JSS Mahavidyapeetha

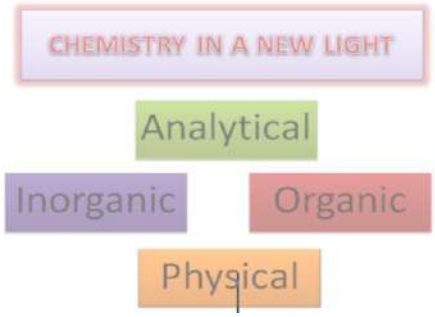
JSS COLLEGE OF ARTS, COMMERCE AND SCIENCE

B. N. ROAD, MYSURU – 570 025

POSTGRADUATE DEPARTMENT OF CHEMISTRY

SYLLABUS FOR M.Sc. DEGREE PROGRAMME IN CHEMISTRY

PROGRAMME CODE: CHE



under

Choice Based Credit System (CBCS) and

Continuous Assessment Grading Pattern (CAGP)

2019-2020

Programme Code: CHE

Programme Outcomes (POs)

At the end of the programme the student able to:

PO1: Learn about the potential uses of analytical, inorganic, organic and physical chemistry.
PO2: Develop scientific communication skills for differently specialized and non-specialized audiences.
PO3: Gather attention about the physical aspects of chemistry.
PO4: Develop knowledge of scientific theories and methods.
PO5: Acquire the skills of planning and conducting advanced experiments by applying suitable simple and sophisticated analytical techniques.
PO6: Examine specific phenomena theoretically and/or experimentally.
PO7: Acquire knowledge, abilities and insight in well-defined area of research within Chemistry.
PO8: Adopt the skills and knowledge required to qualify for training as scientific researcher.
PO9: Work in the pure, interdisciplinary and multidisciplinary areas of chemical sciences and its applications.
PO10: Plan and execute research in frontier areas of chemical sciences.
PO11: Learn professionalism, including the ability to work in teams and apply basic ethical principles.
PO12: Develop the ability to communicate scientific information and research results in written and oral formats.

Programme Specific Outcome (PSOs)

After completion of this programme the candidate able to

PSO1: Think and teach aspects of chemistry to the different levels of students in a futuristic manner.
PSO2: Reach the positions by employment in chemical, pharmaceutical, food and material industries.
PSO3: Reach a level to think about the scientific situations existing around him/her.
PSO4: Take up Global level research opportunities to pursue Ph.D. programme and will be more resourceful and will have targeted approach to qualify CSIR- NET and other competitive examinations.
PSO5: Analyse data obtained from sophisticated instruments for the structure determination and chemical analysis.
PSO6: Understand the background of organic mechanism and instrumental methods of chemical analysis.
PSO7: Apply modern methods of analysis to chemical systems in a laboratory setting.
PSO8: Find placements in R & D and synthetic division of polymer industries & allied division.
PSO9: Explore new areas of research in both chemistry and allied fields of science and technology.

GENERAL REQUIREMENTS

Scheme of Instructions:

A. A Masters Degree program is of 4 semesters-two years duration. A candidate can avail a maximum of 8 semesters – 4 years (in one stretch) to complete Masters Degree (including blank semesters, if any). Whenever a candidate opts for blank semesters, he/ she has to study the prevailing courses offered by the department when he/ she continues his/ her studies.

B. A candidate has to earn a minimum of 76 Credits, for successful completion of a Master Degree. The 76 Credits shall be earned by the candidate by studying Hard Core, Soft Core and Open Elective.

C. **Minimum for Pass:** In case a candidate secures less than Thirty percent in C_1 and C_2 put together, the candidate is said to have DROPPED the course, and such a candidate is not allowed to appear for C_3.

D. In case a candidate secures less than Thirty percent in C_3, or secures more than Thirty percent in C_3 but less than Thirty percent in C_1, C_2 and C_3 put together, the candidate is said to have not completed the course and he/ she may either opt to DROP the course or to utilize PENDING option.

E. **Credits (Minimum) Matrix:** A candidate has to study a minimum of 16 Credits in Soft Core (sum total of 4 semesters) and 04 Credits in Open Elective (in III Semester) for the successful completion of the Masters Degree course. A minimum of 15 students should register for every Soft Core or Open Elective course.

F. All other rules and regulations hold good which are governed by the College/ University.

GENERAL SCHEME WITH RESPECT TO THE ASSESSMENT OF CREDITS

Semester	Hard Core (HC)		Total	Soft Core (SC)		Total	Open Elective (OE)
	Theory	Practicals		Theory	Practicals		
I	3+3+3+3=12	(4+4)+(4+4)=08[a]	**20**	2+2+2+2=08[b]	NIL	**08[b]**	NIL
II	3+3+3+3=12	(4+4)+(4+4)=08[a]	**20**	2+2+2+2=08[b]	NIL	**08[b]**	NIL
III	3+0+3+0=06	NIL	**06**	0+(2x2)+0+(2x2)=08	(4+4)+(4+4)=08[a,c]	**16**	04
IV	0+3+0+3=06	NIL	**06**	(2x2)+0+(2x2)+0=08	4[d]+(4+4)+(4+4)=08[a,c]	**18**	NIL
Grand Total	**36**	**16**	**52**	**26**	**16**	**42**	**04**

[a]Fifty percent of the students will attend Analytical/ Inorganic Practicals and remaining Fifty percent students will attend Organic/ Physical Practicals in I or III Semester and *vice-versa* during II or IV Semester.

[b]Courses are common for both I and II Semesters and the candidate can opt any course of his/ her choice in aforesaid semesters and should ascertain that the course/ s already studied in I Semester are not repeated in the II Semester.

[c]Practicals are only for chemistry students which are compulsory courses.

[d]Dissertation/ Project work

SCHEME OF STUDY AND EXAMINATION

FIRST SEMESTER
HARD CORE

THEORY

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHA 090	Fundamentals of Chemical Analysis	03	03	100	15	15	03	70
CHA 100	Inorganic Chemistry-I	03	03	100	15	15	03	70
CHA 110	Organic Chemistry-I	03	03	100	15	15	03	70
CHA 120	Physical Chemistry-I	03	03	100	15	15	03	70

PRACTICALS

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHA 050	Analytical Chemistry Practicals	08	04	100	15	15	06	70
CHA 060	Inorganic Chemistry Practicals	08	04	100	15	15	06	70
CHA 070	Organic Chemistry Practicals	08	04	100	15	15	06	70
CHA 080	Physical Chemistry Practicals	08	04	100	15	15	06	70

Note: Fifty percent of the students will attend Analytical and Inorganic practicals and remaining Fifty percent of the students will attend Organic and Physical practicals in I semester and *vice-versa* during II semester.

SOFT CORE

THEORY

Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
				C_1	C_2	Duration	Max. Marks
Applied Analysis I	02	02	100	15	15	03	70

Frontiers in Inorganic Chemistry	02	02	100	15	15	03	70
Reaction Mechanisms	02	02	100	15	15	03	70
Solid State Chemistry and Chemistry of Nano Materials	02	02	100	15	15	03	70

SECOND SEMESTER
HARD CORE

THEORY

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHB 090	Separation Techniques	03	03	100	15	15	03	70
CHB 100	Advanced Coordination Chemistry	03	03	100	15	15	03	70
CHB 110	Organic Chemistry-II	03	03	100	15	15	03	70
CHB 120	Physical Chemistry - II	03	03	100	15	15	03	70

PRACTICALS

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHB 050	Analytical Chemistry Practicals	08	04	100	15	15	06	70
CHB 060	Inorganic Chemistry Practicals	08	04	100	15	15	06	70
CHB 070	Organic Chemistry Practicals	08	04	100	15	15	06	70
CHB 080	Physical Chemistry Practicals	08	04	100	15	15	06	70

Note: It is same as that of I Semester. Students who have studied Analytical/ Inorganic or Organic/ Physical Practicals will get interchanged during II Semester.

SOFT CORE

All the courses are common for both I and II Semesters and the candidate can opt any course of his/ her choice in aforesaid semesters and should ascertain that the course/ s already studied in I Semester are not repeated in the II Semester

THIRD SEMESTER

HARD CORE

THEORY

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHC 010	Instrumental Methods of Analysis	03	03	100	15	15	03	70
CHC 020	Spectroscopy	03	03	100	15	15	03	70

OPEN ELECTIVE (for Non-Chemistry Students only)

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHC 030	Selected Topics in Chemistry	04	04	100	15	15	03	70

SOFT CORE

THEORY

Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
				C_1	C_2	Duration	Max. Marks
Inorganic Chemistry-II	02	02	100	15	15	03	70
Structural Methods in Inorganic Chemistry	02	02	100	15	15	03	70
Biophysical Chemistry and polymers	02	02	100	15	15	03	70
Applications of Chemical Kinetics and Quantum Chemistry	02	02	100	15	15	03	70

PRACTICALS

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHC 210	Analytical Chemistry Practicals	08	04	100	15	15	06	70
CHC 220	Inorganic Chemistry Practicals	08	04	100	15	15	06	70
CHC 230	Organic Chemistry Practicals	08	04	100	15	15	06	70
CHC 240	Physical Chemistry Practicals	08	04	100	15	15	06	70

Note: 1. Fifty percent of the students will attend Analytical and Inorganic practicals and remaining Fifty percent of the students will attend Organic and Physical practicals in III semester and *vice-versa* during IV semester.

2. Practicals papers are only for chemistry students which are compulsory

FOURTH SEMESTER

HARD CORE

THEORY

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHD 010	Bioinorganic Chemistry	03	03	100	15	15	03	70
CHD 020	Advanced Physical Chemistry	03	03	100	15	15	03	70

SOFT CORE

THEORY

Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
				C_1	C_2	Duration	Max. Marks
Applied Analysis II	02	02	100	15	15	03	70
Applied Analysis III	02	02	100	15	15	03	70
Retrosynthesis and Organometallic Chemistry	02	02	100	15	15	03	70
Biomolecules and Natural Products	02	02	100	15	15	03	70

PRACTICALS

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHD 210	Analytical Chemistry Practicals	08	04	100	15	15	06	70
CHD 220	Inorganic Chemistry Practicals	08	04	100	15	15	06	70
CHD 230	Organic Chemistry Practicals	08	04	100	15	15	06	70
CHD 240	Physical Chemistry Practicals	08	04	100	15	15	06	70

Note: It is same as that of III Semester. Students who have studied Analytical/ Inorganic or Organic/ Physical Practicals will get interchanged during IV Semester.

PROJECT /DISSERTATION WORK

Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks/ Course	Internal Assessment Marks		Semester End Exams (C_3)	
					C_1	C_2	Duration	Max. Marks
CHD 250	Project /Dissertation Work	08	04	100	15	15	06	70

SCHEME OF EXAMINATION FOR C_1, C_2 AND C_3 COMPONENTS

Preamble: In view of the CBCS syllabus, following is the model distribution of marks for C_1, C_2 and C_3 Components. At a glance, the model includes both theory (HC/ SC/ OE) as well as practicals (HC/ SC) assessment of marks.

The following is the scheme which will be followed for the assessment of marks for both theory (HC/ SC/ OE) as well as practicals (HC/ SC) irrespective of the Credits associated with each Course. Thirty percent of the marks will be assessed for the internals (C_1 and C_2) and remaining seventy percent will be for the semester end examinations (C_3). Each Course carries 100 marks and hence thirty marks for internal assessment and remaining seventy marks will be for Semester End Examinations. Out of thirty marks for internals, fifteen marks will be allotted to

each C_1 and C_2 components. The distribution of marks for C_1 and C_2 varies with HC and SC papers.

Each theory Course (HC/ SC/ OE) consists of three components namely C_1, C_2 and C_3. C_1 and C_2 are designated as Internal Assessment (IA) and C_3 as Semester End Examination. Each Course (HC/ SC/ OE) carries **100 Marks** and hence the allotment of marks to C_1, C_2 and C_3 Components will be fifteen, fifteen and seventy marks respectively. i.e.,

C_1 Component	: 15 Marks	} Internal Assessment Marks
C_2 Component	: 15 Marks	
C_3 Component	: 70 Marks	Semester End Examination
Total	**: 100 Marks**	

The above will be followed in common for all the theory (HC/ SC/ OE) and practical (HC/ SC) Courses in all the four semesters.

1. THEORY:

1.1. HARD CORE (03 CREDITS COURSES)

1.1.1 Distribution of Marks for C_1 and C_2 Components (I/ II Semesters):

IA consists of fifteen marks for each component it will be divided into three parts viz., ***Internal Test, Home Assignment and Seminar***. Internal tests will be conducted during the 8th Week of the semester for C_1 and 16th Week of the semester for C_2. Home Assignment will be concerned for C_1 Component and Seminar for C_2 Component only. Hence, a teacher may give only one assignment (or in their personal interest one more may be given). Since each Course has three units, the marks shall be divided equally. Allotment of marks for C_1 and C_2 is as follows: Out of fifteen Marks for IA for C_1, Internal test will be conducted for Thirty Marks (reduced to 10 Marks) and Home Assignment will be given for 05 Marks (Each Home Assignment from every unit will be assessed for 05 Marks and finally reduced to 05 Marks). IA for C_2 will be distributed as follows: Internal test will be conducted for Thirty Marks (reduced to 10 Marks) and Seminar will be assigned for 05 Marks for the favor of IA. Please note that actual Seminar will be assessed for 20 Marks and finally 05 Marks will be distributed to each theory HC Course. i.e.,

C_1		**C_2**	
Internal Test	: 30 Marks (10+10+10)	Internal Test	: 30 Marks (10+10+10)

	Reduced to 10 Marks		**Reduced to 10 Marks**
Home Assignment	: 15 Marks (05+05+05) **Reduced to 05 Marks**	Seminar	: 20 Marks (05+05+05+05) **Distributed 05 Marks to each HC Course**
Total	**: 15 Marks**	**Total**	**: 15 Marks**

1.1.1a Distribution of Marks for C_1 and C_2 Components (III/ IV Semesters):

The modalities discussed above in 1.1.1 holds good for this also except for Seminar component. Seminar will be assigned for 05 Marks for the favor of IA. Please note that actual Seminar will be assessed for 10 Marks and finally 05 Marks will be distributed to each theory HC Course. i.e.,

C_1		**C_2**	
Internal Test	: 30 Marks (10+10+10) **Reduced to 10 Marks**	Internal Test	: 30 Marks (10+10+10) **Reduced to 10 Marks**
Home Assignment	: 15 Marks (05+05+05) **Reduced to 05 Marks**	Seminar	: 10 Marks (05+05) **Distributed 05 Marks to each HC Course**
Total	**: 15 Marks**	**Total**	**: 15 Marks**

1.1.2 Distribution of Marks for C_3 Component (Semester End Examination):

The question paper is of 3 hr duration with Max. Marks 70. The following question paper pattern will be followed for all the theory Courses (HC/ SC/ OE). Question paper will have 2 parts both parts will cover all units of the course with equal proportional of distribution. Part A is of Short Answer Type questions which will have ten questions and each question carries two Marks. Part B carries fifty Marks and comprises of seven questions where in a student has to answer any five. Each question carries ten marks with sub question i.e.,

Model Question Paper Pattern:

Max. Duration: 3 Hr **Max. Marks: 70**

Note: *Question paper has two parts, answer both the parts*.

PART A

Ten questions will be given and all ten should be answered. Each question carries two marks.

10 x 2 = 20

PART B

Seven questions will be given and any five should be answered. Each question carries Ten marks. An examiner may distribute marks as (3+3+4), (5+5), (7+3) & (4+6). Two marks question shall be avoided to maximum extent. **5 x 10 = 50**

1.2 SOFT CORE (02 CREDITS COURSES):

1.2.1 Distribution of Marks for C_1 and C_2 Components:

IA consists of 15 marks for each components; it will be divided into two parts viz., ***Internal Test and Home Assignment***. Internal tests will be conducted during the 8th Week of the semester for C_1 and 16th Week of the semester for C_2. As far as Home Assignment is concerned, the concerned teacher will assign one or two Home Assignments to each student. Since each Course has two units, the marks will be divided equally. Allotment of marks for C_1 and C_2 is as follows: Out of 15 Marks for IA, Internal tests will be conducted for 10 marks and Home Assignment for 05 Marks. i.e.,

C_1		**C_2**	
Internal Test	: 20 Reduced to10	Internal Test	: 20 Marks 10
Home Assignment	: 10 Marks **Reduced to 05**	Home Assignment	: 10 Marks **Reduced to 05**
Total	**: 15 Marks**	**Total**	**: 15 Marks**

1.2.2 Distribution of Marks for C_3 Component (Semester End Examination):

The above discussed pattern (1.1.2) holds good in this case also.

