5. Preparation of m-nitroaniline from m-dinitrobenzene.
6. Preparation of benzoic acid from toluene/benzyl chloride.

II. Diazotization/Coupling

7. Preparation of methyl orange and methyl red
8. Preparation of benzoic acid from toluene

III. Reduction

9. Preparation of aniline from nitrobenzene
10. Preparation of m-nitroaniline from m-dinitrobenzene

SUGGESTED BOOKS

1. Vogel A.I., Tatchell A. R., Furnis B.S., Hannaford A.J., Smith P.W.G., Vogel's Text Book of Practical Organic Chemistry,5th Edn., Pubs: ELBS, 1989.
2. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Pubs: Thomson Brooks/Cole,2005.
3. Mann F.G., Saunders. P.C., Practical Organic Chemistry, Pubs: Green& Co. Ltd., London, 1978.

BSCH-408L **Title: Physics Lab-III**

Laboratory Experiments / Practical Course

1. To find the value of Planck's constant and photoelectric work function of the material of the cathode using photoelectric cell.
2. To determine the energy band gap of a semiconductor by using four probe method.
3. To determine the energy band gap of a semiconductor by using P-N junction diode.
4. To study the VI characteristics of a Thermistor.
5. To plot the resistance-temperature characteristics of a thermistor.
6. To find the dielectric constant of a given material.
7. To find the Numerical aperture of an Optical Fiber.
8. To find the curie temperature of a ferromagnetic material.

DSE-1 (Coordination Chemistry)

45 Hrs.
M. Marks: 100 (75+25)

UNIT-I **(25 Hrs.)**

Coordination Chemistry: Chelating ligands and chelates, Werners coordination theory, IUPAC nomenclature of coordination compounds, Effective atomic number (Sidgwick theory), Factors effecting the stability of complex ions, Stereochemistry of complexes with 4 and 6 coordination numbers, Irving William series, Isomerism in coordination compounds.
Valence bond theory (with examples of coordination number 4, 5 and 6) and its limitations, Crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, crystal field stabilization energy of octahedral and tetrahedral complexes, factors effecting crystal field splitting, Qualitative aspect of Ligand field and MO Theory.

Electronic Spectra of Transition Metal Complexes: Types of electronic transition, term symbols and LS (Russell Saunders) coupling, determination of spectroscopic ground state term, Hole formulation (Calculation of number of Microstates) Electronic spectra of transition metal complexes (selection rules for d-d transition), Splitting of Russell-Saunders states in octahedral and tetrahedral crystal fields, coupling scheme, Spectrochemical series, Orgel energy level diagrams of d^1 to d^9 of octahedral and tetrahedral complexes.

UNIT-II **(20 Hrs.)**

Magnetic properties of transition metal complexes: Types of magnetic behaviour shown by transition elements and inner transition elements and their compounds. Measurement of magnetic properties: Gouy's and Faraday's method for measuring magnetic susceptibility, variation of magnetic susceptibility with temperature, orbital contribution to magnetic moment, anomalous magnetic moments.

Thermodynamics and kinetic aspects of transition metal complexes: Thermodynamic stability of complexes, stability constants of complexes, kinetic and thermodynamic stability, factors affecting the stability of complexes, substitution reactions in square planar complexes, mechanism of nucleophilic substitution in square planar complexes, Trans effect, Theories of trans effect.

SUGGESTED BOOKS

1. Cotton F. A., Wilkinson G., Murillo C. A., Bochmann M., Advanced Inorg. Chemistry, 6th edn., Pubs: John Wiley India. (2003).
2. Gupta B. D. and Elias A. J., Basic Organometallic Chemistry. Pubs: University Press (2010)
3. Shriver D. F., Atkins F. W. and Langford C. M., Inorganic Chemistry, 3rd edn., Pubs: Oxford University Press, 1999.
4. Huheey J. E., Keiter E. A., Keiter R. L., Inorganic Chemistry : Principles of Structure and Reactivity; 4th edn, Pubs: Harper Collins, 1993.

DSE-2 Environmental Studies

45 Hrs.
M. Marks: 100 (75+25)

UNIT-I **(23 hrs)**

Introduction: Multidisciplinary nature of environmental studies; Scope and importance; Need for public awareness.

Ecosystem: What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems:

a) Forest ecosystem
b) Grassland ecosystem
c) Desert ecosystem
d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Land resources and land use change; Land degradation, soil erosion and desertification.

Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.

Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state).

Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Levels of biological diversity: genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots

India as a mega-biodiversity nation; Endangered and endemic species of India

Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

UNIT-II **(22 Hrs.)**

Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Nuclear hazards and human health risks;

Solid waste management: Control measures of urban and industrial waste. Pollution case studies. Sustainability and sustainable development, Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Human population growth: Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies.

Disaster management: floods, earthquake, cyclones and landslides. Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan. Environmental ethics: Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness.

SUGGESTED BOOKS

1. Bharucha, E. 2003, Textbook for Environmental Studies, University Grants Commission, New Delhi and Bharati Vidyapeeth Institute of Environmental Education and Research, Pune. 361.
2. Carson, Rachel. 1962. Silent Spring (Boston: Houghton Mifflin, 1962), Mariner Books, 2002
3. Economy, Elizabeth. 2010. The River Runs Black: The Environmental Challenge to China's Future.
4. Gadgil, M. & Ramachandra, G. 1993. *This fissured land: an ecological history of India*. Univ of California Press.
5. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
6. Grumbine, R. Edward, and Pandit, M.K. Threats from India's Himalaya dams. *Science* 339.6115 (2013): 36-37.
7. Heywood V.H. & Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press.
8. McCully, P. 1996. *Silenced rivers: the ecology and politics of large dams*. Zed Books.
9. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
10. Odum, E.P., Odum, H.T. & Andrews, J. 1971. *Fundamentals of Ecology*. Philadelphia: Saunders.

DSE-3: Molecular Spectroscopy

Theory: 45 Lectures
M. Marks: 100 (75+25)

Unit-I

General Features of molecular spectra:
Introduction, Electromagnetic radiation, Regions of the electromagnetic spectrum, Absorption and Emission spectrum, Atomic and molecular spectroscopy, Experimental techniques, Basis of selection rules, Width and intensity of spectral lines, Factor effecting width of spectral lines and intensity of spectral lines, Types of Molecular spectra.

Electronic Spectra:
Types of Electronic transition, Auxochromes and Chromophoros, Factor effecting max and intensity, Spectral lines, effect of solvent on max., Franck-Condon Principle, P, Q and R branches of spectra, Applications of electronic spectroscopy.

Rotational Spectra
Rotational spectra of diatomic molecules, Rigid rotor model, Intensities of spectral lines, Effect of isotopic substitution, Determinations of moments of intertia and bond length, Non-rigid rotor, Applications of rotational spectroscopy, Rotational spectra of polyatomic molecules.

Vibrational Spectra
Classical equation of vibration (Hook's law) of linear molecules, simple harmonic oscillator, vibrational energies of diatomic molecules, zero-point energy, Anharmonic oscillator, Vibrations of polyatomic molecules (H_2O and CO_2), Fundamental frequencies, overtones, combination bands and hot bands of polyatomic molecules, Effect of Various Parameters on the Vibrational Frequency. Applications of vibrational spectra in elucidation of molecular structure from Vibration Frequency.

Vibrational-Rotation Spectra
Selection rules and transitions for the rigid rotor - Harmonic oscillator model, relative intensities, coupling of rotation and vibrations.

Unit-II

Raman Spectroscopy:
Classical and quantum theory of Raman effect, Stokes and Antistokes lines, Pure rotational spectra of linear diatomic molecules. O, Q and S branches of Vibrational Raman spectra, Rotational fine structure in the Vibrational Raman spectra.

Photoelectron spectroscopy. Basic Principles Photoelectric Effect, Ionization Process: Koopman's theorem, photoelectron spectra of simple molecule. Auger electron spectroscopy, Electron microscopy (SEM, TEM), basic principle and applications.

Electron Spin Resonance Spectroscopy: Basis for resonance, experimental techniques, A block diagram of a typical ESR spectrometer, ESR of simple systems and of radical anion of aromatic hydrocarbons, mechanism of hyperfine interaction, Mc Connell's relation of electron delocalisation, zero field splitting and Kramer's degeneracy, Predicting the number of lines in E.S.R. spectra of radicals, factors affecting the Magnitude of the g value, some applications including biological structure determination, double resonance technique in ESR.

SUGGESTED BOOKS

1. C.N. Banwell - *Molecular Spectroscopy*.
2. G.M. Barrow - *Molecular Spectroscopy*.
3. H.S. Randhawa – *Atomic and Molecular Spectroscopy.*(Pearson Education).
4. M. Chander - *Atomic Structure, Chemical bonding including Molecular Spectroscopy*.
5. Chang R., *Basic Principles of Spectroscopy*.

DSE-4 Analytical Methods in Chemistry

(Credits: Theory-02)
Theory: 45 Lectures
M. Marks: 100 (75+25)

Unit-I

Optical methods of analysis:

UV-Visible Spectrometry*:* Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

Unit-II

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle and instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points.

Techniques used for the determination of pKa values.

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique; Mechanism of extraction: extraction by solvation and chelation. Technique of extraction: batch, continuous and counter current extractions. Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.
Development of chromatograms: frontal, elution and displacement methods.
Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

SUGGESTED BOOKS

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. &Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry – Methods of separation.

DSE 5: APPLICATIONS OF COMPUTERS IN CHEMISTRY

Theory: 45 Lectures
M. Marks: 100 (75+25)

UNIT-I **(20 Hrs.)**

Basics I:

Constants, variables, bits, bytes, binary and ASCII formats, arithmetic expressions, hierarchy of operations, inbuilt functions.

Basics II:

Elements of the BASIC language. BASIC keywords and commands. Logical and relative operators. Strings and graphics. Compiled versus interpreted languages. Debugging. Simple programs using these concepts. Matrix addition and multiplication. Statistical analysis.

UNIT-II **(25 Hrs.)**

Numerical methods I:

Roots of equations: Numerical methods for roots of equations: Quadratic formula, iterative method, Newton-Raphson method, Binary bisection and Regula-Falsi.
Differential calculus: Numerical differentiation.
Integral calculus: Numerical integration (Trapezoidal and Simpson's rule), probability distributions and mean values.

Numerical methods II:

Simultaneous equations: Matrix manipulation: addition, multiplication. Gauss-Siedal method.
Interpolation, extrapolation and curve fitting: Handling of experimental data.
Conceptual background of molecular modelling: Potential energy surfaces. Elementary ideas of molecular mechanics and practical MO methods.

SUGGESTED BOOKS:

1. Harris, D. C. *Quantitative Chemical Analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
2. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis*, Cambridge Univ. Press (2001) 487 pages.
3. Noggle, J. H. *Physical chemistry on a Microcomputer*. Little Brown & Co. (1985).
4. Venit, S.M. *Programming in BASIC: Problem solving with structure and style.* Jaico Publishing House: Delhi (1996).

DSE 6: NOVEL INORGANIC SOLIDS

Theory: 45 Lectures
M. Marks: 100 (75+25)

UNIT-I (22 Hrs.)

Synthesis and modification of inorganic solids:
Conventional heat and beat methods, Co-precipitation method, Sol-gel methods, Hydrothermal method, Ion-exchange and Intercalation methods.

Inorganic solids of technological importance:
Solid electrolytes – Cationic, anionic, mixed Inorganic pigments – coloured solids, white and black pigments. Molecular material and fullerides, molecular materials & chemistry – one-dimensional metals, molecular magnets, inorganic liquid crystals.

UNIT-II (23 Hrs.)

Nanomaterials:
Overview of nanostructures and nanomaterials: classification. Preparation of gold and silver metallic nanoparticles, self-assembled nanostructures-control of nanoarchitecture-one dimensional control. Carbon nanotubes and inorganic nanowires. Bio-inorganic nanomaterials, DNA and nanomaterials, natural and antisical nanomaterials, bionano composites.

Speciality polymers:
Conducting polymers - Introduction, conduction mechanism, polyacetylene, polyparaphenylene and polypyrole, applications of conducting polymers, Ion-exchange resins and their applications. Ceramic & Refractory: Introduction, classification, properties, raw materials, manufacturing and applications.