1.3 OPEN ELECTIVE (04 CREDITS COURSE):

1.3.1 Distribution of Marks for C_1 and C_2 Components:

IA consists of 15 marks for each components; it will be divided into two parts viz., ***Internal Test and Home Assignment***. Internal tests will be conducted during the 8th Week of the semester for C_1 and 16th Week of the semester for C_2. As far as Home Assignment is concerned, the concerned teacher will assign one or two Home Assignments to each student. Allotment of marks for C_1 and C_2 is as follows: Out of 15 Marks for IA, Internal tests will be conducted for 20 marks and reduced to 10 Home Assignment for 05 Marks. i.e.,

C_1		C_2	
Internal Test	: 20 Marks **Reduced to 10**	Internal Test	: 20 Marks **Reduced to 10**
Home Assignment	: 20 Marks **Reduced to 05**	Home Assignment	: 20 Marks **Reduced to 05**
Total	**: 15 Marks**	**Total**	**: 15 Marks**

1.3.2 Distribution of Marks for C_3 Component (Semester End Examination):

The above discussed pattern (1.1.2) holds good in this case also.

2. PRACTICALS (04 CREDITS COURSES):

The following scheme will be applicable for both HC and SC in all the four semesters (SC courses are for chemistry students only which are compulsory Courses).

Each practical (HC/ SC) consists of three components namely C_1, C_2 and C_3. C_1 and C_2 are designated as Internal Assessment (IA) and C_3 as Semester End Examination. Each practical (HC/ SC) carries **100 Marks** and hence the allotment of marks to C_1, C_2 and C_3 Components will be fifteen, fifteen and seventy marks respectively. i.e.

C_1 Component	: 15 Marks	} Internal Asessment Marks
C_2 Component	: 15 Marks	
C_3 Component	: 70 Marks	Semester End Examination
Total	**: 100 Marks**	

2.1 Distribution of Marks for C_1 and C_2 Components:

IA consists of **15 Marks**; it will be divided into three parts viz., ***Internal Test, Continuous Assessment and Record***. Continuous assessment refers to the daily assessment of each student based on his/ her attendance, skill, results obtained etc. Thus, three marks are allotted for Continuous Assessment. Internal tests will be conducted for ten marks during the 8^{th} Week of the semester for C_1 and 16^{th} Week of the semester for C_2. Finally, remaining two Marks will be for the record. i.e.,

C_1		C_2	
Internal Test	: 10 Marks	Internal Test	: 10 Marks
Continuous Assessment	: 03 Marks	Continuous Assessment	: 03 Marks
Record	: 02 Marks	Record	: 02 Marks
Total	**: 15 Marks**	**Total**	**: 15 Marks**

5.1.2 Distribution of Marks for C_3 Component (Semester End Examination):

The end examination will be conducted for **seventy Marks/ Course** with a maximum duration of six hours. Two experiments will be given to each student which carries thirty Marks each. Each student will be subjected to Viva-Voce Examination for which ten Marks is allotted. i.e.,

Two Experiments	: 60 Marks
Viva-Voce	: 10 Marks
Total	**: 70 Marks**

2.3 Evaluation of Project Work/ Dissertation (Minor):

Each student can take up Project Work/ Dissertation under the guidance of the faculty of the department during the IV Semester as a Soft Core course.

2.3.1 Distribution of Marks for C_1 and C_2 Components:

IA consists of **fifteen Marks** for each components; it will be divided into three parts viz., ***Attendance, Continuous Assessment and Work Progress***. Continuous assessment refers to the daily assessment of each student based on his or her skill, results obtained, literature survey etc. C_1 will be assessed during the 8^{th} Week of the semester and C_2 during the 16^{th} Week of the semester. Hence, the concerned guide will prepare the marks list based on the above said parameters for both C_1 and C_2 Components.

2.3.2 Distribution of Marks for C_3 Component (Semester End Examination):

The semester end examination will be conducted for **seventy Marks**. Every student is suppose to prepare a hard copy of the findings of the work in the form of report and submitted for evaluation. This part will be assessed for fourth Marks. Each student will be subjected to Viva-Voce Examination for which thirty Marks is allotted. i.e.,

Evaluation of Report	: 40 Marks
Viva-Voce	: 30 Marks
Total	**: 70 Marks**

FIRST SEMESTER

THEORY – HARD CORE

FUNDAMENTALS OF CHEMICAL ANALYSIS

Course Code: CHA 090

Course Outcomes

After studying this course the student able to:

CO1: Understand on quantitative and qualitative methods of analysis with relevant equilibrium chemistry.
CO2: Develop the ideas with the fundamental aspects in analytical chemistry.
CO3: Explore topics such as experimental design, sampling, calibration strategies, standardization, optimization, statistics and the validation of experimental results.
CO4: Build the interest in students in developing good experimental protocols, and in interpreting experimental results.
CO5: Gain analytical knowledge for the quantitative analysis of various samples of different origin under titrimetric aspects.
CO6: Learn statistical aspects from which the spirit of assessing the results will be enhanced.
CO7: Learn method development and validation features so that they will become outstanding basement for their career in various industries.

UNIT – I

Analytical Chemistry–Meaning, role, central location of analytical chemistry. Quantitative and qualitative analysis.Steps in quantitative analysis.

Language of analytical chemistry - Analysis, determination and measurement.Techniques, methods, procedures and protocols.Classifying analytical techniques.

Errors and treatment of analytical data: Limitations of analytical methods – Error: determinate and indeterminate errors, minimization of errors. Accuracy and precision,distribution of random errors, the normal error curve. Statistical treatment of finite samples-measures of central tendency and variability: mean, median, range, standard deviation and variance. Student's t-test,confidence interval of mean.Testing for significance-comparison of two means and two standard deviations.Comparison of an experimental mean and a true mean.Criteria for the rejection of an observation- Q-test. Propagation of errors: determinate errors and indeterminate errors.

Standardization and calibration: Comparison with standards-direct comparison and titrations. External standard calibration-the least squares methods, regression equation, regression coefficient. Internal standard methods and standard-addition methods.

Selecting an analytical method: Accuracy, precision, sensitivity, selectivity, robustness and ruggedness,scale of operation, equipment, time and cost.Making the final choice.Figures of merit of analytical methods–sensitivity, detection and quantitation limit, linear dynamic range.

[16 HOURS]

UNIT – II

Titrimetric analysis: An overview of titrimetry. Principles of titrimetric analysis. Titration curves. Titrations based on acid-base reactions-titration curves for strong acid and strong base, weak acid and strong base and weak base and strong acid titrations. Selecting and evaluating the end point. Finding the end point by visual indicators, monitoring *p*H and temperature. Quantitative applications – selecting and standardizing a titrant, inorganic analysis-alkalinity, acidity and free CO_2 in water and waste waters, nitrogen, sulphur ammonium salts, nitrates and nitrites, carbonates and bicarbonates. Organic analysis-functional groups like carboxylic acid, sulphonic acid, amine, ester, hydroxyl, carbonyl. Air pollutants like SO_2.Quantitative calculations. Characterization applications-equivalent weights and equilibrium constants.

Acid-base titrations in non-aqueous media: Role of solvent in acid-base titrations, solvent systems, differentiating ability of a solvent, some selected solvents, titrants and standards, titration curves, effect of water, determining the equivalence point, typical applications-determination of carboxylic acids, phenols and amines.

Precipitation titrations: Titration curves, feasibility of precipitation titrations, factors affecting shape - titrant and analyte concentration, completeness of the reaction, titrants and standards, indicators for precipitation titrations involving silver nitrate, the Volhard, the Mohr and the Fajan's methods, typical applications.

[16 HOURS]

UNIT – III

Complexometric titrations: Complex formation reactions, stability of complexes, stepwise formation constants, chelating agents, EDTA-acidic properties, complexes with metal ions, equilibrium calculations involving EDTA, conditional formation constants, derivation of EDTA titration curves, effect of other complexing agents, factors affecting the shape of titration curves-completeness of reaction, indicators for EDTA titrations-theory of common indicators, titration methods employing EDTA-direct, back and displacement titrations, indirect determinations, titration of mixtures.

Redox titrations: Balancing redox equations, calculation of the equilibrium constant of redox reactions, calculating titration curves, detection of end point, visual indicators and potentiometric end point detection. Quantitative applications-adjusting the analyte's oxidation state, selecting

and standardizing a titrant. Inorganic analysis-chlorine residuals, dissolved oxygen in water, water in non-aqueous solvents. Organic analysis-chemical oxygen demand (COD) in natural and waste waters, titrations of mercaptans and ascorbic acid with $I_3^-$and titration of organic compounds using periodate.

Obtaining and preparing samples for analysis: Importance of sampling, designing a sample plan-random, judgement, systematic-judgement, stratified and convenience sampling. Type of sample to collect - grab and composite samples. *Insitu* sampling. Size of sample and number of samples.Implementing the sampling plan - solutions, gases and solids. Bringing solid samples into solution - digestion and decomposing.

[16 HOURS]

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch, 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001, John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993,Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
6. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
7. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.

INORGANIC CHEMISTRY-I

Course Code: CHA 100

Course Outcomes

After studying this course the student able to:

CO1: Acquire the skills for molecular symmetry and group theory and interpretation in rather simple point groups.
CO2: Get idea about representation of groups and applications of group theory.
CO3: Illustrate an understanding of the principles of VSEPR model and molecular orbital theory.
CO4: Understand the treatment involving delocalized π-bonding of molecular orbital.
CO5: Demonstrate an understanding of the basic principles of acid – base chemistry and non aqueous solvents.
CO6: Design the synthesis of higher boranes and extraction of lanthanides and actinides.
CO7: Demonstrate an understanding of chemistry of 'd' and 'f' block elements.
CO8: Understand the organometallic compounds, Ferrocene and ruthenocene, Complexes containing alkene, alkyne, arene and allyl ligands.

UNIT – I

Molecular symmetry and group theory: Symmetry elements and symmetry operations. Concept of a group, definition of a point group. Classification of molecules into point groups. Subgroups. Schoenflies and Hermann-Maugin symbols for point groups. Multiplication tables (C_n, C_{2V} and C_{3V}). Matrix notation for the symmetry elements. Classess and similarity transformation.

Representation of groups: The Great Orthogonality theorem and its consequences. Character tables (C_s, C_i, C_2, C_{2v}, C_{2h} and C_{3v}).

Applications of group theory: Group theory and hybrid orbital. Group theory to Crystal field theory and Molecular orbital theory (octahedral and tetrahedral complexes). Determining the symmetry groups of normal modes (both linear and non-linear molecules).

[16 HOURS]

UNIT – II

Structures and energetics of inorganic molecules: Introduction, Energetics of hybridization. VSEPR model for explaining structure of AB, AB_2E, AB_3E, AB_2E_2, ABE_3, AB_2E_3, AB_4E_2, AB_5E and AB_6 molecules. M.O. treatment of homonuclear and heteronuclear diatomic molecules. M.O. treatment involving delocalized π-bonding (CO_3^{2-}, NO_3^-, NO_2^-, CO_2 and N_3^-).

Non-aqueous solvents: Classification of solvents, Properties of solvents (dielectric constant, donor and acceptor properties) protic solvents (anhydrous H_2SO_4, HF and glacial acetic acid) aprotic solvents (liquid SO_2, BrF_3 and N_2O_4). Solutions of metals in liquid ammonia. Super acids.
Electron deficient compounds: Higher boranes, polyhedral boranes (preparations, properties, structure and bonding). Wade's rules, carboranes and metallocarboranes.
Lanthanides & Actinides: Spectral & magnetic properties. Use of lanthanide compounds as shift reagents.

[16 HOURS]

UNIT – III

Fundamental concepts: Introduction, Classification of organometallic compounds by bond type, nomenclature, the effective atomic number rule, complexes that disobey the EAN rule, common reactions used in complex formation.
Organometallics of transition metals: Preparation, bonding and structures of nickel, cobalt, iron and manganese carbonyls. Preparation and structures of metal nitrosyls in organometallics.
Ferrocene and ruthenocene: Preparation, structure and bonding.
Complexes containing alkene, alkyne, arene and allyl ligands: preparation, structure and bonding. The isolobal principles.

[16 HOURS]

References:

1. Symmetry and spectroscopy of molecules, 2nd Ed. Veera Reddy, New Age International Publication (2009).
2. Group Theory and its Chemical Applications, P.K. Bhattacharya, Himalaya Publishing House (1986).
3. Chemical Applications of Group Theory, 3rd Ed., F.A. Cotton,Wiley, New York (1990).
4. Inorganic Chemistry, 3rd edition. James E. Huheey, Harper and Row Publishers (1983).
5. Inorganic Chemistry, 3rd edition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
6. Inorganic Chemistry, 4th edition. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Oxford University Press (2004).
7. Inorganic Chemistry, 2nd edition. C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd. (2005).
8. Basic Organometallic Chemistry - B.D. Gupta and A.J. Elias, Universities Press (2010).

ORGANIC CHEMISTRY-I

Course Code: CHA 110

Course Outcomes

After studying this course the student to:

CO1: Learn the deeper concepts of stereochemistry, rearrangements as well as heterocyclic chemistry.
CO2: Assign the configuration and conformation for an organic molecule and also gain more knowledge about the chiral carbon atoms, isomerism, symmetry concepts, etc.
CO3: Acquire knowledge on different concepts of migration, fate of the reaction, mechanistic approach under molecular rearrangements.
CO4: Classify the different categories of heterocyclics, their preparation and also synthetic applications nu mechanistic pathways.

UNIT – I

Stereoisomerism: Projection formulae [Fly wedge, Fischer, Newman and Saw horse], enantiomers, diasteroisomers, configurational notations of simple molecules, *DL* and *RS* configurational notations.

Stereoselectivity: Stereoselective reactions, diasteroselective reactions, stereospecific reactions, regioselective and regiospecific reactions, enantioselective and enantiospecific reactions.

Optical isomerism: Conditions for optical isomerism, Elements of symmetry – plane of symmetry, centre of symmetry, alternating axis of symmetry (rotation-reflection symmetry); optical isomerism due to chiral centers and molecular dissymmetry, allenes and biphenyls, criteria for optical purity.

Geometrical isomerism: Due to C=C, C=N and N=N bonds, E, Z conventions, determination of configuration by physical and chemical methods.

Conformational isomerism: Elementary account of conformational equilibria of ethane, butane and cyclohexane. Conformation of cyclic compounds such as cyclopentane, cyclohexane, cyclohexanone derivatives and decalins. Conformational analysis of 1,2, 1,3, and 1,4-disubstituted cyclohexane derivatives and *D*-Glucose, Effect of conformation on the course/ rate of reactions.

[16 HOURS]

UNIT – II

Molecular rearrangements: Introduction

Carbon to carbon migration: Pinacol-pinacolone, Wagner-Meerwein, Benzidine, Demjanov, benzylic acid, Favorskii, Arndt-Eistert synthesis, Fries rearrangement, Steven's rearrangement, dienophine rearrangement.

Carbon to nitrogen migration: Hofmann, Curtius, Lossen, Schmidt and Beckmann rearrangements.

Miscellaneous rearrangements: Sommelet-Hauser, Wittig, Smiles, Neber, Japp-Klingemann rearrangement, Meisenheimer rearrangements, Bayer-Villeger rearrangement, Allylic rearrangements.

[16 HOURS]

UNIT – III

Heterocyclic chemistry: Nomenclature of heterocyclic systems

Structure, reactivity, synthesis and reactions of indole, pyridine, benzofuran, quinoline, isoquinoline, pyrazole, imidazole, pyrone, coumarin, chromones, pyrimidines and purines. Synthesis and synthetic applications of azirines and aziridines, isoxazole, oxazole and azepine.

[16 HOURS]

References:

1. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mc Graw Hill, New York, 1987.
2. Organic Chemistry by Morrison & Boyd.
3. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
4. E.L. Eliel and S.H. Wilen, Stereochemistry of Organic Compounds, John Wiley and Sons, New York. 1994.
5. Introduction to Stereochemistry by K. Mislow.
6. Basic Principles of Organic Chemistry by Roberts & Caserio
7. N.S. Issacs, Reactive Intermediates in Organic Chemistry, John Wiley and Sons, New York.1974.
8. R.K. Bansal, Organic Reaction Mechanism, Wiley Eastern Limited, New Delhi, 1993.
9. J. March, Advanced Organic Chemistry, Wiley Interscience, 1994.
10. E.S. Gould, Mechanism and Structure in Organic Chemistry, Halt, Rinhart & Winston, New York, 964.
11. A Guide Book to Mechanism in Organic Chemistry by Petersykes

12. Stereochemistry and Mechanism through Solved Problems by P.S. Kalsi.
13. Text book of Organic Chemistry by P.S. Kalsi.
14. F.A. Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.
15. D. Nasipuri, Stereochemistry of Organic Compounds, 2nd edition, Wiley Eastern Limited, New Delhi, 1991.
16. S.K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998.
17. Heterocyclic Chemistry – Joule & Smith
18. Heterocyclic Chemistry – Achaeson
19. Basic Principles of Heterocyclic Chemistry – L.A. Pacquette
20. Comprehensive Heterocyclic Chemistry – Kartritzky series, Pergamon Press, New York, 1984.