SUGGESTED BOOKS:

1. Shriver & Atkins. Inorganic Chemistry, Peter Alkins, Tina Overton, Jonathan Rourke, Mark Weller and Fraser Armstrong, 5th Edition, Oxford University Press (2011-2012)
2. Adam, D.M. Inorganic Solids: An introduction to concepts in solid-state structural chemistry.
3. Frank J. Ovens, Introduction to Nanotechnology

DSE 7: POLYMER CHEMISTRY

Theory: 45 Lectures
M. Marks: 100 (75+25)

UNIT-I (22 Hrs.)

Introduction and Functionality of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

UNIT-II (23 Hrs.)

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

Nature and structure of polymers-Structure Property relationships.

Determination of molecular weight of polymers (*Mn*, *Mw*, etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Glass transition temperature (Tg).

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties). Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyaniline, poly(p-phenylene sulphidepolypyrrole, polythiophene)].

SUGGESTED BOOKS:

1. *Seymour's Polymer Chemistry,* Marcel Dekker, Inc.
2. G. Odian: Principles of Polymerization, John Wiley.
3. F.W. Billmeyer: Text Book of Polymer Science, John Wiley.
4. P. Ghosh: Polymer Science & Technology, Tata Mcgraw-Hill.
5. R.W. Lenz: Organic Chemistry of Synthetic High Polymers.

DSE 8: RESEARCH METHODOLOGY FOR CHEMISTS

(Credits: Theory-04)
Theory: 45 Lectures
M. Marks: 100 (75+25)

UNIT-I (20 Hrs.)

Literature Survey:

Print: Sources of information: Primary, secondary, tertiary sources; Journals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples.

Information Technology and Library Resources: The Internet and World Wide Web. Internet resources for chemistry. Finding and citing published information.

Methods of Scientific Research and Writing Scientific Papers:

Reporting practical and project work. Writing literature surveys and reviews. Organizing a poster display. Giving an oral presentation. Writing scientific papers – justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.

UNIT-II (25 Hrs.)

Chemical Safety and Ethical Handling of Chemicals:

Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric – safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of explosives, identification, verification and segregation of
laboratory waste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.

Data Analysis

The Investigative Approach: Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments.

Analysis and Presentation of Data: Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals,
General polynomial fitting, linearizing transformations, exponential function fit, *r* and its abuse. Basic aspects of multiple linear regression analysis.

SUGGESTED BOOKS:

1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry*. 2nd Ed. Prentice-Hall, Harlow.
2. Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry*. Oxford University Press.
3. Topping, J. (1984) *Errors of observation and their treatment.* Fourth Ed., Chapman Hall, London.
4. Harris, D. C. *Quantitative chemical analysis*. 6th Ed., Freeman (2007) Chapters 3-5.
5. Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis.* Cambridge Univ. Press (2001) 487 pages.

DSE 9: Green Methods in Chemistry

(45 lectures)
M. Marks: 100 (75+25)

UNIT-I **(20 Hrs.)**

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Principles of Green Chemistry

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/ minimization of hazardous/ toxic products; designing safer chemicals – different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization - careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents designing of biodegradable products; prevention of chemical accidents; strengthening/ development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

UNIT-II **(25 Hrs.)**

Examples of Green Synthesis/ Reactions

Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzole acid), Oxidation (of toluene, alcohols). Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation. Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2- dihydrotriazine derivatives; benzimidazoles. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizaro reaction, Strecker synthesis, Reformatsky reaction.

Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solvent-less reactions; on covalent derivatization; Green chemistry in sustainable development.

SUGGESTED BOOKS

1. V. K. Ahluwalia & M. R. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
2. P. T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
3. A. S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
4. M. C. Cann & M. E. Connely: Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).

DSE 10: INDUSTRIAL CHEMISTRY

(Credits: Theory-04)
Theory: 45 Lectures
M. Marks: 100 (75+25)

UNIT-I (24 Hrs.)

Cement Industry: Classification of cements, Study of raw materials and their availability. Manufacture of Portland cement with construction and working of rotary kiln. Comparison between dry and wet process. Role of gypsum in cement. Setting, hardening and strength characteristics of cement compounds. ISI specifications of Portland cement. Study of special cements like high alumina cements, high early strength (HES) cements and white Portland cement. Decay of cement concrete and its protection. Refractories: Definition, characteristics of a good refractory. Study of raw materials, classification of refractories. Properties and manufacture of refractories in general. Fireclay, silica and alumina refractories. Super refractories, cermets and insulating refractories.

Glass Industry: Definition. Study of raw materials, Manufacture of glass in general by pot and tank furnaces using recuperative/regenerative method. Manufacture of safety glass, toughened glass, laminating glass and glasswool. Manufacture of coloured glass. Composition, Properties and uses of soft glass, hard glass, Lead (Flint) glass, Borosilicate (Pyrex or Jena) glass, Aluminosilicate glass and silica (Vitreosil) glass.

UNIT-II (21 Hrs.)

Some Important Chemicals in lab use:

(a) Nitric acid: Manufacture of ammonia and nitric acid by Ostwald process. Methods to manufacture concentrate nitric acid.

(b) Sulphuric acid: Study of raw materials, Extraction of sulphur by Frasch Process. Manufacture of sulphuric acid by lead chamber and contact process. Concentration of sulphuric acid, Oleum.

(c) Sodium Carbonate: Manufacture by Solvay and modified Solvay Process.

(d) Sodium hydroxide, Chlorine and Hydrochloric acid: Manufacture of sodium hydroxide by causticization process and by electrolysis of brine using mercury electrolytic cell and diaphragm cell.

Industrial Wastes and Treatment: Types and characteristics of industrial wastes. Treatment of industrial wastes with organic and inorganic impurities. Air Pollution: Sources of air pollutants. Classification and effects of air pollutants. Control of air pollutants with reference to oxides of nitrogen and sulphur. Green house effect and its consequences. Ozone layer and its significance. Smog, Acid rain. Industrial Hazards and Safety.

SUGGESTED BOOKS:

1. Austin Heorge T., Shreve's Chemical Process Industries, Pubs: McGrawHill Book Company, New York (1984).

2. Kent James A. (ed.), Keigel's Handbook of Industrial Chemistry, Pubs:VanNostrandinhold Company, London (1983).
3. Buchner V., Sohliebs P., Winter G. & Buchel K.H., Industrial Inorganic Chemistry, Pubs: V. Ch. Publishers, New York (1989).