PHYSICAL CHEMISTRY – I

Course Code: CHA 120

Course Outcomes

After studying this course the student to:

CO1: Get knowledge on the basic fundamental concepts of physical chemistry i.e, Thermodynamics, Chemical kinetics and Electrochemistry.
CO2: Explore the topics such as second law of thermodynamics, partial molar properties, fugacity, statistical thermodynamics, kinetics of fast reaction, some of the important theories of kinetics, istopic effects, batteries construction and working, liquid junction potential, etc.
CO3: Apply the reaction rate for simple, complex reaction and also fast reactions.
CO4: Understand primary and secondary batteries.

UNIT – I

Concepts of entropy and free energy: Second law of thermodynamics, definition of entropy,entropy of phase transition,entropy change during spontaneous process. Helmholtz and Gibbs free energies,Maxwellrelations,Variation of free energy with temperature and pressure. Third law of thermodynamics,Nernst heat theorem & its applications,numericals based on entropy and free energy changes.

Partial molar properties: Partial molar quantities,Partial molar gibbsfunction,Partial molar volume and its determination by intercept method and density measurements.Chemical potential and its significance. Variation of chemical potential with temperature and pressure.Formulation of the Gibbs Duhem equation.Derivation of Duhem-Margules equation.

Fugacity: Determination of fugacity of gases. Variation of fugacity with temperature and pressure.Activity and activity coefficients.Variation of activity with temperature and pressure.Determination of activity co-efficients by vapour pressure, depression in freezing points and solubility measurements by electrical methods.

Statistical thermodynamics: Different types of ensembles, ensemble averaging, distribution law (Boltzmann statistics),partition function and thermodynamic parameters; relation between molecular and molar partition functions, translational partition function, rotational partition function for linear and non-linear molecules.

[16 HOURS]

UNIT – II

Chemical Kinetics: Basic concepts of chemical kinetics. Complex reactions: measurement of kinetics. Chain, parallel, consecutive and reversible reactions. Arrhenius equation, energy of activation and its experimental determination. Simple collision theory-mechanism of bimolecular reaction. Lindemann's theory, Hinshelwood's theory for unimolecular reaction. Activated complex theory of reaction rate.

Kinetics of reactions in solution-salt effects, effect of dielectric constant (single sphere and double sphere model), effect of pressure, volume and entropy change on reaction rates. Cage effect with an example. Oscillatory reactions: oxidation of malonic acid. Kinetics of heterogeneous reactions - Langmuir's theory, unimolecular and bimolecular surface reactions.

Linear free energy relationship: Hammett equation, Taft equation. Isokinetic relationship and significance of isokinetic temperature.

Enzyme kinetics: Effect of substrate concentration (Michaelis Menton equation), Effect of *p*H, effect of catalysts and inhibitors, effect of temperature.

[16 HOURS]

UNIT – III

Electrochemistry: Arrhenius theory of strong and weak electrolytes and its limitations. Factor effecting conductance, Debye-Huckel-Onsager equation of conductivity and its validity. Walden`s rule. Debye-Huckel theory - concept of Ionic strength, Debye-Huckel limiting law (DHL), its modification for appreciable concentrations. Determination of transference number by moving boundary and Hittorf's methods. True and apparent transference numbers (TrN). Abnormal TrN, effect of temperature on TrN. Liquid junction potential-determination and minimization.

Energetics of cell reactions: Effect of temperature, pressure and concentration on energetics of cell reactions (calculation of ΔG, ΔH and ΔS). Electrochemical energy sources – batteries, classification, primary & secondary.

Corrosion: Manifestations of corrosion, types of corrosion, basis of electrochemical corrosion, theories of corrosion. Local cell theory (Wagner and Traud theory), Corrosion inhibition and prevention.

[16 HOURS]

References:

1. Thermodynamics for Chemists by S. Glasstone, Affiliated East-West Press, New Delhi, (1965).
2. Chemical Thermodynamics by I.M. Klotz, W.A. Benzamin Inc. New York, Amsterdam (1964).
3. Basic Physical Chemistry by W.J. Moore, Prentice Hall of India Pvt. Ltd., New Delhi (1986).
4. Text Book of Physical Chemistry by Samuel Glasstone, MacMillan Indian Ltd., 2nd edition (1974).
5. Theoretical Chemistry by S. Glasstone.
6. Elementary Statistical Thermodynamics by N.D. Smith Plenum Press, NY (1982).
7. Elements of Physical Chemistry by Lewis and Glasstone.
8. Physical Chemistry by P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990)
9. Chemical Kinetics by K.J. Laidler.
10. Chemical Kinetics by Frost and Pearson.
11. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J.C. Kuriacose.
12. Chemical Kinetics by L.K. Jain.
13. Chemical Kinetics by Benson.

PRACTICALS – HARD CORE

ANALYTICAL CHEMISTRY PRACTICALS

Course Code: CHA 050

Course Outcomes

After studying this course the student to:

CO1: Analyze various samples with different classical and simple instrumental skills.
CO2: Obtain knowledge for selection of analytical methods with suitable technique being adopted for the analysis different samples like, water, laboratory chemicals and reagents, body fluids such as urine etc.
CO3: Distinguish classical and instrumental methods.
CO4: Propose and conduct experiment for quantification of individual analytes.

[128 HOURS]

PART – I

1. Determination of total acidity of vinegar and wines by acid-base titration.
2. Determination of purity of a commercial boric acid sample, and Na_2CO_3 content of washing soda.
3. Determination of relative equivalent weight of a weak organic acid by titration with NaOH.
4. Determination of ephedrine and aspirin in their tablet preparations by residual acid-basetitrimetry.
5. Determination of carbonate and bicarbonate in a mixture by *p*H-metric titration and comparison with visual acid-base titration.
6. Determination of carbonate and hydroxide-analysis of a commercial washing soda by visual and *p*H-titrimetry.
7. Determination of purity of a commercial sample of mercuric oxide by acid-base titration.
8. Determination of benzoic acid in food products by titration with methanolic KOH in chloroform medium using thymol blue as indicator.
9. Determination of the *p*H of hair shampoos and *p*H determination of an unknown soda ash.
10. Analysis of water/ waste water for acidity by visual, *p*H metric and conductometric titrations.
11. Analysis of water/ waste water for alkalinity by visual, *p*H metric and conductometric titrations.
12. Determination of ammonia in house-hold cleaners by visual and conductometric titration.
13. Determination of chromate and dichromate in mixture by acid-base titration: visual and pH metric methods.
14. Potentiometric determination of the equivalent weight and Ka for a pure unknown weak acid.

15. Determination of purity of aniline by non-aqueous acid-base titration by visual and potentiometric methods.
16. Determination of purity of ethylene glycol and glycerol by oxidimetric method using periodate (Malprade reaction).
17. Spectrophotometric determination of creatinine and phosphorus in urine.
18. Flame emission spectrometric determination of sodium, potassium and calcium in river/ lake water.

PART – II

1. Determination of percentage of chloride in a sample by precipitation titration- Mohr, Volhard and Fajan's methods.
2. Determination of silver in an alloy and Na_2CO_3 in soda ash by Volhard method.
3. Mercurimetric determination of chloride in blood or urine.
4. Determination of total hardness, calcium and magnesium hardness and carbonate and bicarbonate hardness of water by complexation titration using EDTA.
5. Determination of calcium in calcium gluconate/ calcium carbonate tablets/ injections and of calcium in milk powder by EDTA titration.
6. Determination of zinc in a sample of foot powder and thallium in a sample of rodenticide by EDTA titration.
7. Analysis of commercial hypochlorite and peroxide solution by iodometric titration.
8. Determination of copper in an ore/ an alloy by iodometry and tin in stibnite by iodimetry.
9. Determination of ascorbic acid in vitamin C tablets by titrations with $KBrO_3$ and of vitamin C in citrus fruit juice by iodimetric titration.
10. Determination of iron in razor blade by visual and potentiometric titration using sodium metavanadate.
11. Determination of iron in pharmaceuticals by visual and potentiometric titration using cerium(IV) sulphate.
12. Determination of nickel in steel by synergic extraction and boron in river water/ sewage using ferroin.
13. Determination of total cation concentration of tap water by ion-exchange chromatography.
14. Determination of magnesium in milk of magnesium tablets by ion-exchange chromatography.
15. Cation exchange chromatographic separation of cadmium and zinc and their estimation by EDTA titration.
16. Gas chromatographic determination of ethanol in beverages.
17. Solvent extraction of zinc and its spectrophotometric determination.

18. Anion exchange chromatographic separation of zinc and magnesium followed by EDTA titration of the metals.
19. Separation and determination of chloride and bromide on an anion exchanger.
20. Separation of *o*- and *p*-nitroaniline and analysis by thin layer chromatography.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.
7. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
8. Practical Clinical Biochemistry by Harold Varley and Arnold.Heinmann, 4th edition.

INORGANIC CHEMISTRY PRACTICALS

Course Code: CHA 060

Course Outcomes

After studying this course the student to:

CO1: Prepare reagents required for analysis.
CO2: Propose and conduct experiment for quantitative analysis of inorganic samples such as ore, metals, complexes mixture of metals and complexes etc.
CO3: Propose schemes for semi-micro qualitative analysis.
CO4: Develop skills for the scientific and relevant documentation and risk and security assessment.

[128 HOURS]

PART – I

1. Determination of iron in haematite using cerium(IV) solution (0.02M) as the titrant, and gravimetric estimation of insoluble residue.
2. Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.
3. Determination of manganese dioxide in pyrolusite using permanganate titration.
4. Quantitative analysis of copper-nickel in alloy/ mixture:
    i. Copper volumetrically using KIO_3.
    ii. Nickel gravimetrically using DMG
5. Determination of lead and tin in a mixture: Analysis of solder using EDTA titration.
6. Quantitative analysis of chloride and iodide in a mixture:
    i. Iodide volumetrically using KIO_3
    ii. Total halide gravimetrically
7. Gravimetric analysis of molybdenum with 8-hydroxyquinoline.
8. Micro-titrimetric estimation of :
    a) Iron using cerium(IV)
    b) Calcium and magnesium using EDTA
9. Quantitative estimation of copper(II), calcium(II) and chloride in a mixture.
10. Circular paper chromatographic separation of: (Demonstration)
    a. Iron and nickel
    b. Copper and nickel

PART – II

Semimicro qualitative analysis of mixtures containing **TWO** anions and **TWO** cations (excluding sodium, potassium and ammonium cations) and **ONE** of the following less common cations: W, Mo, Ce, Th, Ti, Zr, V, U and Li.

References

1. Vogel's Text Book of Quantitative Chemical Analysis – 5th edition, J. Basset, R.C. Denney, G.H. Jeffery and J. Mendhom.
2. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel, 3rd edition.
3. Spectrophotometric Determination of Elements by Z. Marczenko.
4. Vogel's Qualitative Inorganic Analysis – Svelha.
5. Macro and Semimicro Inorganic Qualitative Analysis by A.I. Vogel.
6. Semimicro Qualitative Analysis by F.J. Welcher and R.B. Halin.
7. Quantitative Chemical Analysis by Daniel C. Harris, 7th edition, (2006).

ORGANIC CHEMISTRY PRACTICALS

Course Code: CHA 070

Course Outcomes

After studying this course, the student to:

CO1: Prepare several simple organic compounds and also propose suitable mechanisms.
CO2: Acquire knowledge of different reactions, conditions to be maintained, precautions to be exercised before/during/after the reaction.
CO3: Learn qualitative analysis and to separate a mixture of two components.
CO4: Gain confidence to set up reactions individually either in the pharma industry or for the Research.

[128 HOURS]

PART – I

1. Preparation of *p*-nitro aniline from acetanilide.
2. Preparation of *p*-bromo aniline from acetanilide.
3. Preparation of benzoic acid from benzaldehyde
4. Preparation of n-butyl bromide from n-butanol.
5. Preparation of *p*-nitroiodobenzene from paranitroaniline.
6. Preparation of aniline from nitrobenzene.
7. Preparation of ß-*D*-Glucose penta acetate.
8. Preparation of phenoxy acetic acid.
9. Preparation of cyclohexanone from cyclohexanol.
10. Preparation of chalcone.
11. Preparation of *S*-benzylthiuronium chloride.
12. Condensation of anthracene and maleic anhydride (Diels-Alder reaction).
13. Preparation of *m*-nitrobenzoic acid from methyl benzoate.

PART – II

Qualitative analysis: Separation of binary mixtures, identification of functional groups and preparation of suitable solid derivatives.

References

1. Manual of Organic Chemistry -Dey and Seetharaman.

2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry -Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry–A.I. Vogel, Vol.III.
5. Practical Organic Chemistry, Mann & Saunders.
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet.
7. J. N. Guthru & R. Kapoor, Advance experimental Chemistry, New Delhi-1991.
8. R. K. Bansal, Laboratory Manual of Organic Chemistry, New PGE International (P) LTd. London, 3rd edition. 1996.18
9. N. K. Visno, Practical Organic Chemistry, New PGE International (P) Ltd. London, 3rd edition, 1996.

PHYSICAL CHEMISTRY PRACTICALS

Course Code: CHA 080

Course Outcomes

After studying this course, the student to:

CO1: An idea about handling of instruments like UV-Visible Spectrophotometer, Potentiometer, pH meter, etc.
CO2: Determine the concentration of the species in given solutions using kinetic methods.
CO3: Distinguish between different physical properties of substances or compounds.
CO4: Acquire knowledge of different thermodynamic parameters.

[128 HOURS]

PART – I (Non-instrumental)

1. Study of kinetics of hydrolysis of an ester using HCl/ H_2SO_4 at two different temperature, determination of rate constants and energy of activation.
2. Study of kinetics of the iodine-hydrogen peroxide clock reaction.
3. Determination of activation energy for the bromide-bromate reaction.
4. Determination of heat of solution of benzoic acid by variable temperature method (graphical method).
5. Determination of partial molar volume of NaCl-H_2O system.
6. Determination of critical solution temperature of phenol-water system.
7. Binary analysis of two miscible liquids by viscometric method (Ethanol & Water).
8. To study oscillating or periodic or rhythmic reactions of malonic acid.
9. Thermometric titration of hydrochloric acid with NaOH.

10. Kinetics of photodegradation of indigocarmime(IC) using ZnO as photocatalyst and study the effect of [ZnO] and [IC] on the rate of photodegradation.

PART – II (Instrumental)

1. Conductometric titration of a mixture of HCl and CH_3COOH against NaOH.
2. Conductometric titration of orthophosphoric acid /formic acid/ oxalic acid against NaOH and NH_4OH.
3. Determination of PI of glycine by by potentiometric method.
4. Potentiometric titration of KI vs $KMnO_4$ solution.
5. pH Titration of (a) polybasic acid(H_3PO_4), (b) (CH_3COOH+HCl) and (c) $CuSO_4$*vs*NaOH and determination of K_a.
6. To obtain the absorption spectra of colored complexes, verification of Beer's law and estimation of Ni^{+2} ions from $[Ni(NH_3)_6]^{2+}$ by spectrophotometry.
7. Analysis of binary mixture (Glycerol and Water) by the measurement of refractive index.
8. Study the kinetics of reaction between CAT and indigo carmine spectrophotometrically and determination of rate constant.
9. Spectrophotometric titration of $FeSO_4$ against $KMnO_4$.
10. Determination of the molecular weight of a polymer material by viscosity measurements (cellulose acetate/methyl acrylate).

References

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry – F. Daniels *et al*.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments – J. Rose.
7. Practical Physical Chemistry – S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry – R.C. Das and B. Behera, Tata Mc Graw Hill.

THEORY – SOFT CORE

APPLIED ANALYSIS I

Course Outcomes

After studying this course, the student to:

CO1: Describe the meaning of applied analysis.
CO2: Make out the causes for air pollution and water pollution, and knowledge an control devices or techniques or processes of such pollutions.
CO3: Understand the importance of food and drug analysis.
CO4: Acquire the knowledge to choose methodologies for the preliminary and complete analysis of air, water, food and drugs.
CO5: Adopt suitable analytical technique for sampling and analysis of air, water, food and drug samples for analysis.
CO6: Describe suitable analytical method for the determination of required analytes/components of the sample provided.

UNIT – I

Air pollution, analysis and control: Historical overview-global implications of air pollution, sources of pollutants, classification of pollutants. Sources and effects of particulates, carbonmonoxide, sulphur oxides, nitrogen oxides, hydrocarbons and photochemical oxidants on human health, vegetation and materials.Standards for air pollutants.

Air quality monitoring: Sampling methods and devices for particulates and gaseous pollutants.SO_2: ambient air measurements and stack gas measurements-Turbidimetric,colorimetric, conductometric and coulometric methods, NOX: Griess-Ilosvay and Jacobs-Hockheiser colorimetric methods, Hydrocarbons: total and individual hydrocarbons by gas chromatography. Oxidants and ozone: colorimetric, titrimetric and chemiluminescence methods.

Control devices for particulates: Gravitational settlers, centrifugal collectors, wet collectors, electrostatic precipitation and fabric filtration.

Control devices for gaseous pollutants: adsorption, absorption, condensation and combustion processes. Automative emission control-catalytic converters.

Water pollution and analysis: Water resources, origin of wastewater, types of water pollutants; their sources and effects, chemical analysis for water pollution control-objectives of analysis, parameters of analysis, sample collection and preservation. Environmental and public health significance and measurement of colour, turbidity, total solids, acidity, alkalinity, hardness, chloride, residual chlorine, chlorine demand,sulphate, fluoride, phosphates, total nitrogen, NO_3^-

and NO_2^-nitrogesn in natural and waste/ polluted waters, heavy metal pollution-public health significance of Pb, Cd, , Hg, andAs, general survey of the instrumental techniques for the analysis of heavy metals in aquatic systems, organic loadings-significance and measurement of DO, BOD, COD, TOD, and TOC.

[16 HOURS]

UNIT – II

Food analysis: Objectives of food analysis. Sampling procedures.Detection and determination of sugars and starch.Methods for protein determination.Oils and fats and their analysis-iodine value, saponification value and acid value. Rancidity-detection and determination (peroxide number). Tests for common edible oils.Analysis of foods for minerals-phosphorus, sodium, potassium and calcium.General methods for the determination of moisture, crude fibre and ash contents of food.Analysis of milk for fat and added water.Non-alcoholic beverages-determination of chicory and caffeine in coffee; caffeine and tannin in tea.Alcoholic beverages-methanol in alcoholic drinks and chloral hydrate in toddy. Food additives-chemical, preservatives-inorganic preservatives-sulphur dioxide and sulphites, their detection and determination. Organic preservatives-benzoic acid and benzoates, their detection and determination.Flavouring agents-detection and determination of vanilla and vanillin. Coloring matters in foods-classification, certified colors, detection of water soluble dyes, color in citrus fruits, beet dye in tomato products, mineral color. Pesticide residues in foods-determination of chlorinated organic pesticides. Control food quality-codex alimentarius, Indian standards.

Drugs and pharmaceutical analysis: Importance of quality control; drugs and pharmaceuticals. Sources of impurities in pharmaceutical chemicals.Analytical quality control in finished/ final products.Common methods of assay. Analysis of common drugs; Analgesics-aspirin, paracetamol; Anthelmintics-mebendazole; Antiallergies-chlorpheneraminemalleate; Antibiotics-penicillin, chloromecytin; Anti-inflammatory agents-oxyphenbutazone; Antimalarials-primaquine phosphate; Antituberculosists-INH; Narcotics-nicotine, morphine; Expectorants-Benadryl; Sedative-diazepam; Vitamins-A. C, B1, B2, B6, niacin and folic acid.

[16 HOURS]

References

1.Standard Methods of Chemical Analysis, A.J.Weleher(Part B), Robert E.KriegorPublishing Co.USA, 1975.

2. Environmental Chemistry, S.E. Manahan Willard grant press, London, 1983.

3. Environmental Chemical Analysis, Iain L Marr and Malcolm S. Cresser, Blackie and Son Ltd., London, 1983.

4. Chemistry for Environmental Engineering, Chair N. Sawyer and Perry L.M Canty,Mcgraw Hill Book, Co., New York, 1975.
5. The Air Pollution Hand Book, Richard Mabey, Penguin, 1978.
6. The Pollution Hand Book, Richard Mabey, Ponguin 1978.
7. Soil Chemical Analysis, M.L.Jackson, Prentice Hall of India Pvt, Ltd., New Delhi, 1973.
8. Experiments in Environmental Chemistry,P.D.Vowler and D.W. Counel, Pergamon press,Oxford 1980.
9. Manual Soil Laboratory Testing, vol I, K.H. Head, Pentech Press, London 1980.
10. A Text Book of Environmental Chemistry and Pollution Control, S.S. Dara, S.Chand andco. Ltd. New Delhi 2004.
11. Air pollution Vol II edition by A.C. Stern, Academic Press New York, 1968.
12. Instrumental Methods for Automatic Air Monitoring Systems in Air Pollution Control, Part-III edition by W.Stranss, John-Wiley and Sons, New York, 1978.
13. Analysis of Air pollutants, P.O.Warner, John Wiley and Sons, New York, 1976.
14. The Chemical Analysis Air pollutants, Interscience, New York, 1960.
15. The Analysis of Air Pollutants, W.Liethe, Ann Arbor Science Pub.Inc. Michigan 1970.
16. Environmental Chemistry, A. K. De.
17. Food Analysis, A.G. Woodman, McGraw Hill. 1971.
18. Chemical Analysis of Foods, H.E. Cox and Pearson.
19. Analysis of Foods and Food Products, J.B. Jacob.
20. A First Course in Food Analysis, A.Y. Sathe, New Age Internationals (P) Ltd., Publishers, Bangalore, 1999.
21. Analytical Agricultural Chemistry, S.L. Chopra and J.S. Kanwar, Kalyani Publishers, New Delhi, 1999.
22. Pharmaceutical Analysis, (Ed). T. Higuchi and E.B. Hanssen, John Wiley and Sons, New York, 1997.
23. Pharmaceutical Analysis-Modern Methods, Part A and B, (Ed). James W. Hunson.
24. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rd edition. CBS Publishers and Distributors, New Delhi, 1997.

FRONTIERS IN INORGANIC CHEMISTRY

Course Outcomes

After studying this course, the student to:

CO1: Know the significance of materials chemistry

CO2: Acquire knowledge of various characterization techniques

CO3: Obtain the skills about the inorganic pigments.

CO4: Obtain the skills about the nanomaterials, nanoscience and nanotechnology.

UNIT – I

Materials chemistry

General principles-Defects, nonstoichiometric compounds and solid solutions, atom and ion diffusion, solid electrolytes. Synthesis of materials-The formation of extended structures, chemical deposition.

Metal oxides, nitrides and fluorides: Monoxides of the 3d metals, higher oxides and complex oxides, oxide glasses, nitrides and fluorides.

Chalcogenides, intercalation chemistry and metal rich phases: Layered MS_2 compounds and intercalation, Chevrel phases.

Framework structures: Structures based on tetrahedral oxoanions, structures based on octahedral and tetrahedral.

Inorganic pigments: Coloured pigments, white and black inorganic materials.

Molecular materials and fullerides: Fullerides, Molecular material chemistry.

Silicates: Structure, classification - silicates with discrete anions, silicates containing chain anion, silicates with layer structure, silicones with three dimensional net work and applications.

[16 HOURS]

UNIT – II

Nanomaterials, nanoscience and nanotechnology

Fundamentals-Terminology and history, novel optical properties of nanomaterials.

Characterization and fabrication: Characterization methods. Top-down and bottom-up fabrication. Solution based synthesis of nanoparticles. Vapour-phase synthesis of nanoparticles. Synthesis using frameworks, supports and substrates.

Artificially layered materials: Quantum wells and multiple quantum wells. Solid state superlattices. Artificially layered crystal structures.

Self-assembled nanostructures: Self-assembly and bottom-up fabrication. Supramolecular chemistry and morphosynthesis. Dimensional control in nanostructures.

Bioinorganic nanomaterials: DNA and nanomaterials. Natural and artificial nanomaterials-Biomimetics. Bionanocomposites.

Inorganic-organic nanocomposites: Uses and design strategies. Polymer nanocomposites.

[16 HOURS]

References:

1. Inorganic Chemistry, 4th edition. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Oxford University Press (2006).
2. Inorganic Chemistry Principles of Structure and Reactivity: James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Delhi University, New Delhi (2006)
3. Chemistry of the Elements – N.N. Greenwood and A. Earnshaw, Pergamon Press (1985).
4. Industrial Inorganic Chemistry – 2nd edition. K.H. Buchel, H.H. Moretto and P. Woditsh, Wiley - VCH (2000).
5. Basic Inorganic Chemistry – 3rd edition. F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons (2002).
6. 6.Inorganic Chemistry, 3rd edition. James E. Huheey, Harper and Row Publishers (1983).
7. Inorganic Chemistry, 3rd edition. G.L. Miessler and D.A. Tarr, Pearson Education (2004).
8. Inorganic Chemistry, 2nd edition. C.E. Housecroft and A.G. Sharpe, Pearson Education.

REACTION MECHANISMS

Course Outcomes

After studying this course, the student to:

CO1: Identify the reactivity of the molecules

CO2: Fate of the reaction by knowing the thermodynamic and kinetic requirements.

CO3: Identify the products, structure, and stability through mechanistic approach.

CO4: Mechanistic pathway of different reactions.

CO5: Know the nucleophilic, electrophilic and elimination reactions. Each of these will have different mechanistic route.

UNIT – I

Structure and reactivity: Brief discussion on effects of hydrogen bonding, resonance, inductive and hyperconjugation on strengths of acids and bases.

Methods of determining organic reaction mechanism: Thermodynamic and kinetic requirements for reactions, kinetic and thermodynamic control. Hammonds postulates and Curtin-Hammett principle.

Identification of products. Formation, structure, stability, detection and reactions of carbocations (classical and non-classical), carbanions, free radicals, carbenes, nitrenes, nitrile oxides, nitrile imines, nitrile ylides and arynes. Determination of reaction intermediates, isotope labeling and effects of cross over experiments. Kinetic and stereochemical evidence, solvent effect. Linear free energy relationship-Hammet equation and Taft treatment.

[16 HOURS]

UNIT – II

Basics of organic reactions: Meaning and importance of reaction mechanism, classification and examples for each class.

Aliphatic substitution reactions:

Nucleophilic substitution reactions: Kinetics, mechanism and stereochemical factors affecting the rate of $S_N1, S_N2, S_Ni, S_N1', S_N2'$ and S_Ni' reactions, Neighbouring group participation.

Electrophilic substitution reactions: S_E1 and S_E2 reactions

Aromatic substitution reactions:

Nucleophilic substitution reactions: S_N1, S_N2 and benzyne mechanism, Bucherer reaction.

Electrophilic substitution reactions: Mechanism of Friedel-Crafts alkylation and acylation, Mannich reaction, chloromethylation, Vilsmeier-Haack reaction.

Mechanism of hydrolysis of carboxylic acid derivatives: Hydrolysis of esters, amides and acid chlorides.

Elimination reactions: Mechanism and stereochemistry of eliminations - E_1, E_2, E_1cB. *cis* elimination, Hofmann and Saytzeff eliminations, competition between elimination and substitution, decarboxylation reactions. Chugaev reaction.

[16 HOURS]

References:

1. Organic Chemistry by Morrison and Boyd.

2. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mc Graw Hill, New York, 1987.

3. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.

4. E.L. Eliel and S.H. Wilen, Stereochemistry of Organic Compounds, John Wiley and Sons, New York. 1994.

5. Basic Principles of Organic Chemistry by Roberts & Caserio

6. N.S. Issacs, Reactive Intermediates in Organic Chemistry, John Wiley and Sons, New York.1974.

7. R.K. Bansal, Organic Reaction Mechanism, Wiley Eastern Limited, New Delhi, 1993.

8. J. March, Advanced Organic Chemistry, Wiley Interscience, 1994.

9. A Guide Book to Mechanism in Organic Chemistry by Petersykes

10. Stereochemistry and Mechanism through Solved Problems by P.S. Kalsi.

11. Text book of Organic Chemistry by P.S. Kalsi.

12. F.A. Carey and Sundberg, Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York, 1990.

13. S.K. Ghosh, Advanced General Organic Chemistry, Book and Alleied (P) Ltd, 1998.

14. Organic chemistry, Gram Solomons.

SOLID STATE CHEMISTRY AND CHEMISTRY OF NANOMATERIALS

Course Outcomes

After studying this course, the student to:

CO1: Learn solid state chemistry, X-ray crystallography, etc.

CO2: Learn the fundamentals of semiconductors, superconductors, nanomaterials and the methods by which nanoparticle is synthesized.

UNIT – I

Solid state chemistry: Types of imperfections, classification of imperfections, point defects, Schottky defects, Frenkel defects, disordered crystals, line defects, dislocation types, plane defects, small-angle and large-angle boundaries, stacking faults, crystal growth and twinning.

X-ray crystallography: law of interfacial angles, laws of symmetry, Miller indices, Bragg equation (no derivation), Experimental methods – powder and rotating crystal methods, indexing of powder and rotating crystal photographs. Atomic scattering factor, structure factor, Fourier synthesis and electron density diagrams. Electron diffraction of gases, experimental technique,

Scattering-Intensity curves, Wierl equation (no derivation), Radial distribution method determination of bond lengths and bond angles. Heat capacity of solids: Einstein and Debye equations (with derivation).

[16 HOURS]

UNIT – II

Semiconductors: Band theory, energy bands, intrinsic and extrinsic semiconductors. Conductivity: electrons and holes, temperature dependence on conductivity, Optical properties: absorption spectrum, photoconductivity, photovoltaic effect and luminescence. Junction properties: metal-metal junctions, metal-semiconductor junctions, p-n junctions, transistors, industrial applications of semiconductors: Mixed oxides, spinels and other magnetic materials.

Superconductors: Meissner effect, type I and II super conductors, isotope effect, basic concepts of BCS theory, manifestations of the energy gap, Josephson devices.

Chemistry of nanomaterials: Nano particles. Synthesis - Laser abalation, chemical vapour transportor (CVT) and sol-gel methods. Metal oxides nanoparticles with supercritical water and precursor method. Synthesis of metal oxides and its composite nanoparticles by solvothermal and hydrothermal methods. Carbon nanotube, carbon nanowires and its composites. Applications of nanomaterials in renewable energy. Inorganic and organic nanoporous aerogels.

[16 HOURS]

References:

1. Solid State Chemistry and its Applications, Anthony R. West.
2. Solid State Chemistry: An Introduction, 3rd edition, Lesley E. Smart and Elaine A. Moore.
3. Introduction to Solid State Physics - C. Kittel, 5th edition, Wiley Eastern Ltd.
4. Advances in Technologically Important Crystals - Binay Kumar, R.P. Tandon, Mcmillan.
5. Hand Book of Nanotechnology, Bharat Bhushan, Springer Publisher.
6. Nanotechnology - Importance and Applications, M. H. Fulekar, Ink International publisher.

SECOND SEMESTER

THEORY – HARD CORE

SEPARATION TECHNIQUES

Course Code: CHB 090

Course Outcomes:

After completion of this course, a student will be able to

CO1: Acquire knowledge of various physico-chemical separation techniques with principle, mechanism of separation, materials or compounds or analytes in the sample to be separated.
CO2: Select appropriate separation technique for intended problem.
CO3: Build knowledge to separate analytes in multi-component mixtures.
CO4: Design separation procedure for the effective solution of intended problem.
CO5: Enrich knowledge on method development and validation to propose new analytical separation method.
CO6: Describe the instrumentation required for the various separation techniques and their associated operating principles.
CO7: Understand the significance, quality, and limitations of the results produced by the various separation techniques.
CO8: Execute separation procedure and troubleshooting during the separation.

UNIT – I

Solvent extraction: Theory-Nernst partition law, efficiency and selectivity of extraction.

Extraction systems: Extraction of covalent neutral molecules, extraction of uncharged metal chelates and synergic extraction, extraction of ion-association complexes-non chelated complexes, chelated complexes and oxonium systems. Use of salting out agents.Methods of extraction-batch and continuous extractions.applications.

Solid Phase Extraction (SPE): Principles,apparatus and instrumentation. Solid phase sorbents, extraction formats - Automated solid phase extraction. Solid phase micro extraction (SPME).Applications of SPE and SPME.

Chromatography: Definition, principles and mechanism of separation, classification of chromatographic techniques. General descriptions of column chromatography-frontal analysis, displacement analysis and elution analysis. General theory of column chromatography: characterizing a chromatogram-retention time, retention volume and baseline width. Chromatographic resolution, capacity factor, column selectivity.Column efficiency-band broadening-rate theory and plate theory.Peak capacity, non ideal behavior.Optimizing

chromatographic separations using capacity factor, column selectivity and column efficiency-van Deemter equation, and its modern versions, Golay equation and Huber-Knox equations.