SEC-1 (BASIC ANALYTICAL CHEMISTRY) **(Credits: 02)**
22 Lectures

Unit-1 **(15 Lectures)**

Introduction: Introduction to Analytical Chemistry and its interdisciplinary nature. Concept of sampling. Importance of accuracy, precision and sources of error in analytical measurements. Presentation of experimental data and results, from the point of view of significant figures.

Analysis of soil: Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.

b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.

b. Determination of dissolved oxygen (DO) of a water sample.

Unit-II **(7 Lectures)**

Chromatography: Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).

b. To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible).

Suggested Applications (Any one):

a. To study the uses of phenolphthalein in trap cases.

b. To analyze arson accelerants.

c. To carry out analysis of gasoline.

SUGGESTED BOOKS:

1. Willard, H. H. *Instrumental Methods of Analysis*, CBS Publishers.
2. Skoog & Lerry. *Instrumental Methods of Analysis*, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
5. Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.
6. Day, R. A. & Underwood, A. L. *Quantitative Analysis*, Prentice Hall of India.
7. Vogel, A. I. *Vogel's Qualitative Inorganic Analysis 7th Ed.,* Prentice Hall.

SEC-2 (ANALYTICAL CLINICAL BIOCHEMISTRY) (Credits: 02)
22 Lectures

Unit-I (15 Lectures)

Basic understanding of the structures, properties and functions of carbohydrates, lipids and proteins:

Carbohydrates*:* Biological importance of carbohydrates, Metabolism, Cellular currency of energy (ATP), Glycolysis, Alcoholic and Lactic acid fermentations, Krebs cycle. Isolation and characterization of polysachharides.

Proteins: Classification, biological importance; Primary and secondary and tertiary structures of proteins: α-helix and β- pleated sheets, Isolation, characterization, denaturation of proteins.

Enzymes: Nomenclature, Characteristics (mention of Ribozymes), Classification; Active site, Mechanism of enzyme action, Stereospecificity of enzymes, Coenzymes and cofactors, Enzyme inhibitors, Introduction to Biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

Lipids: Classification. Biological importance of triglycerides and phosphoglycerides and cholesterol; Lipid membrane, Liposomes and their biological functions and underlying applications, Lipoproteins, Properties, functions and biochemical functions of steroid hormones. Biochemistry of peptide hormones.

Unit-II (7 Lectures)

Biochemistry of disease: A diagnostic approach by blood/ urine analysis.

Blood: Composition and functions of blood, blood coagulation. Blood collection and preservation of samples. Anaemia, Regulation, estimation and interpretation of data for blood sugar, urea, creatinine, cholesterol and bilirubin.

Urine: Collection and preservation of samples. 6. Formation of urine. Composition and estimation of constituents of normal and pathological urine.

SUGGESTED BOOKS:

1. T. G. Cooper: Tool of Biochemistry.
2. Keith Wilson and John Walker: Practical Biochemistry.
3. Alan H Gowenlock: Varley's Practical Clinical Biochemistry.
4. Thomas M. Devlin: Textbook of Biochemistry.
5. Jeremy M. Berg, John L Tymoczko, Lubert Stryer: Biochemistry.
6. G. P. Talwar and M Srivastava: Textbook of Biochemistry and Human Biology. A. L. Lehninger: Biochemistry.
7. O. Mikes, R.A. Chalmers: Laboratory Handbook of Chromatographic Methods.

SEC-3 (GREEN METHODS IN CHEMISTRY) **(Credits: 02)**
22 Lectures

Unit-I **(12 Lectures)**

Tools of Green chemistry, twelve principles of Green Chemistry, with examples. Surfactants for Carbon Dioxide – replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments, environmentally safe antifoulant, CO_2 as an environmentally friendly blowing agent for the polystyrene foam sheet packaging market.

Unit-II **(10 Lectures)**

Using a catalyst to improve the delignifying (bleaching) activity of hydrogen Peroxide, A new generation of environmentally advanced preservative: getting the chromium and arsenic out of pressure treated wood, Right fit pigment: synthetic azo-pigments to replace toxic organic and inorganic pigments.

SUGGESTED BOOKS:

1. Manahan S.E. (2005) Environmental Chemistry, CRC Press
2. Miller, G.T. (2006) Environmental Science 11th edition. Brooks/Cole
3. Mishra, A. (2005) Environmental Studies. Selective and Scientific Books, New

SEC-4 (FUEL CHEMISTRY) **(Credits: 02)**

22 Lectures

Unit-I (12 Lectures)

Review of energy sources (renewable and non-renewable). Classification of fuels and their calorific value, *Coal:* Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal, Coal gas, producer gas and water gas—composition and uses. Fractionation of coal tar, uses of coal tar bases chemicals, requisites of a good metallurgical coke, Coal gasification.

Unit-II (10 Lectures)

Petroleum and Petrochemical Industry: Composition of crude petroleum, Refining and different types of petroleum products and their applications.

Fractional Distillation (Principle and process), Cracking (Thermal and catalytic cracking), Reforming Petroleum and non-petroleum fuels (LPG, CNG, LNG, bio-gas, fuels derived from biomass), fuel from waste, synthetic fuels (gaseous and liquids), clean fuels.

Lubricants*:* Classification of lubricants, lubricating oils (conducting and non-conducting), Solid and semisolid lubricants, synthetic lubricants.

SUGGESTED BOOKS

1. E. Stocchi: *Industrial Chemistry*, Vol -I, Ellis Horwood Ltd. UK.
2. P.C. Jain, M. Jain: *Engineering Chemistry*, Dhanpat Rai & Sons, Delhi.
3. B. K. Sharma: *Industrial Chemistry,* Goel Publishing House, Meerut.

SRI GURU GRANTH SAHIB WORLD UNIVERSITY

FATEHGARH SAHIB

Faculty of Basic and Applied Sciences

DEPARTMENT OF CHEMISTRY

Syllabi and outline of Examination

for

B.Sc. (Honours School) Chemistry
(Semester V-VI)

(Under Credit Based Choice System, CBCS)

EXAMINATION: 2015-18, 2016-19, 2017-20

SRI GURU GRANTH SAHIB WORLD UNIVERSITY
FATEHGARH SAHIB

SEMESTER: V

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-501	**Biomolecules**	3	1	-	4	25	75
BSCH-502	**Quantum Chemistry & Spectroscopy**	3	1	-	4	25	75
BSCH-503	DSE 1	3	1	-	4	25	75
BSCH -504	DSE-2	3	1	-	4	25	75
BSCH -505L	Chemistry Lab- II **Organic and Physical Chemistry Lab**	-	-	4	2	25	75
	TOTAL	12	4	4	18	125	375

SEMESTER: VI

COURSE CODE	TITLE	SCHEDULE OF TEACHING (HRS. PER WEEK)			CREDITS	MARKS	
		LECTURE	TUTORIAL	PRACTICAL		INTERNAL	EXTERNAL
BSCH-601	Organometallic chemistry	3	1	-	4	25	75
BSCH-602	Organic Spectroscopy	3	1	-	4	25	75
BSCH-603	DSE-3	3	1	-	4	25	75
BSCH-604	DSE-4	3	1	-	4	25	75
BSCH-605L	CHEMISTRY PRACTICALS (Inorganic and Physical Chemistry)	-	-	4	2	25	75
	TOTAL	12	4	4	18	125	375

BSCH-501: Biomolecules **(45 Hrs.)**
M. Marks: 100 (75+25)

UNIT- I **(23 Hrs.)**

Nucleic Acids: Components of nucleic acids, Nucleosides and nucleotides; Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides: various RNAs and DNA.

Amino Acids, Peptides and Proteins: Amino acids, Peptides and their classification; α-Amino Acids: Synthesis, ionic properties and reactions; Zwitterions; pKa values; isoelectric point and electrophoresis.

Study of peptides: Determination of their primary structures-end group analysis; methods of peptide synthesis; Synthesis of peptides using N-protecting, C-protecting and C-activating groups.

Enzymes: Introduction, classification and characteristics of enzymes; active site of enzymes; Mechanism of enzyme action, factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Unit II **(22 Hrs.)**

Lipids: Introduction to oils and fats; common fatty acids present in oils and fats; Hydrogenation of fats and oils; Saponification value; acid value; iodine number; Reversion and rancidity.
Concept of Energy in Biosystems: Cells obtain energy by the oxidation of foodstuff (organic molecules); Introduction to metabolism (catabolism, anabolism); **ATP:** The universal currency of cellular energy, ATP hydrolysis and free energy change; Agents for transfer of electrons in biological redox systems: NAD^+, FAD; Conversion of food to energy: Outline of catabolic pathways of carbohydrate- glycolysis, fermentation, Krebs cycle; Overview of catabolic pathways of fat and protein; Interrelationship in the metabolic pathways of protein, fat and carbohydrate; Caloric value of food, standard caloric content of food types.

Pharmaceutical Compounds: Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Recommended Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry. VIth Edition. W. H. Freeman and Co.
2. Nelson, D. L., Cox, M. M. and Lehninger, A. L. (2009) Principles of Biochemistry. IV Edition. W. H. Freeman and Co.
3. Murray, R. K., Granner, D. K., Mayes, P. A. and Rodwell, V. W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.

BSCH-502: Quantum Chemistry and Spectroscopy **(45 Hrs.)**

M. Marks: 100 (75+25)

UNIT- I **(23 Hrs.)**

Quantum Chemistry: Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule.Schrödinger equation, transformation to spherical polar coordinates.Separation of variables.Spherical harmonics.Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

UNIT- II **(22 Hrs.)**

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H2+. Bonding and antibonding orbitals.Qualitative extension to H2. Comparison of LCAO-MO and VB treatments of H2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB).Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH2, H2O) molecules. Qualitative MO theory and its application to AH2 type molecules.

Photochemistry: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws, of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

(12 Lectures)

Recommended Books:

1. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006).
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
3. House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004).
4. Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
5. Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

BSCH-505L Chemistry Lab-II (Organic and Physical Chemistry Lab)

Time: 8 Hours/week MM: 100

I. Aromatic electrophlic substitution

1. Preparation of m-dinitrobenzene from nitrobenzene.
2. Preparation of p-nitroacetanilide from acetanilide.
3. Preparation of p-bromoacetanilide from acetanilide.
4. Preparation of 2,4,6-tribromophenol from phenol
5. Preparation of m-nitroaniline from m-dinitrobenzene.
6. Preparation of benzoic acid from toluene/benzyl chloride.

II. Diazotization/Coupling

7. Preparation of methyl orange and methyl red
8. Preparation of benzoic acid from toluene

III. Reduction

9. Preparation of aniline from nitrobenzene
10. Preparation of m-nitroaniline from m-dinitrobenzene

IV. Optical Measurements by using Polarimeter

1. To determine the specific and molecular rotation of an optically active substance.

2. To determine the concentration of a solution of an optically active substance by polarimetric measurements.

V. Optical Measurements by Calorimetrically

13. Determine the wavelength of maximum absorption of a compound using a spectrophotometer and hence verify Lambert Beer Law and also determine the unknown concentration of a solution.
14. To determine the composition of binary mixture containing potassium dichromate and potassium permanganate using spectrophotometer.

VI. Conductometric titrations

15. To determine the concentration of given strong acid (HCl) using strong base (NaOH) by conductometric titrations.
16. To determine the concentration of given weak acid (CH_3COOH) using strong base (NaOH) by conductometric titrations.

VII. pHMetery

17. To determine the strength of given acid by pH metrically.

18. To determine the pH of various mixtures of sodium acetate and acetic acid in aqueous solution and hence determine the dissociation constant of the acid.

Suggested Books

1. Vogel A.I., Tatchell A.R., Furnis B.S., Hannaford A.J., Smith P.W.G., Vogel's Text Book of Practical Organic Chemistry,5th Edn., Pubs: ELBS, 1989.

2. Pavia D.L., Lampanana G.M., Kriz G.S. Jr., Introduction to Organic Laboratory Techniques, 3rd Edn., Pubs: Thomson Brooks/Cole,2005.