[16 HOURS]

UNIT – II

Gas chromatography (GC): Principles, instrumentation-mobile phase, chromatographic columns, stationary phases, sample introduction, temperature control, and detectors for gas chromatography. Quantitative and qualitative applications.

Highperformance liquid chromatography (HPLC): Principles, instrumentation- columns (analytical and guard columns), stationary phases, mobile phases, choosing a mobile phase, isocratic *vs*gradient elution, HPLC plumbing, sample introduction. Detectors for HPLC-spectroscopic, electrochemical and others, quantitative applications.

Ion exchange chromatography (IEC): Definitions, requirements for ion-exchange resin, synthesis and types of ion-exchange resins, principle, basic features of ion-exchange reactions, resin-properties-ion-exchange capacity, resin selectivity and factors affecting the selectivity, applications of IEC in preparative, purification and recovery processes.Ion chromatography (IC) : Double column IC and single column IC.

Size-exclusion chromatography: Theory and principle of size-exclusion chromatography, experimental techniques of gel-filtration chromatography (GFC) and gel-permeation chromatography (GPC), materials for packing-factors governing column efficiency, methodology and applications.

[16 HOURS]

UNIT – III

Thin layer chromatography: Principle, apparatus and methodology, applications, HPTLC

Affinity chromatography: Definitions, separation-mechanism-matrices, matrix activation, role of spacer arms and applications.

Supercritical fluid chromatography (SFC): Properties of supercritical fluids, instrumentation and operating variables, comparison of SFC with other types of chromatography, applications.

Supercritical fluid extraction: Advantages of supercritical fluid extraction, instrumentation, supercritical fluid choice, off-line and on-line extractions, typical applications of supercritical fluid extraction.

Electrophoretic methods - Electrophoresis & Capillary Electrophoresis**:** Theory-electrophoretic mobility, electroosmotic mobility, electroosmotic flow velocity, total mobility, migration time, efficiency, selectivity and resolution. Instrumentation-capillary tubes, hydrodynamic and electrokinetic methods of sample injection, applying electric field and detectors. Capillary

electrophoresis methods-capillary zone electrophoresis, micellarelectrokinetic capillary chromatography, capillary gel electrophoresis and capillary electrochromatography.

[16 HOURS]

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
6. Introduction to Instrumental Analysis, Robert. D. Braun, Pharm. Med. Prem. India, 1987.
7. Instrumental Method of Analysis, W.M. Dean and Settle, 7th edition, 1986, CBS Publishers, New Delhi.
8. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva Books Pvt. Ltd., 2002.
9. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
10. Principles and Practice of Analytical Chemistry, F. W. Fifield and Kealey, 5th edition, 2000, Blackwell Sci., Ltd. Malden, USA.

ADVANCED COORDINATION CHEMISTRY

Course Code: CHB 100

Course Outcomes:

After studying this course, the student to:

CO1: Get experience from demonstration and understanding of nomenclature and isomerism of coordination compounds, stability of coordination compounds.

CO2: Illustrate an understanding of the principles of theories of metal-ligand bond.

CO3: Demonstrate an understanding of coordination numbers and determination of stability constant of coordination compounds.

CO4: Analyze CFT, MOT, Electronic spectra, Orgel and Tanabe – Sugano diagrams.

CO5: Understand the magnetic property.

CO6: Understand the reaction and mechanisms, substitution reactions in transition metal complexes, electron transfer process.

UNIT – I

Preparation of coordination compounds: Introduction, Preparative methods - simple addition reactions, substitution reactions, oxidation-reduction reactions, thermal dissociation reactions, reactions of coordinated ligands, the trans-effect & other methods.

Stability of coordination compounds: Introduction, trends in stepwise stability constants, factors influencing the stability of metal complexes with reference to the nature of metal ion and ligands, the Irving-William series, chelate effect.

Geometries of metal complexes: Coordination numbers 2-8.

Determination of stability constants: Theoretical aspects of determination of stability constants of metal complexes by spectrophotometric, *p*H metric and polarographic methods.

Crystal field theory: Salient features of CFT, d-orbital splitting in octahedral, tetrahedral, square planar and tetragonal complexes, Jahn-Teller distortions, measurement of 10 Dq and factors affecting it. Evidences for metal-ligand covalency.

[16 HOURS]

UNIT – II

Molecular Orbital Theory: Introduction, Principles of Molecular orbital theory, sigma and pi-bonds in MOT. Applications to Ligand filed theory. MOT to octahedral, tetrahedral and square planar complexes with and without pi-bonding.

Electronic spectra: Introduction, selection rules and intensities, electronic spectra of octahedral and tetrahedral complexes, Term symbols for d^n ions, Orgel and Tanabe-Sugano diagrams, charge-transfer spectra. Ligand-field transition, Optical rotatory dispersion and Circular dichroism.

Magnetic properities: Origin of magnetism, types of magnetism, Curie law, Curie Weiss law, magnetic susceptibility and its measurements. Spin and orbital contributions to the magnetic moment, the effects of temperature on μeff, spin-cross over, ferromagnetism, antiferromagnetism and ferrimagnetism.

[16 HOURS]

UNIT - III

Reaction and Mechanisms: Introduction

Substitution reactions - Inert and labile compounds, mechanisms of substitution.

Kinetic consequences of Reaction pathways - Dissociation, interchange and association. Experimental evidence in octahedral substitution - Dissociation, associative mechanisms, the conjugate base mechanism, the kinetic chelate effect.

Stereochemistry of reactions- Substitution in trans and its complexes, isomerization of chelate rings.

Substitution reactions of square-planar complexes - kinetics and stereochemistry of square-planar substitutions, evidence for associative reactions, explanations of the trans effect.

Electron-transfer processes: Inner-sphere mechanism and outer-sphere mechanism, conditions for high and low oxidation numbers.

[16 HOURS]

References

1. Physical Inorganic Chemistry - A Coordination Chemistry Approach- S.F.A. Kettle, Spektrum, Oxford, (1996).
2. Inorganic Chemistry - 2nd edition, C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd., (2005).
3. Inorganic Chemistry - 3rd edition, G.L. Miessler and D.A. Tarr, Pearson Education, (2004).
4. Inorganic Chemistry - 2nd edition, D.F. Shriver, P.W. Atkins and C.H. Langford, Oxford University Press, (1994).
5. Inorganic Chemistry- 3rd edition, James E. Huheey, Harper and Row Publishers, (1983).
6. Basic Inorganic Chemistry- 3rd edition, F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons, (2002).

ORGANIC CHEMISTRY-II

Course Code: CHB 110

Course Outcomes:

After studying this course, the student to:

CO1: Judge which reagent is needed for a particular type of reaction.

CO2: Learn the mechanism by which reagent/s work during the reaction.

CO3: Know about Environmental friendly reactions, Green Synthesis, choice of

solvents/reagents/catalysts that needs be incorporated for the reactions.

CO4: Learn about the thermal or photochemical conditions and the different products formed.

CO5: Judge the stereochemistry of the products obtained.

CO6: Acquire knowledge on pericyclic reactions, concerned pathways, judge stereochemistry, products and different reaction conditions.

UNIT – I

Reductions: Catalytic hydrogenations (homogeneous and heterogeneous) - catalysts, reduction of functional groups, catalytic hydrogen transfer reactions. Wilkinson catalyst. Baker's yeast, $LiAlH_4$, $NaBH_4$, metal dissolving reactions (Birch reduction). Leukart reaction (reductive amination), diborane, Meerwein-Ponndorf-Verley reduction, Wolf-Kishner reduction, Clemensen reduction, tributyl tinhydride, stannous chloride.

Oxidations: Oxidation with chromium and manganese compounds (CrO_3, $K_2Cr_2O_7$, PCC, PDC, Sarret reagent, Jones reagent, MnO_2, $KMnO_4$), ozone, peroxides and peracids, lead tetra acetate, periodic acid, OsO_4, SeO_2, NBS, chloramine-T, Sommelet oxidation, Oppenauer oxidation, Sharpless epoxidation, Woodward and Prevost hydroxylation. Electrochemical Oxidation and reduction of organic compounds, green oxidation agents.

[16 HOURS]

UNIT – II

Reagents in organic synthesis: Use of following reagents in organic synthesis and functional group transformations: Lithium disopropylamide (LDA), Gilmann reagent, dicyclohexyl carbodimide (DCC), dichloro dicyano quinone (DDQ), trialkyl silyl halides, phase transfer catalyst, crown ethers, Fenton's reagent, Ziegler-Natta catalyst, diazomethane, Stark enamine reaction, Phosphorus ylides – Wittig and related reactions, 1,3-dithiane anions - Umpolung reaction, sulphur ylides – reactions with aldehydes and ketones, Peterson reactions - synthesis of alkenes.

Green Synthesis: Designing of green synthesis, choice of reagents and catalysis. Microwave induced organic synthesis, ionic liquids in organic synthesis, polymer supported reagents and synthesis and the use of ultra sound in organic synthesis.

[16 HOURS]

UNIT – III

Photochemistry and concerted reactions: Introduction, light absorption and electronic transitions, Jablonski diagram, intersystem crossing, energy transfer, sensitizers, quenchers.

Photochemistry of olefins, conjugated dienes, aromatic compounds, ketones, enones, photooxidations, photoreductions, Norrish type I and II reactions, Paterno-Buchi reaction, Barton reaction, Di-pi-rearrangements.

Electrocyclic reactions: Stereochemistry, symmetry and Woodward-Hofmann rules for electrocyclic reactions, FMO theory of electrocyclic reactions, correlation diagram for cyclobutadiene and cyclohexadiene systems.

Cycloaddition reactions: Classification, analysis by FMO and correlation diagram method. **1,3-dipolar cycloadditions**: involving nitrile oxide, nitrile imine, nitrile ylide cycloaddition. Intra and intermolecular 3+2 cycloaddition and their application in organic synthesis. **[4+2] cycloaddition reactions**: Deils-Alder reacion, hetero Diels-Alder reaction and their applications.

Sigmatropic reactions: Classification, stereochemistry and mechanisms. suprafacial and antarafacial shifts of H, sigmatropic shifts involving carbon moieties. [3,3] and [5,5]- sigmatropic rearrangement, Claisen, Cope and aza-Cope rearrangement

[16 HOURS]

References

1. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mac Grow Hill, New York, 1987.
2. Organic Chemistry - Morrison and Boyd
3. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. 1 & II, 1984.
4. J. March, Advanced Organic Chemistry, Wiley Interscience, 1994.
5. E.S. Gould, Mechanism and Structure in Organic Chemistry, Halt, Rinhart & Winston, New York, 1964.
6. F.A. Carey and Sundberg. Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York. 1990.
7. Principles of Organic Synthesis - ROC Norman and Coxon
8. S.K. Ghosh, Advanced General Organic Chemistry, Book and Allied (P) Ltd. 1998.
9. R.K. Kar, Frontier orbital and symmetry controlled Pericyclic reaction.

PHYSICAL CHEMISTRY – II

Course Code: CHB 120

Course Outcomes:

After studying this course, the student to:

CO1: Learn the principles of microwave, vibration, Raman, UV-Visible, NQR and

Mossbauer spectroscopic techniques.

CO2: Know the interaction of electromagnetic radiation with matter.

CO3: Gain knowledge about the fundamental concepts like black body radiation, photoelectric effect, Schrodinger wave equation and applications, etc.

CO4: Acquire knowledge on calculation of ionization energy and binding energy by simple expressions.

UNIT – I

Quantum Chemistry: A brief resume of black body radiation, and atomic spectra-Bohr's theory of hydrogen atom. Photoelectric and Compton effects, de-Broglie concept, uncertainty principle, operators (algebra of operators, commutative and non-commutative operators, linear operator, Laplacian operator, Hermitian operator-Hamiltonian operator, turn over rule. Schrodinger wave equation for particles, Eigen values and Eigen functions, postulates of quantum mechanics. Application of Schrodinger equation to a free particle and to a particle trapped in a potential field (one dimension and three dimensions). Degeneracy, Wave equation for H-atom, separation and solution of R, ϕ and θ equations. Application of Schrodinger equation to rigid rotator and harmonic oscillator. Quantum numbers and their characteristics, orbital diagrams.

Approximate methods – Necessity of approximate methods, perturbation method, and the theory of perturbation method – first order and second order correction, application to He-atom (first order correction only).

[16 HOURS]

UNIT-II

Microwave spectroscopy: Rotation spectra of diatomic Molecules - rigid and non rigid rotator model. Rotational quantum number and the selection rule. Effect of isotopic substitution on rotation spectra. Relative intensities of the spectral lines. Classification of polyatomic molecules based on moment of inertia - Linear, symmetric top, asymmetric top and spherical molecules. Rotation spectra of polyatomic molecules (OCS,CH_3F and BCl_3). Moment of inertia expression for linear tri-atomic molecules. Applications - Principles of determination of Bond length and moment of inertia from rotational spectra. Stark effect in rotation spectra and determination of dipole moments.

Vibration spectroscopy: Vibration of diatomic molecules, vibrational energy curves for simple harmonic oscillator. Effects of anharmonic oscillation. Vibration - rotation spectra of carbon monoxide. Expressions for fundamental and overtone frequencies. Vibration of polyatomic molecules – The number of degrees of freedom of vibration. Parallel and perpendicular vibrations (CO_2 and H_2O). fundamental, overtone, combination and difference bands. Fermi resonance. Force constant and its significance. Theory of infrared absorption and theoretical

group frequency. Intensity of absorption band and types of absorptions. Correlation chart. Important spectral regions - hydrogen stretching region, double and triple bonds regions, fingerprint region. Factors affecting the group frequency – Physical state, vibrational coupling, electrical effect, hydrogen bonding, steric effect and ring strain. Applications: Structures of small molecules: XY_2 – linear or bent, XY_3 – planar or pyramidal.

[16 HOURS]

UNIT- III

Raman spectroscopy: Introduction, Raman and Rayleigh scattering, Stokes and anti-Stokes lines, polarization of Raman lines, depolarization factor, polarizability ellipsoid. Theories of Raman spectra - classical and quantum theory. Rotation-Raman and vibration-Raman spectra. Comparison of Raman and IR spectra, rule of mutual exclusion principle. Vibration modes of some simple molecules and their activity in Raman.

UV Visible spectroscopy: Quantitative aspects of absorption – Beer's law, Technology associated with absorption measurements. Limitations of the law – real, chemical, instrumental and personal.

NQR Spectroscopy: Quadrupolar nuclei, electric field gradient, nuclear quadrupole coupling constants, energies of quadrupolar transitions, effect of magnetic field. Applications.

Mössbauer spectroscopy: The Mössbauer effect, chemical isomer shifts, quadrupole interactions, measurement techniques and spectrum display, application to the study of Fe^{2+} and Fe^{3+} compounds, Sn^{2+} and Sn^{4+} compounds, nature of M-L bond, coordination number and structure), detection of oxidation states and inequivalent Mössbauer atoms.

Electron Spin Resonance Spectroscopy: Basic principles, hyperfine couplings, the 'g' values, factors affecting 'g' values, isotropic and anisotropic hyperfine coupling constants, Zero Field splitting and Kramer's degeneracy. Measurement techniques and Applications to simple inorganic and organic free radicals and to inorganic complexes.

[16 HOURS]

References

1. Vibrational Spectroscopy - Theory and Applications- D.N. Sathyanarayana, New Age International Publications, New Delhi (1996).
2. Spectroscopy, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York, Vol. 1 and 2, 1976.
3. Vibration Spectroscopy Theory and Applications, D.N. Satyanarayana, New Age International, New Delhi.

4. Spectroscopy, B.P. Straughan and S. Salker, John Wiley and Sons Inc., New York, Vol.2, 1976.
5. Organic Spectroscopy, William Kemp, English Language Book society, Macmillan, 1987.
6. Quantum Chemistry – A.K. Chandra. 2nd edition, Tata McGraw Hill Publishing Co. Ltd., (1983).
7. Quantum Chemistry – Eyring, Walter and Kimball. John Wiley and Sons, Inc., New York.
8. Quantum Chemistry – I.N. Levine. Pearson Education, New Delhi, (2000).
9. Theoretical Chemistry – S. Glasstone. East West Press, New Delhi, (1973).
10. Quantum Chemistry – R.K. Prasad, New Age International Publishers, (1996).
11. Valence Theory – Tedder, Murel and Kettle.
12. Quantum Chemistry – D.A. McQuarrie.
13. Theoretical Inorganic Chemistry – Day and Selbin.
14. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash. 4th edition, Tata McGraw Hill, New Delhi.
15. Introduction to Spectroscopy - Pavia, Lampman and Kriz, 3rd edition, Thomson.
16. Spectroscopy, B.P. Straughan and S. Walker, John Wiley & Sons Inc., New York, Vol. 1 and 2, 1976.
17. Vibration Spectroscopy Theory and Applications, D.N. Satyanarayana, New Age International, New Delhi.
18. D. A. McQuarrie and J.D. Simon –Physical Chemistry, VIVA Students Ed. (2003).
19. J. D. Graybeat. Molecular Spectroscopy, McGraw-Hill International Edition (1988). Spectroscopy of Organic Compounds-3rd Ed.-P.S. Kalsi (New Age, New Delhi) 2000.
20. E.A.V. Ebsworth, D.W.H. Ranklin and S. Cradock: Structural Methods in Inorganic Chemistry, Blackwell Scientific, 1991.
21. J. A. Iggo: NMR Spectroscopy in Inorganic Chemistry, Oxford University Press, 1999.
22. C. N. R. Rao and J. R. Ferraro: Spectroscopy in Inorganic Chemistry, Vol I & II (Academic) 1970.
23. Spectroscopy, B. P. Straughan and S. Salker, John Wiley and Sons Inc., New Yourk, Vol.2, 1976.