3. Mann F.G., Saunders. P.C., Practical Organic Chemistry, Pubs:Green& Co. Ltd., London, 1978.

4. Vogel's Quantitative Chemical Analysis, J. Mendham, Pearson Education, 2009.

5. Vogels Qualitative Inorganic Analysis, G. S

BSCH-601: ORGANOMETALLIC CHEMISTRY

Theory: 45 Lectures **M. Marks: 100 (75+25)**

UNIT-I **(26 Lectures)**

Organometallic Compounds-I

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni. Π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

Organometallic Compounds-II

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Metal Alkyls: Important structural features of methyl lithium (tetramer) and trialkylaluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler – Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, MannichCondensation). Structure and aromaticity.Comparison of aromaticity and reactivity with that of benzene.

UNIT-II **(19 Lectures)**

Reaction Kinetics and Mechanism

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans- effect, theories of trans effect, Mechanism of nucleophilic substitution in square planar complexes, Thermodynamic and Kinetic stability, Kinetics of octahedral substitution, Ligand field effects and reaction rates, Mechanism of substitution in octahedral complexes.

Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinsons Catalyst)
2. Hydroformylation (Co salts)

3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)
5. Synthesis gas by metal carbonyl complexes

Reference Books:

1. Svehla, G. Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall,1996.
2. Cotton, F.A.G.; Wilkinson & Gaus, P.L. Basic Inorganic Chemistry 3rd Ed.; Wiley India,
3. Huheey, J. E.; Keiter, E.A. & Keiter, R.L. Inorganic Chemistry, Principles of Structure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
4. Sharpe, A.G. Inorganic Chemistry, 4th Indian Reprint (Pearson Education) 2005
5. Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. Concepts and Models in Inorganic Chemistry3rd Ed., John Wiley and Sons, NY, 1994.
6. Greenwood, N.N. & Earnshaw, A. Chemistry of the Elements, Elsevier 2nd Ed, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
7. Lee, J.D. Concise Inorganic Chemistry 5th Ed., John Wiley and sons 2008.
8. Powell, P. Principles of Organometallic Chemistry, Chapman and Hall, 1988.
9. Shriver, D.D. & P. Atkins, Inorganic Chemistry 2nd Ed., Oxford University Press, 1994.
10. Basolo, F. & Pearson, R. Mechanisms of Inorganic Reactions: Study of Metal Complexes in Solution 2nd Ed., John Wiley & Sons Inc; NY.
11. Collman, J. P. et al. Principles and Applications of Organotransition Metal Chemistry. Mill Valley, CA: University Science Books, 1987.
12. Crabtree, R. H.The Organometallic Chemistry of the Transition Metals.jNew York, NY: John Wiley, 2000.
13. Spessard, G. O. &Miessler, G.L. Organometallic Chemistry. Upper Saddle River, N J: Prentice-Hall, 1996.

BSCH-602: ORGANIC SPECTROSCOPY

(Credits: 4)

Theory: 45 Lectures **M. Marks: 100 (75+25)**

UNIT-I

Organic Spectroscopy-I **(22 Lectures)**

General principles Introduction to absorption and emission spectroscopy.

UV Spectroscopy: Types of electronic transitions, λmax, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of λmax for the following systems: α,β-unsaturated aldehydes, ketones, carboxylic acids and esters; Conjugated dienes: alicyclic,homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis. Applications of IR and UV for identification of simple organic molecules.

Organic Spectroscopy-II

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin – Spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics, Interpretation of NMR spectra of simple compounds. Carbon-13 Nucleus, Carbon-13 chemical shifts, Proton couples 13C- spectra spin-spin splitting of Carbon-13 signals, Proton decoupled 13C-spectra, Nuclear Overhauser effect.

Applications of NMR for identification of simple organic molecules.

UNIT-II **(23 Lectures)**

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers. Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bifunctional systems, Poly-functional systems.

Kinetics of Polymerization:

Mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Properties of Polymers (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers

Reference Books:

1. Kalsi, P. S. *Textbook of Organic Chemistry 1st Ed.*, New Age International (P) Ltd. Pub.
2. Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
3. Billmeyer, F. W. *Textbook of Polymer Science*, John Wiley & Sons, Inc.
4. Gowariker, V. R.; Viswanathan, N. V. &Sreedhar, J. *Polymer Science*, New Age International (P) Ltd. Pub.
5. Finar, I. L. *Organic Chemistry* (*Volume 2: Stereochemistry and the Chemistry of Natural Products*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. Graham Solomons, T.W. *Organic Chemistry*, John Wiley & Sons, Inc.
7. McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
8. Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; *Organic Chemistry*, Oxford University Press.
9. Singh, J.; Ali, S.M. & Singh, J. *Natural Product Chemistry*, Prajati Prakashan(2010).
10. Kemp, W. *Organic Spectroscopy*, Palgrave.
11. Pavia, D. L. *et al. Introduction to Spectroscopy* 5th Ed. Cengage Learning India Ed. (2015).

Code: BSCH-605L (Inorganic and Physical Chemistry Lab)

Time: 8 Hours/week MM: 100

IV. Complexometeric Titrations

13. Prepare M/20 magnesium salt standard solution and find out the strength of supplied of the magnesium ion solution using EDTA as an intermediate solution.
14. To determine the temporary and permanent hardness of water sample by Complexometeric titration.

V. Preparations and estimations

15. Preparation of Hexaammine cobalt (III) chloride.
16. Preparation of potassium trisoxalatocobalatate (III).
17. To estimate lead as lead sulphate in the given solution of lead nitrate or lead acetate.
18. To estimate chloride ion as silver chloride in the given solution containing chloride ions.

VI. Iodometeric-Iodimetric Titrations

19. Prepare N/20 Potassium dichromate standard solution and find out the strength of supplied Potassium dichromate solution using sodium thiosulphate solution as an intermediate solution.
20. To determine the percentage of available chlorine in a sample of bleaching powder.
21. Prepare N/20 arsenious oxide standard solution and find out the strength of supplied arsenious oxide solution using iodine solution as an intermediate solution.
22. To estimate the percentage purity of the given sample of sodium sulphite using iodine and 0.1 N sodium thiosulphate solution.

VII. Optical Measurements by using Abbe's Refractometer

23. To determine the refractive index of a given liquid by Abbe's refractometer and hence the specific and molar refraction.
24. To determine the molar refraction of a solid substance by dissolving it in a solvent and its refractive index.

VIII. Chemical Kinetics

25. To determine the rate constant of hydrolysis of an ester by an acid. Determine also the energy of activation of the reaction.
26. Determine the relative strength of two acids studying the hydrolysis of two acids.

IX. EMF Measurements (Potentiometry)

27. Titration of a mixture of HCl and CH_3COOH potentiometrically and hence the composition of the mixture.
28. To determine the mean ionic activity coefficient of HCl at different concentrations.

X. **Thermochemistry**

29. Determination of heat of neutralization of sulphuric acid using Dewar flask
30. Determination of heat of ionization of weak base calorimetrically.
31. Determination of heat of neutralization of two acids and hence their relative strength.

Suggested books:

1. Vogel's Quantitative Chemical Analysis, J. Mendham,Pearson Education, 2009.
2. Vogels Qualitative Inorganic Analysis, G. Svehla,Pearson Education, 2012.
3. Experiments in Applied Chemistry, Sunita Rattan, S. K. Kataria& Sons, 2012.
4. Advanced Practical Physical Chemistry, J. B. Yadav, Krishna Prakashan Media (P) Ltd., 2012.

DSE-1: COORDINATION CHEMISTRY-II **(BSCH-503)**

(Credits: Theory-04)

Theory: 45 Lectures **M. Marks: 100 (75+25)**

UNIT-I

a) Electronic Spectra of Transition Metal Complexes: **(22 Hrs.)**

Electronic spectra of transition metal complexes: General features, Russell-Saunders coupling scheme, Selection rules, Orgel diagrams; week field splitting, Intermediate and strong field splitting. Tanabe and Sugano diagrams. Electronic spectra of d^1-d^9 metal complexes and f type compounds. Calculation of Dq, B and Δ' of d^1, d^2& d^8 configurations.

b) Magnetic properties of transition metal complexes:

Types of magnetic behaviour shown by transition elements and inner transition elements and their compounds. Gouy's method for measuring magnetic susceptibility, importance of magnetic susceptibility measurementsin structure determination of transition metal compounds, anomalous magnetic moments, magnetic exchange coupling and spin crossover.

a) General Chemistry of 1st row d-block elements:

Electronic configuration, ionization potential, oxidation states, complex forming, magnetic, catalytic and spectral properties.

b) The Chemistry of Ti and V complexes:

Solution Chemistry and complexes of Ti(III). Chemistry of vanadium (V) withemphasis on structure and formation of vanadates. Chemistry ofvanadium(IV).

UNIT-II

a) Cr and Mn: Oxidation states and complexes: **(23 Hrs.)**

Isolation of Cr from its chromite ore. Chemistry of Chromium(II); binuclearcompounds, Chemistry of Cr(III) complexes; The Chemistry of Cr (VI)chromates, dichromates and peroxo complexes of Cr(IV), Cr(V) and Cr(V).Chemistry of Mn (II) and Mn (III) complexes.

b) Stereo-electronic effects in Transition metal complexes:

Substitution in square planar complexes. The trans-effect, its synthetic application, I.D. theories of trans effects, Redox reactions., electron transfer reactions, mechanism of one electron transfer reactions, outer-sphere type reactions, inner sphere type reactions.

Reaction Mechanism of Transition Metal Complexes:

Nature and classification of ligand substitution reactions.Application ofvalence bond and crystal field theories to predict substitution reactions.Mechanism of ligand replacement reactions. Substitution in octahedralcomplexes, acid hydrolysis, base hydrolysis, acid-catalyzed acid hydrolysisand acid hydrolysis chelates.

Reference Books:

1. Cotton F. A.,Wilkinson G., Murillo C. A., Bochmann M., AdvancedInorg. Chemistry, 6th edn., Pubs: John Wiley India. (2003).
2. Gupta B. D. and Elias A. J., Basic Organometallic Chemistry. Pubs:University Press (2010)
3. Shriver D. F., Atkins F. W. and Langford C. M., Inorganic Chemistry, 3rd edn., Pubs: Oxford University Press, 1999.
4. Huheey J. E., Keiter E. A., Keiter R. L., Inorganic Chemistry : Principles of Structure and Reactivity; 4th edn, Pubs: Harper Collins, 1993.

DSE 2: INDUSTRIAL CHEMISTRY **(BSCH-504)**

(Credits: Theory-04)

Theory: 45 Lectures **M. Marks: 100 (75+25)**

UNIT-I **(24 Hrs.)**

Cement Industry: Classification of cements, Study of raw materials and their availability. Manufacture of Portland cement with construction and working of rotary kiln. Comparison between dry and wet process. Role of gypsum in cement.Setting, hardening and strength characteristics of cement compounds. ISI specifications of Portland cement. Study of special cements like high alumina cements, high early strength (HES) cements and white Portland cement. Decay of cement concrete and its protection. Refractories: Definition, characteristics of a good refractory. Study of raw materials, classification of refractories.Properties and manufacture of refractories in general. Fireclay, silica and alumina refractories.Super refractories, cermets and insulating refractories.

Glass Industry: Definition. Study of raw materials, Manufacture of glass in general by pot and tank furnaces using recuperative/regenerative method. Manufacture of safety glass, toughened glass, laminating glass and glasswool. Manufacture of coloured glass. Composition, Properties and uses of soft glass, hard glass, Lead (Flint) glass, Borosilicate (Pyrex or Jena) glass, Aluminosilicate glass and silica (Vitreosil) glass.

UNIT-II **(21 Hrs.)**

Heavy Chemical:

(a) Nitric acid: Manufacture of ammonia and nitric acid by Ostwald process. Methods to manufacture concentrate nitric acid.

(b) Sulphuric acid: Study of raw materials, Extraction of sulphur by Frasch Process. Manufacture of sulphuric acid by lead chamber and contact process. Concentration of sulphuric acid, Oleum.

(c) Sodium Carbonate: Manufacture by Solvay and modified Solvay Process.

(d) Sodium hydroxide, Chlorine and Hydrochloric acid: Manufacture of sodium hydroxide by causticization process and by electrolysis of brine using mercury electrolytic cell and diaphragm cell.

Industrial Wastes and Treatment: Types and characteristics of industrial wastes. Treatment of industrial wastes with organic and inorganic impurities.Air Pollution: Sources of air pollutants.Classification and effects of air pollutants.Control of air pollutants with reference to oxides of nitrogen and sulphur.Green house effect and its consequences.Ozone layer and its significance.Smog, Acid rain.Industrial Hazards and Safety.