PRACTICALS – HARD CORE

ANALYTICAL CHEMISTRY PRACTICALS

Course Code: CHB 050

Course Outcomes

After studying this course, the student to:

CO1: Analyze various samples with different classical and simple instrumental skills.

CO2: Obtain knowledge for selection of analytical methods with suitable techniques.

CO3: Distinguish classical and instrumental methods.

CO4: Propose and conduct experiment for quantification of individual analytes.

[128 HOURS]

PART – I

1. Determination of total acidity of vinegar and wines by acid-base titration.
2. Determination of purity of a commercial boric acid sample, and Na_2CO_3 content of washing soda.
3. Determination of relative equivalent weight of a weak organic acid by titration with NaOH.
4. Determination of ephedrine and aspirin in their tablet preparations by residual acid-basetitrimetry.
5. Determination of carbonate and bicarbonate in a mixture by *p*H-metric titration and comparison with visual acid-base titration.
6. Determination of carbonate and hydroxide-analysis of a commercial washing soda by visual and *p*H-titrimetry.
7. Determination of purity of a commercial sample of mercuric oxide by acid-base titration.
8. Determination of benzoic acid in food products by titration with methanolic KOH in chloroform medium using thymol blue as indicator.
9. Determination of the *p*H of hair shampoos and *p*H determination of an unknown soda ash.
10. Analysis of water/ waste water for acidity by visual, *p*H metric and conductometric titrations.
11. Analysis of water/ waste water for alkalinity by visual, *p*H metric and conductometric titrations.
12. Determination of ammonia in house-hold cleaners by visual and conductometric titration.
13. Determination of chromate and dichromate in mixture by acid-base titration: visual and pH metric methods.
14. Potentiometric determination of the equivalent weight and Ka for a pure unknown weak acid.

15. Determination of purity of aniline by non-aqueous acid-base titration by visual and potentiometric methods.
16. Determination of purity of ethylene glycol and glycerol by oxidimetric method using periodate (Malprade reaction).
17. Spectrophotometric determination of creatinine and phosphorus in urine.
18. Flame emission spectrometric determination of sodium, potassium and calcium in river/ lake water.

PART – II

1. Determination of percentage of chloride in a sample by precipitation titration- Mohr, Volhard and Fajan's methods.
2. Determination of silver in an alloy and Na_2CO_3 in soda ash by Volhard method.
3. Mercurimetric determination of chloride in blood or urine.
4. Determination of total hardness, calcium and magnesium hardness and carbonate and bicarbonate hardness of water by complexation titration using EDTA.
5. Determination of calcium in calcium gluconate/ calcium carbonate tablets/ injections and of calcium in milk powder by EDTA titration.
6. Determination of zinc in a sample of foot powder and thallium in a sample of rodenticide by EDTA titration.
7. Analysis of commercial hypochlorite and peroxide solution by iodometric titration.
8. Determination of copper in an ore/ an alloy by iodometry and tin in stibnite by iodimetry.
9. Determination of ascorbic acid in vitamin C tablets by titrations with $KBrO_3$ and of vitamin C in citrus fruit juice by iodimetric titration.
10. Determination of iron in razor blade by visual and potentiometric titration using sodium metavanadate.
11. Determination of iron in pharmaceuticals by visual and potentiometric titration using cerium(IV) sulphate.
12. Determination of nickel in steel by synergic extraction and boron in river water/ sewage using ferroin.
13. Determination of total cation concentration of tap water by ion-exchange chromatography.
14. Determination of magnesium in milk of magnesium tablets by ion-exchange chromatography.
15. Cation exchange chromatographic separation of cadmium and zinc and their estimation by EDTA titration.
16. Gas chromatographic determination of ethanol in beverages.
17. Solvent extraction of zinc and its spectrophotometric determination.

18. Anion exchange chromatographic separation of zinc and magnesium followed by EDTA titration of the metals.
19. Separation and determination of chloride and bromide on an anion exchanger.
20. Separation of *o*- and *p*-nitroaniline and analysis by thin layer chromatography.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc, India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003, Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. Bothers Medical Publishers (P) Ltd., 1995.
7. Laboratory manual in biochemistry, J. Jayaraman, New Age International Publishers, New Delhi, 1981.
8. Practical Clinical Biochemistry by Harold Varley and Arnold.Heinmann, 4th edition.

INORGANIC CHEMISTRY PRACTICALS

Course Code: CHB 060

Course Outcomes

After studying this course, the student to:

CO1: Prepare reagents required for analysis.

CO2: Propose and conduct experiment for quantitative analysis of inorganic samples such as ore, metals, complexes mixture of metals and complexes etc.

CO3: Propose schemes for semi-micro qualitative analysis.

CO4: Develop skills for the scientific and relevant documentation and risk and security assessment.

[128 HOURS]

PART – I

1. Determination of iron in haematite using cerium(IV) solution (0.02M) as the titrant, and gravimetric estimation of insoluble residue.
2. Estimation of calcium and magnesium carbonates in dolomite using EDTA titration, and gravimetric analysis of insoluble residue.
3. Determination of manganese dioxide in pyrolusite using permanganate titration.
4. Quantitative analysis of copper-nickel in alloy/ mixture:
    a) Copper volumetrically using KIO_3.
    b) Nickel gravimetrically using DMG
5. Determination of lead and tin in a mixture: Analysis of solder using EDTA titration.
6. Quantitative analysis of chloride and iodide in a mixture:
    a) Iodide volumetrically using KIO_3
    b) Total halide gravimetrically
7. Gravimetric analysis of molybdenum with 8-hydroxyquinoline.
8. Micro-titrimetric estimation of :
    a) Iron using cerium(IV)
    b) Calcium and magnesium using EDTA
9. Quantitative estimation of copper(II), calcium(II) and chloride in a mixture.
10. Circular paper chromatographic separation of: (Demonstration)
    a) Iron and nickel
    b) Copper and nickel

PART – II

Semimicro qualitative analysis of mixtures containing **TWO** anions and **TWO** cations (excluding sodium, potassium and ammonium cations) and **ONE** of the following less common cations: W, Mo, Ce, Th, Ti, Zr, V, U and Li.

References

1. Vogel's Text Book of Quantitative Chemical Analysis – 5th edition, J. Basset, R.C. Denney, G.H. Jeffery and J. Mendhom.
2. A Text Book of Quantitative Inorganic Analysis by A.I. Vogel, 3rd edition.
3. Spectrophotometric Determination of Elements by Z. Marczenko.
4. Vogel's Qualitative Inorganic Analysis – Svelha.
5. Macro and Semimicro Inorganic Qualitative Analysis by A.I. Vogel.

6. Semimicro Qualitative Analysis by F.J. Welcher and R.B. Halin.
7. Quantitative Chemical Analysis by Daniel C. Harris, 7th edition, (2006).

ORGANIC CHEMISTRY PRACTICALS

Course Code: CHB 070

Course Outcomes

After studying this course, the student to:

CO1: Prepare several simple organic compounds and also propose suitable mechanisms.

CO2: Acquire knowledge of different reactions, conditions to be maintained, precautions to be exercised before/during/after the reaction.

CO3: Learn qualitative analysis and to separate a mixture of two components.

CO4: Gain confidence to set up reactions individually either in the pharma industry or for the Research.

[128 HOURS]

PART – I

1. Preparation of *p*-nitro aniline from acetanilide.
2. Preparation of *p*-bromo aniline from acetanilide.
3. Preparation of benzoic acid from benzaldehyde
4. Preparation of n-butyl bromide from n-butanol.
5. Preparation of *p*-nitroiodobenzene from paranitroaniline.
6. Preparation of aniline from nitrobenzene.
7. Preparation of ß-*D*-Glucose penta acetate.
8. Preparation of phenoxy acetic acid.
9. Preparation of cyclohexanone from cyclohexanol.
10. Preparation of chalcone.
11. Preparation of *S*-benzylthiuronium chloride.
12. Condensation of anthracene and maleic anhydride (Diels-Alder reaction).
13. Preparation of *m*-nitrobenzoic acid from methyl benzoate.

PART – II

Qualitative analysis: Separation of binary mixtures, identification of functional groups and preparation of suitable solid derivatives.

References

1. Manual of Organic Chemistry -Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry -Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry–A.I. Vogel, Vol.III.
5. Practical Organic Chemistry, Mann & Saunders.
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet.
7. J. N. Guthru & R. Kapoor, Advance experimental Chemistry, New Delhi-1991.
8. R. K. Bansal, Laboratory Manual of Organic Chemistry, New PGE International (P) LTd. London, 3rd edition. 1996.18
10. N. K. Visno, Practical Organic Chemistry, New PGE International (P) Ltd. London, 3rd edition, 1996.

PHYSICAL CHEMISTRY PRACTICALS

Course Code: CHB 080

Course Outcomes

After studying this course, the student to:

CO1: An idea about handling of instruments like UV-Visible Spectrophotometer, Potentiometer, pH meter, etc.

CO2: Determine the concentration of the species in given solutions using kinetic methods.

CO3: Distinguish between different physical properties of substances or compounds.

CO4: Acquire knowledge of different thermodynamic parameters.

[128 HOURS]

PART – I (Non-instrumental)

1. Study of kinetics of hydrolysis of an ester using HCl/ H_2SO_4 at two different temperature, determination of rate constants and energy of activation.
2. Study of kinetics of the iodine-hydrogen peroxide clock reaction.
3. Determination of activation energy for the bromide-bromate reaction.
4. Determination of heat of solution of benzoic acid by variable temperature method (graphical method).

5. Determination of partial molar volume of NaCl-H_2O system.
6. Determination of critical solution temperature of phenol-water system.
7. Binary analysis of two miscible liquids by viscometric method (Ethanol & Water).
8. To study oscillating or periodic or rhythmic reactions of malonic acid.
9. Thermometric titration of hydrochloric acid with NaOH.
10. Kinetics of photodegradation of indigocarmime(IC) using ZnO as photocatalyst and study the effect of [ZnO] and [IC] on the rate of photodegradation.

PART – II (Instrumental)

1. Conductometric titration of a mixture of HCl and CH_3COOH against NaOH.
2. Conductometric titration of orthophosphoric acid /formic acid/ oxalic acid against NaOH and NH_4OH.
3. Determination of PI of glycine by by potentiometric method.
4. Potentiometric titration of KI vs $KMnO_4$ solution.
5. pH Titration of (a) polybasic acid(H_3PO_4), (b) (CH_3COOH+HCl) and (c) $CuSO_4$*vs*NaOH and determination of K_a.
6. To obtain the absorption spectra of colored complexes, verification of Beer's law and estimation of Ni^{+2} ions from $[Ni(NH_3)_6]^{2+}$ by spectrophotometry.
7. Analysis of binary mixture (Glycerol and Water) by the measurement of refractive index.
8. Study the kinetics of reaction between CAT and indigo carmine spectrophotometrically and determination of rate constant.
9. Spectrophotometric titration of $FeSO_4$ against $KMnO_4$.
10. Determination of the molecular weight of a polymer material by viscosity measurements (cellulose acetate/methyl acrylate).

References

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry – F. Daniels *et al*.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments – J. Rose.
7. Practical Physical Chemistry – S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.

9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry – R.C. Das and B. Behera, Tata Mc Graw Hill.

THEORY – SOFT CORE

All the courses are same as that of I Semester and a student can chose any course of his/ her choice provided that the same course has not been studied in the I Semester.

THIRD SEMESTER

THEORY – HARD CORE

INSTRUMENTAL METHODS OF ANALYSIS

Course Code: CHC 010

Course Outcomes:

After studying this course, the student to:

CO1: Gain the knowledge on the differences between classical and instrumental methods of chemical analysis.

CO2: Explain different types of instrumental methods employed in chemical analysis.

CO3: Develop an understanding of the range and theories of instrumental methods available in analytical chemistry.

CO4: Make clear distinctions among spectrometric, electro-analytical, thermal and microscopic methods.

CO5: Gain knowledge pertaining to the appropriate instrumental techniques.

CO6: Obtain the practical experience in selected instrumental methods of analysis.

CO7: Develop the skills on instrumental methods for planning, developing, conducting, reviewing, conducting experiments and reporting results.

UNIT – I

Flame photometry and Atomic absorption spectrometry: Energy level diagrams-atomic absorption spectra. Flame characteristics. Flame atomizers and electrothermal atomization.Comparison of spectral interferences, chemical and physical interferences in FP and AAS. Background correction methods in AAS.Use of organic solvents. Quantitative techniques-calibration curve procedure and the standard addition technique. Typical commercial instruments for FP and AAS (Single and double beam atomic absorption spectrophotometers), applications of FES and AAS.Qualitative analysis and quantitative evaluations. Relative detectabilities of atomic absorption and flame emission spectrometry.

Molecular luminescence spectrometry: Theoretical basis for fluorescence and phosphorescence. Singlet and triplet excited states. Variables affecting luminescence-quantum efficiency, transition types, structure and structural rigidity, temperature and solvent effects, effect of *p*H, dissolved oxygen and concentration effect. Excitation spectra *vs* emission

spectra.Origin of fluorescence, relationship between fluorescence and concentration.Fluorescence instrumentation-fluorometers and spectrofluorometers.Sensitivity and selectivity.Modification necessary to measure phosphorescence.Applications of fluorometry: inorganic and organic analyses.

Nephelometry and turbidometry: Principles, instrumentation and applications.

[16 HOURS]

UNIT – II

Electroanalytical methods: Classification. Potentiometers, galvanostats and potentiostats.

Potentiometric methods of analysis.Potentiometric electrochemical cells.The Nernst equation.Liquid junction potentials.Reference electrodes-SHE, calomel electrode and silver/ silver chloride electrode.Metallic indicator electrodes-electrodes of first kind and second kind.Redox electrodes.Membrane electodes –membrane potential, selectivity of membranes.Glass ion selective electrodes.Crystalline solid state ion selective electrodes.Liquid-based ion selective electrodes.Gas sensing electrodes.Potentiometric biosensors.Quantitative applications.Activity *vs* concentration.Quantitative analysis using external standards and the method of standard additions. Measurement of*p*H. Clinical and environmental applications.

Electrogravimetric analysis: Theory, apparatus, cell processes, deposition and separation, electrolytic separation of metals, applications.

Coulometric methods of analysis: General discussion, coulometry at controlled potential, apparatus and general technique, applications,coulometric titrations (amperometriccoulometric)-principles, apparatus, comparison of coulometric titrations with conventional titrations, automatic coulometric titrations, applications.

Amperometric titrations: Principle, titration curve, apparatus and techniques, applications.

Voltammetry: Fundamentals of voltammetry. Cyclic voltammetry**:** Principles and applications. Stripping analysis:Stripping voltammetry-basic principles, electrodes used for stripping analysis, apparatus for stripping analysis, applications, determination of lead in water voltammetry with micro electrodes.

[16 HOURS]

UNIT – III

Thermal method of analysis: Introduction,

Thermogravimetric analysis (TGA): Types of thermogravimetric analysis, principles and general thermal decomposition curve. Factors affecting the results-heating rate, furnace, instrument control/ data handling. Applications-purity and thermal stability, evaluation of correct drying temperature, analysis of complex mixture and determination of kinetic parameters of thermal degradation.

Differential thermal analysis (DTA): General principles. Theory-variables affecting the DTA curves. Instrumentation. Applications-analysis of the physical mixtures and thermal behaviour study. Determination of melting point, boiling point and decomposition point.

Differential scanning calorimetry (DSC): Basic principle. Instrumentation-power compensated DSC, Heat flux DSC. Applications- studies of thermal transitions and isothermal crystallization. Testing the purity of the pharmaceutical samples.

Thermomechanical analysis.Dynamic mechanical analysis**.**

Enthalpimetric analysis: Thermometric titrations and direct injection enthalpimetry: Principles, apparatus and applications.

Microscopic analysis: Principle and mechanism in characterization of compounds by scanning electron and transmission electron microscopic (SEM & TEM) techniques.Components of instruments of SEM and TEM.

[16 HOURS]

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition,1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
6. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean,7th Edition, CBS Publishers, New Delhi, 1988.
7. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
9. Introduction to Instrumental Analysis, Braun, Pharm. Med. Press. India.
10. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva Books Pvt. Ltd., New Delhi, 2002.

11. Analytical Transmission Electron Microscopy, An Introduction for OperatorsThomas, Jürgen, Gemming, Thomas., Springer, 2014.
12. Scanning Transmission Electron Microscopy, Imaging and Analysis.Pennycook, Stephen J., Nellist, Peter D. (Eds.), Springer, 2011.

SPECTROSCOPY

Course Code: CHC 020

Course Outcomes:

After studying this course, the student to:

CO1: Learn the principles involved in UV-Vis, IR, Mass and NMR spectroscopy.

CO2: Identify the unknown compounds by applying different spectroscopic techniques

CO3: Study different types of transitions that are involved in UV-Vis spectroscopy.

CO4: Assign wavelength of the organic compounds (different classes).

CO5: Identify the molecules based on the functional group present and the make a clear distinction between intra and intermolecular H-bonding.

CO6: Learn ^{1}H and ^{13}C different chemical environments and assign chemical shifts.

CO7: Learn techniques involved in the simplification of the complex spectra.

CO8: Learn to calculate the molecular weight of the unknown compounds using mass spectrometry.

CO9: Solve composite problems involving UV, IR, NMR and Mass.

UNIT – I

UV Visible spectroscopy: Introduction, electronic transitions, simple chromophoric groups - systems of extended conjugation - aromatic systems - types of auxochromes - Functions of auxochromes - absorption and intesity shift - types of trasitions - transition probability - types of absorption bonds - solvent effects and choice of solvent - effect of polarity on various type of bonds Woodwards empirical rules for predicting the wavelength of maximum absorption for conjugated dienes, cyclic trienes and polyenes, α,ß-unsaturated aldehydes and ketones, benzene and substituted benzene rings.

IR spectroscopy: Introduction, instrumentation, sample handling, modes of vibrations, Hooks law, Characteristic group frequencies and skeletal frequencies. Finger print region, Identification of functional groups - alkenes, aromatics, cabonyl compounds (aldehydes and ketones, esters and lactones), halogen compounds, sulphur and phosphorus compounds, amides, lactums, amino acids and amines. Factors affecting group frequencies and band shapes, conjugation, resonance

and inductance, hydrogen bonding and ring strain. Tautomerism, *Cis-trans* isomerism. Applications of IR spectroscopy.

[16 HOURS]

UNIT – II

Nuclear magnetic resonance spectroscopy: General introduction and definition, magnetic properties of nuclei (magnetic moment, g factor) and theory of nuclear resonance. Larmor precession frequency, resonance condition and relaxation processes.

Chemical shift: Standards employed in NMR, factors affecting chemical shift, electronegativity, shielding and deshielding mechanism, van der Waals deshielding, H-bonding, diamagnetic and paramagnetic anisotropics. Spin-spin coupling, chemical shift values and correlation for protons bonded to carbon and other nuclei. Instrumentation and sample handling.

Equivalence and magnetic equivalence proton exchange reactions, effects of chiral center, complex spin-spin interaction, stereochemistry, hindered rotation, Karplus curve - variation of coupling constants with dihedral angles. Simplification of complex spectra: isotopic substitution, increasing magnetic field strength, double resonance, spin decoupling, contact shift reagents, FT-NMR: Principle and applications, variable temperature profile, Nuclear Overhauser Effect (NOE).

[16 HOURS]

UNIT – III

^{13}C-NMR spectroscopy: Comparison of ^{1}H-NMR and ^{13}C-NMR. Multiplicity - proton decoupling, noise decoupling, off resonance decoupling, selective proton decoupling, noise decoupling by FT mode, chemical shift, application of ^{13}C-NMR. ^{31}P & ^{19}F, Two dimensional NMR.

Mass spectroscopy: Principles, instrumentation, different methods of ionization. EI, CI, FD and FAB, Ion separators - single focusing separator with magnetic deflection, double focusing analyzer, time-of-fight separator and quadrupole analyzer, Mass spectra – molecular ion, base peak, meta-stable peak. General rules for fragmentation pattern. Nitrogen rule, ortho effect, Hydrogen transfer rearrangement and McLafferty rearrangement. Mass spectral fragmentation of organic compounds (acids, esters, hydrocarbons, halogenated hydrocarbons, alcohols, carbonyl compounds, amines, ethers and heterocyclic compounds).

Composite problems: Problems involving the application of the above spectroscopic techniques for structural elucidation of organic molecules.

[16 HOURS]

References:

1. Spectroscopy, B.P. Straughan and S. Salker, John Wiley and Sons Inc., New York, Vol.2, 1976.
2. Organic Spectroscopy, William Kemp, English Language Book society, Macmillan, 1987.
3. Application of Absorption Spectroscopy of Organic Compounds, John R. Dyer, Prentice Hall of India Private Ltd., New Delhi, 1974.
4. Spectrometric Identification of Organic Compounds, 4th edition, Robert M. Silverstein, G. Clayton Bassler and Terence C. Morrill, John Wiley & Sons, New York, 1981.
5. Organic Spectroscopy, V.R. Dani, Tata MeGraw-Hall Publishing Company Limited, New Delhi. 1995.
6. Interpretation of Carbon-13 NMR Spectra, F.W. Wehrli and T. Wirthin, Heyden, London, 1976.
7. NMR spectroscopy – Powai.
8. Introduction to spectroscopy 3ed, Pavia, Lampman, Kriz.

THEORY – OPEN ELECTIVE

SELECTED TOPICS IN CHEMISTRY

Course Code: CHC 030

Course Outcomes:

After studying this course, the student to:

CO1: Gain knowledge on importance of chemistry or different branches of chemistry.

CO2: Acquire knowledge about the use of chemistry in everyday life.

CO3: Get knowledge about the extraction and purification techniques.

CO4: Learn importance of metals in biology; natural products and also various physical aspects.

UNIT – I

Solvent extraction: Basics of solvent extraction principal and application of solvent extraction.

Purification techniques: Crystallization, fractional crystallization, distillation techniques (simple distillation, steam distillation, distillation under reduced pressure, fractional distillation).

Chromatography: Definition, terms, classification of chromatographic techniques, principles of column and planar chromatography

Column chromatography: gas chromatography, high performance liquid chromatography, ion exchange chromatographic method.

Planar chromatography: Paper chromatography and TLC principles, mechanism of separation and application.

Electrophoretic methods: principles, definition, terms, types and applications.

[16 HOURS]

UNIT – II

An overview of metals in Biology: Introduction, the element content of living systems, biological chemistry of hydrogen, the economical use of resources- abundance and availability. Biological need for and the behaviors of inorganic elements.

Basic coordination chemistry for biologists: Introduction, ionic bonding, covalent bonding, coordination geometry, crystal field and ligand field theory.

Metal assimilation pathways: Introduction, metal assimilation in bacteria, plants, fungi and in mammals (iron, copper and zinc).

Metals in medicine: Introduction, *cis*-platin, radioactive pharmaceuticals, lithium compounds in therapy.

[16 HOURS]

UNIT – III

Chemistry of natural products: Carbohydrates (classification and structure of glucose, fructose, galactose, sucrose, maltose and lactose, carbohydrates as source of energy and breakdown process.

Proteins: amino acids classification and structure of α-amino acid, zwitter ion, isoelectric point and its determination by electrophoretic method, Elementary aspect of primary and secondary structures.

Vitamins: Classification, importance of vitamin A, D, E, K, B & C.

[16 HOURS]

UNIT – IV

Thermodynamics: First and second laws of thermodynamics. Concept of entropy and free energy, entropy as a measure of unavailable energy. Entropy and free energy changes and spontaneity of process. Variation of free energy with temperature and pressure. **Chemical kinetics**: Factor affecting the rate of reaction. Order of reaction and its determination. Energy of

activation and its determination. Assumption of activated complex theory. **Electrochemistry:** Arrhenius theory of strong and weak electrolytes. Assumptions of Debye-Huckel theory of strong electrolytes. Electrode potential and construction of electrochemical cells. Corrosion and its prevention. **Photochemistry:** Laws of photochemistry, quantum yield and its determination, photodegradation.

[16 HOURS]

References:

1. Arthur I Vogel, Elementary Practical Organic Chemistry, Part I, II and III, CBS Publishers and Distributors, New Delhi, India.
2. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. I and II, 1984.
3. S K. Ghosh, Advanced General Organic Chemistry, Book and Allied (P) Ltd, 1998.
4. Organic Spectroscopy, William Kemp, English Language Book society, Macmillan, 1987.
5. Application of Absorption Spectroscopy of Organic Compounds, John R. Dyer, Prentice Hall of India Private Ltd., New Delhi, 1974.
6. Spectrometric Identification of Organic Compounds, 4th edition, Robert M. Silverstein, G. Clayton Bassler and Terence C. Morrill, John Wiley & Sons, New York, 1981.
7. Basic Inorganic Chemistry- 3rd edition, F.A. Cotton, G. Wilkinson and P.L. Gaus, John Wiley and Sons, (2002).
8. Inorganic Chemistry Principles of Structure and Reactivity: James E. Huheey, Ellen A. Keiter, Richard L. Keiter, Okhil K. Medhi, Delhi University, New Delhi (2006)
9. Elements of Physical Chemistry – Lewis and Glasstone.
10. Physical Chemistry by P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990).
11. Basic Physical Chemistry by W.J. Moore, Prentice Hall, New Delhi, (1986).
12. Physical Chemistry – G.M. Barrow, McGraw Hill International Service (1988).

THEORY – SOFT CORE

INORGANIC CHEMISTRY-II

Course Outcomes:

After studying this course, the student to:

CO1: Gain knowledge from basic concepts of ionic solids, modern concept of acids and bases.

CO2: Demonstrate and understand the basic principles of acid-base chemistry and non-aqueous solvents.

CO3: Acquire knowledge to handle homogeneous and heterogeneous catalysis.

UNIT – I

Ionic solids: Introduction, Characteristic structures of ionic solids (NaCl, CsCl, ZnS, fluorite, rutile, β-crystobalite and cadmium iodide). The rationalization of structures.

The energetics of ionic bonding: Lattice enthalpy and Born-Haber cycle. Calculation of lattice enthalpies. Comparison of experimental and theoretical values of lattice enthalpy. The Kapustinskii equation. Consequences of lattice enthalpies.

Modern concept of acids and bases: Lux-Flood and Usanovich concepts, solvent system and leveling effect. Hard-Soft Acids and Bases, Classification and Theoretical backgrounds.

Supercritical fluids: Properties of supercritical fluids and their uses as solvents. Supercritical fluids as media for inorganic chemistry.

[16 HOURS]

UNIT – II

Biological and Medicinal Applications: Organomercury, boron, silicon and aresenic compounds.

Catalysis: General principles-The language of catalysis. Homogeneous and heterogeneous catalysts.

Homogeneous catalysis: Alkene hydrogenation, hydroformylation, The Wacker's process, Monsanto acetic acid process and L-DOPA synthesis, alkene oligomerizations, water-gas shift reactions. Palladium catalysed C-C bond forming reactions.

Heterogeneous catalysis: Alkene polymerization: Ziegler-Natta catalysis, Fischer-Tropsch carbon chain growth.

Zeolites as catalysts for organic transformation: Uses of ZSM - 5

Alkene metathesis, hydroboration, arylation or vinylation of olefins (Heck reaction).

Hybrid catalysts: Tethered catalysis. Biphasic systems.

Hydrosilylation: Platinum catalyst, Asymmetric palladium catalyst, Rhodium catalysts for asymmetric ketone reduction.

Asymmetric catalysis: General features of chiral ligands and complexes; mechanisms and catalytic cycles in hydrogenation, isomerization, epoxidation and catalytic reactions of C-C bond formation.

[16 HOURS]

References:

1. Basic Organometallic Chemistry - B.D. Gupta and A.J. Elias, Universities Press (2010).
2. Organometallics - A Concise Introdution, 2nd edition, Chistoph Elschenbroich and Albert salzer VCH, (1992).
3. Inorganic Chemistry, 2nd edition, C.E. Housecroft and A.G. Sharpe, Pearson Education Ltd., (2005).
4. Inorganic Chemistry- 3rd edition, G.L. Miessler and D.A. Tarr, Pearson Education, (2004).
5. Inorganic Chemistry, 4th edition. P. Atkins, T. Overton, J. Rourke, M. Weller and F. Armstrong, Oxford University Press (2004).

STRUCTURAL METHODS IN INORGANIC CHEMISTRY

Course Outcomes:

After studying this course, the student to:

CO1: Gain knowledge from basic concepts of instrumentation.

CO2: Demonstrate and understand basic principles of spectroscopic techniques.

CO3: Acquire knowledge about applications of spectroscopic techniques.

UNIT – I

NMR spectroscopy: Basic principles, chemical shift and factors affecting it, coupling constants. ^{19}F, ^{31}P, ^{11}B - NMR and NMR of paramagnetic complexes. Double resonance technique, The Nuclear Overhauser Effect, Magnetic susceptibility measurements by Evan's method. NMR to solids.

ESR spectroscopy: Theory, presentation of the spectrum, hyperfine coupling, the g value and factors affecting the magnitude of the g value. Zero-field splitting and Kramers' degeneracy. Application to simple inorganic and organic free radicals and to metal complexes.

NQR spectroscopy: Theory, energies of the quadrapole transitions, instrumentation, effect of magnetic field on the spectra, relationship between electric field gradient and molecular structures. Applications - interpretation of e^2Qq data, structural information from NQR data.

[16 HOURS]

UNIT – II

Vibrational spectroscopy: Introduction, theory of infrared absorption, theoretical group frequencies, correlation chart. Applications to coordination compounds - aquo, amine, urea,

DMSO, *cis* and *trans* metal complexes. Change in spectra accompanying change in symmetry upon coordination (nitrite, sulphate, nitrate, perchlorate and carbonate)

Mossbauer spectroscopy: Theoretical basis, interpretation of Mossbauer spectra - isomer shift, quadrupole splitting and magnetic hyperfine structures. Application: $I_2Br_2Cl_4$, $Fe_3(CO)_{12}$, Prussian blue, nitroprusside, hexacyanoferrate.

Photoelectron spectroscopy: Introduction, principles, chemical shifts, photoelectron spectra of simple molecules, X-ray photoelectron and Auger electron spectroscopy. Applications.

Mass spectrometry: Theory, experimental techniques, molecular ions, fragmentation and ion reaction, Applications to coordination compounds.

[16 HOURS]

References:

1. Electronic Absorption Spectroscopy and Related Techniques – D.N. Sathyanarayana, Universities Press (2001).
2. Structural Methods in Inorganic Chemistry – E.A.V. Ebsworth, D.W.H. Ranklin and Cradock, Blackwell Scientific Publications (1988).
3. Physical Methods in Inorganic Chemistry – R.S. Drago, Saunders Publishers (1966).

BIOPHYSICAL CHEMISTRY AND POLYMERS

Course Outcomes:

After studying this course, the student to:

CO1: Learn electrophoresis, kinetics of polymerization, phase transition in polymer, polymers in solutions.

CO2: Distinguish different types of electrophoresis like free electrophoresis, zone electrophoresis, gel electrophoresis.

UNIT – I

Electrokinetic phenomena: Electrophoresis - principles of free electrophoresis, zone electrophoresis, gel electrophoresis and its applications in qualitative and quantitative study of proteins. Determination of isoelectric point of a protein. Electroosmosis and streaming potential and its biological significance. Biological significance of Donnan membrane phenomenon. Micelles and its involvement during digestion and absorption of dietary lipids. Diffusion of solutes across biomembranes and its application in the mechanism of respiratory exchange. “Salting In” and “Salting Out” of proteins. Osmotic behaviour of cells and osmo-regulation and

its application in the evolution of excretory systems of organisms. Effect of temperature and *p*H on the viscosity of biomolecules (albumin solution). Significance of viscosity in biological systems - mechanism of muscle contraction, detection of intrastrand disulfide bonds in proteins, polymerization of DNA and nature of blood flow through different vessels. Effect of temperature, solute concentration (amino acids) on surface tension. Biological significance of surface tension - stability of Alveoli in lungs, interfacial tension in living cells (Danielli and Davson model). Application of sedimentation velocity and sedimentation equilibrium method for molecular weight determination of proteins.