Reference Books:

1. Austin Heorge T., Shreve's Chemical Process Industries, Pubs: McGrawHill Book Company, New York (1984).
2. Kent James A. (ed.), Keigel's Handbook of Industrial Chemistry, Pubs:VanNostrandinhold Company, London (1983).
3. Buchner V., Sohliebs P., Winter G. & Buchel K.H., Industrial Inorganic Chemistry, Pubs: V. Ch. Publishers, New York (1989).

DSE-3: MOLECULAR SPECTROSCOPY **(BSCH-603)**

(Credits: Theory-04)

Theory: 45 Lectures **M. Marks: 100 (75+25)**

UNIT–I (20 hrs.)

Molecular Interactions and other topics:

Intermolecular forces: dipole-dipole interaction, dipole induced dipole, dispersive forces, repulsive forces and total interaction. Electrical properties: Permanent dipole moment, polarizability and refractive index, optical activity. Magnetic properties: magnetic susceptibility, permanent magnetic moment, induced magnetic moment. Ionic solids.

Molecular spectroscopy: Introduction: Electromagnetic radiation, absorption co-efficient, Einstein coefficient, transition moment and oscillator strength. Microwave absorption: Rotational Spectra; rotational transitions, rotational spectra of diatomic molecules, molecular dimensions, polyatomic molecules. Rotational Raman Spectra. Infrared absorption: Vibrational spectra of diatomic molecules.Vibration rotation-spectra of diatomic molecules, vibrational spectra of polyatomic molecules, vibrational Raman Spectra.

Visible-Ultraviolet: Absorption, Electronic spectra: Electronic energy levels of molecules, selection rules for electronic spectra of molecules, Frank-Condon principle, determination of dissociation energies, Beer-Lambert Law, Oscillator strength, electronic spectra of polyatomic molecules. Introduction to Flourescence.

UNIT-II (25 Hrs.)

Molecular spectroscopy and Nuclear spectroscopy: Laser action. Photoelectron spectroscopy. Resonance Spectroscopy: Nuclear magnetic resonance, the techniques, relaxation processes, chemical shift, the fine structure, Electron spin resonance, hyperfine splitting, applicaions of ESR.

Statistical Thermodynamics-I: Molecular energy levels and the Boltzmann distribution: configurations and weights, most probable configuration. The molecular partition function: translational, rotational, vibrational and electronic contributions. Physical interpretation and Factorization of the partition function.

Statistical Thermodynamics-II: Thermodynamic properties in terms of partition function: Internal energy, molecular heat capacity, Entropy, work function and Enthalpy. Thermodynamic properties of an ideal monoatomic gas. Calculation of thermodynamic functions in terms of partition functions. Meanenergies and equipartition principle, heat capacities, residual entropies.

Reference Books:

1. Physical Chemistry by P.W. Atkins 7th Edn. (1994).
2. Physical Chemistry by I.N. Levine 4h ed. (1993).

3. Physical Chemistry by Donald C. McQuarre (1983).
4. Fundamentals of Spectroscopy by C. N. Banwell 4th Edn.(1994).

DSE 4: ANALYTICAL METHODS IN CHEMISTRY **(BSCH-604)**

(Credits: Theory-04)

Theory: 45 Lectures **M. Marks: 100 (75+25)**

UNIT-I **(23 Hrs.)**

Optical methods of analysis:

UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument;

Basic principles of quantitative analysis: estimation of metal ions from aqueous solution, geometrical isomers, keto-enol tautomers. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method.

Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator& detector) for single and double beam instrument; sampling techniques. Structural illustration through interpretation of data, Effect and importance of isotope substitution.

Flame Atomic Absorption and Emission Spectrometry: Basic principles of instrumentation (choice of source, monochromator, detector, choice of flame and Burner designs. Techniques of atomization and sample introduction; Method of background correction, sources of chemical interferences and their method of removal. Techniques for the quantitative estimation of trace level of metal ions from water samples.

Qualitative and quantitative aspects of analysis:

Sampling, evaluation of analytical data, errors, accuracy and precision, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q and t test, rejection of data, and confidence intervals.

UNIT-II **(22 Hrs.)**

Thermal methods of analysis:

Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture.

Electroanalytical methods:

Classification of electroanalytical methods, basic principle of pH metric, potentiometric and conductometric titrations. Techniques used for the determination of equivalence points. Techniques used for the determination of pKa values.

Separation techniques:

Solvent extraction: Classification, principle and efficiency of the technique.

Mechanism of extraction: extraction by solvation and chelation.

Technique of extraction: batch, continuous and counter current extractions.

Qualitative and quantitative aspects of solvent extraction: extraction of metal ions from aqueous solution, extraction of organic species from the aqueous and nonaqueous media.

Chromatography: Classification, principle and efficiency of the technique.

Mechanism of separation: adsorption, partition & ion exchange.

Development of chromatograms: frontal, elution and displacement methods.

Qualitative and quantitative aspects of chromatographic methods of analysis: IC, GLC, GPC, TLC and HPLC.

Reference Books:

1. Vogel, Arthur I: A Test book of Quantitative Inorganic Analysis (Rev. by G.H. Jeffery and others) 5th Ed. The English Language Book Society of Longman .
2. Willard, Hobert H. et al.: Instrumental Methods of Analysis, 7th Ed. Wardsworth Publishing Company, Belmont, California, USA, 1988.
3. Christian, Gary D; Analytical Chemistry, 6th Ed. John Wiley & Sons, New York, 2004.
4. Harris, Daniel C: Exploring Chemical Analysis, Ed. New York, W.H. Freeman, 2001.
5. Khopkar, S.M. Basic Concepts of Analytical Chemistry. New Age, International Publisher, 2009.
6. Skoog, D.A. Holler F.J. and Nieman, T.A. Principles of Instrumental Analysis, Thomson Asia Pvt. Ltd. Singapore.
7. Mikes, O. &Chalmes, R.A. Laboratory Hand Book of Chromatographic & Allied Methods, Elles Harwood Ltd. London.
8. Ditts, R.V. Analytical Chemistry – Methods of separation.