[16 HOURS]

UNIT – II

Polymers: Fundamentals of polymers - monomers, repeat units, degree of polymerization. Linear, branched and network polymers. Classification of polymers. Polymerization - condensation, addition, free radical, ionic, co-ordination polymerization and ring opening polymerization. Molecular weight and size. Polydispersion. Average molecular weight concepts – number, weight and viscosity average molecular weight. Determination of molecular weights - viscosity method, osmotic pressure method, sedimentation and light scattering method.

Kinetics of Polymerization - condensation, addition, free radical, ionic, co-ordination polymerization. Kinetics of copolymerisation and polymer degradation.

Phase transitions in polymers and thermal characterization: Glass transition, crystallinity and melting- correlation with the polymer structure.

Polymers in solution: Criteria of polymer solubility. Thermodynamics of polymer solutions.

[16 HOURS]

References

1. Introduction to Physical Organic Chemistry, R.D. Gilliom, Madison – Wesley, USA (1970).
2. Physical Organic Chemistry, Reaction Rate and Equilibrium Mechanism – L.P. Hammett, McGraw HillBook, Co., (1970).
3. Biophysical Chemistry, Principle and Technique – A. Upadhyay, K. Upadhyay and N. Nath, Himalaya Publishing House, Bombay, (1998).
4. Essentials of Physical Chemistry and Pharmacy – H. J. Arnikar, S. S. Kadam, K.N. Gujan, Orient Longman, Bombay, (1992).
5. Text book of polymer Science. F.W. Billmeyer, Jr., John Wiley. London (1994).

6. Polymer Science. V. R. Gowrikar, N. V. Vishwanathan and J. Sreedhar, Wiley Eastern, New Delhi (1990).
7. Fundamentals of Polymer Science and Engineering. A. Kumar and S.K. Gupta, Tata – McGraw Hill New Delhi (1978).
8. Polymer Characterization, D. Campbell and J. R. White, Chapman and Hall, New York.

APPLICATIONS OF CHEMICAL KINETICS AND QUANTUM CHEMISTRY

Course Outcomes:

After studying this course, the student to:

CO1: Understand the fundamentals of polymers, degree of polymerization and classification of polymers.

CO2: Acquire knowledge on different methods for the classification of compounds based on their molecular weights.

CO3: Develop knowledge on different methods for the classification of homogeneous catalysis.

UNIT - I

Homogenous catalysis: Acid-base catalysis, specific acid and base catalysis. General acid and base catalysis. Oxidation of amino acids and carbohydrates in presence of acid and base catalysis. Acidity functions - Bronstead, Hückel, Hammett and Bunnett hypothesis.

Chain reactions: Rice-Herzfeld mechanism for the thermal decomposition of acetaldehyde, Kinetics of explosive reactions, explosion limits (H_2 and O_2 reaction). Kinetics of autocatalytic and oscillatory chemical reactions, oscillatory chemical reaction of oxidation of malic acid by bromate ion catalyzed by Ce(III). Catalyzed and uncatalyzed reaction: Ru(III) catalyzed oxidation reaction of primary amines by chloramine – T in HCl medium.

[16 HOURS]

UNIT – II

Applications of quantum chemistry: Variation theorem- statement and proof. Application of variation method to He atom, the structure of many electron systems/ atoms (secular equations & determinants), Spin-orbit interaction, antisymmetry and Pauli exclusion principle. Angular momenta (commutations, relations, operators), Term symbols, Russell-Saunders terms and coupling schemes, Slater orbitals and SCF method for many electron systems.

Molecular wave functions: Born-Oppenheimer approximations. Covalent bond –valence bond and molecular orbital approaches with comparisons. MO theory applied to homonuclear and heteronuclear diatomics by LCAO methods, correlation diagrams, non-crossing rule.

Theory of directed valence-hybridization and geometry of molecules in terms of molecular orbitals (bond angle, dihedral angle), localised and delocalised molecular orbitals.

Conjugated and aromatic molecules: Huckel molecular orbital (HMO) theory of linear conjugated systems (ethane & allyl systems) and aromatic molecules (benzene as an example). Calculation of delocalization energies, bond order & charge density.

[16 HOURS]

References:

1. Statistical Thermodynamics by B.C. Mclelland, Chapman and Hall, London (1973).
2. Elementary Statistical Thermodynamics by N.D. Smith, Plenum Press, NY (1982).
3. Elements of Classical and Statistical Thermodynamics by L.K. Nash, Addison-Wesley (1970).
4. Statistical Thermodynamics by I.M. Klotz.
5. Introduction to Statistical Thermodynamics by M. Dole, Prantice Hall, (1962).
6. Text Book of Physical Chemistry by Samuel Glasstone, McMillan Indian Ltd., 2nd edition (1974).
7. Elements of Physical Chemistry by Lewis and Glasstone.
8. Physical Chemistry by P.W. Atkins, ELBS, 4th edition, Oxford University Press (1990).
9. Kinetics and Mechanism of Chemical Transformation by J. Rajaram and J.C. Kuriacose.
10. Chemical Kinetics – L.K. Jain.
11. Chemical Kinetics – Benson.
12. Physical Organic Chemistry, Reaction Rate and Equilibrium Mechanism – L.P. Hammett, McGraw HillBook, Co., (1970).
13. Fundamentals of Photochemistry – Rohatgi and Mukherje (New Age Bangalore) 2000.

PRACTICALS – SOFT CORE

ANALYTICAL CHEMISTRY PRACTICALS

Course Code: CHC 210

Course Outcomes:

After studying this course, the student to:

CO1: Get experience on analysis of various complex mixtures by following multistep reactions.

CO2: Acquire the knowledge on handling instruments and to overcome the general problems arises during the analysis.

CO3: Acquire industrial skills required for sampling, analytical and interpretation and presentation of results.

CO4: Possess adequate knowledge on literature search for developed analytical methods.

[128 HOURS]

PART – III

1. Determination of calcium in limestone by redox, acid-base and complexation titrations.
2. Determination of vitamin C in orange juice by titration with cerium(IV) and with 2,6-dichlorophenol indophenol.
3. Determination of mercury in an algaecide by EDTA titration; and arsenic in ant control preparation by redox titration.
4. Determination of aluminium and magnesium in antacids by EDTA titration.
5. Analysis of a copper-nickel alloy sample for copper and nickel by EDTA titration using masking and selective demasking reactions.
6. Determination of saccharin in tablets by precipitation titration.
7. Determination of iodine value and saponification value of edible oils.
8. Determination of ascorbic acid in goose berry/bitter gourd by titrimetry and spectrophotometry using *N*-bromosuccinimide (NBS).
9. Analysis of a mixture of iron(II) and iron(III) by EDTA titration using *p*H control.
10. Determination of sulpha drugs by potentiometry using $NaNO_2$ and iodometric assay of penicillin.
11. Solvent extraction method for determination of silver as ion-associate with 1,10-phenanthroline and bromopyragallol red.
12. Electrolytic determination of copper and lead in brass.

13. Polarographic determination of copper and zinc in brass.
14. Determination of sodium, potassium and calcium in mineral waters by atomic emission spectrometry.
15. Determination of iron in mustard seeds and phosphorus in peas by spectrophotometry.
16. Analysis of waste water for anionic detergents and phenol by spectrophotometry.
17. Fluorimetric determination of riboflavin (vit.B_2) in tablets.
18. Colorimetric analysis of procaine by diazotization and coupling reaction.
19. Determination of manganese in steel by extraction-free spectrophotometry and molybdenum in steel by extractive spectrophotometry.
20. Determination of ethanol in wine by titrimetric and spectrophotometric dichromate methods

PART – IV

1. Analysis of waste waters for DO and COD by titrimetry.
2. Analysis of a ground water sample for sulphate by titrimetry (EDTA) and turbidimetry.
3. Potentiometric determination of formula and stability constant of a silver-ammonia complex ion.
4. Determination of aspirin, phenacetin and caffeine in mixture and APC tablets by solvent extraction and UV spectrophotometry.
5. Kinetic determination of urinary creatinine and purity of a commercial H_2O_2 sample.
6. Determination of chromium(III) and iron(III) in a mixture by kinetic masking methods.
7. Catalytic determination of traces of selenium in biological materials and iodide in blood serum.
8. Photometric and potentiometric titration of iron(III) with EDTA.
9. Photometric and potentiometric titration of copper with EDTA.
10. Determination of copper(II) and iron(III) in mixture by photometric titration with EDTA.
11. Analysis of brackish water for chloride content by a**)** spectrophotometry (mercuric thiocyanate method), b) conductometry (silver nitrate) and c**)** potentiometry (silver nitrate).
12. Conductometric titration of sodium acetate with HCl and NH_4Cl with NaOH.
13. Ascorbic acid determination in natural orange juice by coulometry.
14. Spectrophotometric determination of iron in natural waters using thiocyanate and 1,10-phenanthroline as reagents.
15. Determination of fluoride in drinking water/ground water by spectrophotometry(alizarin red lake method).

16. Analysis of waste water for
    a) phosphate by molybdenum blue method
    b) ammonia-nitrogen by Nessler's method
    c) nitrite-nitrogen by NEDA method

15. Analysis of a soil sample for
    a) calcium carbonate and organic carbon by titrimetry.
    b) calcium and magnesium by EDTA titration.

16. Analysis of a soil sample for
    a) Nitrogen content by Kjeldahl method
    b) Available phosphorus by spectrophotometry.
    c) Nitrate-nitrogen/nitrite nitrogen/ammonia nitrogen by spectrophotometry.
    d) sodium and potassium by flame photometry.

17. Analysis of urine for
    a) urea and uric acid by titrimetrysnd spectrophotometry.
    b) Sulphate by precipitation titration after ion-exchange separation.
    c) Sugar by Benedict's reagent.

18. Analysis of blood for
    a) cholesterol by spectrophotometry
    b) bicarbonate by acid-base titration.

19. Fluorimetric determination of quinine in an antimalarial tablet.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8thedition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson EducationPvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
6. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rdedition, CBS Publishers & Distributors, New Delhi, 1997.

7. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. BothersMedical Publishers (P) Ltd., 1995.
8. Laboratory Manual in Biochemistry, J. Jayaraman, New Age International Publishers,New Delhi, 1981.
9. Experiments on Water Pollution, D.I.Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
10. Experiments on Land Pollution, D.I. Williams and D. Anglesia, Wayland PublishersLtd., England, 1978.
15. Experiments in Environmental Chemistry, P.D. Vowler and D.W. Counel, Pergamon Press,Oxford 1980.
16. Manual Soil Laboratory Testing, vol.I, K.H. Head, Pentech Press, London 1980.

INORGANIC CHEMISTRY PRACTICALS

Course Code: CHC 220

Course Outcomes:

After studying this course, the student to:

CO1: Get experience on analysis of various complex mixtures by multistep reactions.

CO2: Acquire knowledge on handling instruments.

CO3: Acquire skills required for sampling, analytical and interpretation and presentation of results.

CO4: Possess adequate knowledge on literature search for developed preparative methods.

CO5: Synthesize and characterization of complexes.

[128 HOURS]

PART – III

1. Determination of aluminium and bismuth by complexometric titration.
2. Determination of lead and tin in a mixture.
3. Determination of calcium and lead in a mixture by pH control and complexation method.
4. Determination of zinc, manganese and magnesium in a mixture using fluoride as a demasking agent.
5. Quantitative analysis of copper(II) and iron(II) in a mixture:
   i. Copper gravimetrically as CuSCN and

ii. Iron volumetrically using cerium(IV) solution

6. Determination of iron as the 8-hydroxyquinolate by solvent extraction method.
7. Determination of the composition of iron-phenanthroline complex by:
   (a) Job's method
   (b) Mole-ratio method and
   (c) Slope-ratio method.
8. Polarographic estimation of cadmium and zinc.
9. Spectrophotometric determinations of:
   a. Titanium using hydrogen peroxide
   b. Chromium using diphenyl carbazide in industrial effluents
   c. Nickel using dimethylglyoxime in steel solution
10. Solvent extraction of ferric thiocyanate complex and determination by colorimetry.

PART – IV

1. Preparation of hexaamminecobalt(III) chloride and estimate cobalt ion.
2. Preparation and characterization of Chloropentaamminecobalt(III) chloride and estimate cobalt ion.
3. Using chloropentaamminecobalt(III) chloride, prepare nitro and nitritopentamamine cobalt(III) chloride. Record the IR spectra of the isomers and interpret.
4. Preparation of potassium tris-oxolatochromate(III) trihydrate.
5. Preparation of mercurytetrathiocyanatocobaltate(II) and estimation of mercury by gravimetry.
6. Preparation of tetraamminecopper(II) sulphate terahydrate
7. Preparation and characterization of manganese dioxide nano-particles
8. Preparation of bis-dichlorotriphenyl phosphine nickel (II).
9. Preparation and characterization of hexaamminenickel(II) chloride.
10. Demonstration Experiments:
    (a) Recording and interpretation of IR and NMR spectra of complexes.
    (b) Spectrochemical series - Evaluation of Dq value.
    (c) DNA interaction with metal complexes by UV-visible absorption and viscosity methods.

References

1. Basic principles of Practical Chemistry – V. Venkateswaran, R. Veeraswamy and A.R. Kulandraivelu
2. Instrumental Analysis Manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5^{th} edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Inorganic Synthesis – O. Glemser.
6. Experimental Inorganic/ Physical Chemistry- Mounir A. Malati.
7. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7^{th} edition.
8. Spectrophotometric Determination of Elements – Z. Marczenko

ORGANIC CHEMISTRY PRACTICALS

Course Code: CHC 230

Course Outcomes:

After studying this course, the student to:

CO1: Develop experience in multistep synthesis and also mechanisms.

CO2: Learn different kinds of reactions under multistep synthesis.

CO3: Learn isolation experiments, preliminary identification and separation.

CO4: Acquire knowledge of various estimations like sugars, enol content, ketones, nitro, protein etc.

[128 HOURS]

PART – III

Multi step synthesis

1. Oxidation of cyclohexanol to adipic acid via cyclohexanone
2. Preparation of benzoccaine from *p*-nitrotoluene
3. Preparation of *p*-chlorobenzoic acid from *p*-toluidine (Sandmeyer's reaction)
4. Molecular rearrangement:
   i. Preparation of *o*-chlorobenzoic acid from phthalic anhydride
   ii. Preparation benzilic acid from benzaldehyde
   iii. Preparation of *o*-hydroxy benzophenone from phenyl benzoate via Fries rearrangement
   iv. Prepartion of benzanilide from benzophenone (Beckmann rearrangement).

5. Grignard reaction: Prepearation of triphenyl carbinol
6. Preparation of luminol from phthalic anhydride
7. Synthesis of isoxazolines and pyrazolines via 1,3-dipolar cycloaddition.
8. Synthesis of tetralones from aryl aldehydes.
9. Synthesis of *m*-chloroiodobenzene from *m*-dinitrobenzene
10. Synthesis of Schiff base from nitro compound.

PART – IV

Isolation of natural products

1. Fractional crystallization: separation of mixture of naphthalene and biphenyl
2. Fractional distillation: Separation of mixture of hexane and toluene.
3. Thin layer chromatography: Separation of plant pigments
4. Column chromatography: Separation of mixture of *o* and *p*-nitro anilines
5. Isolation of piperine from pepper
6. Isolation of caffeine from tea
7. Isolation of azeleic acid from castor oil
8. Isolation of clove oil from clove
9. Estimation of sugars by Fehlings method
10. Determination of enol content by Meyer's method
11. Estimation of ketones by haloform reaction
12. Estimation of sugars by Bertrand's method
13. Estimation of nitro groups
14. Estimation of protein by biuret method

Spectral analysis: Structural elucidation of some simple organic compounds by UV, IR, NMR and mass. The spectra have to be provided by the teachers.

References

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry – A.I. Vogel, Vol.III
5. Practical Organic Chemistry - Mann & Saunders
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet .
7. R.K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Ltd. London, 3rd edition, 1996.

PHYSICALCHEMISTRY PRACTICALS

Course Code: CHC 240

Course Outcomes:

After studying this course, the student to:

CO1: Acquire knowledge on handling instruments and to overcome the general problems arises during the analysis.

CO2: Learn concepts of rate constants, energy of activation, order of the reaction and also thermodynamics parameters.

CO3: Learn concepts of kinetics experiments.

[128 HOURS]

PART – III (NON-INSTRUMENTAL)

1. Determination of energy of activation for reaction between sodium formate and iodine.
2. To study the kinetics of reaction between acetone and iodine-determination of order of reaction w.r.t. iodine and acetone.
3. Determination of rate of decomposition of hydrogen peroxide with manganese dioxide.
4. Determination of order and rate constant of hydrolysis of ethyl acetate in acid medium.
5. Kinetics of decomposition of benzene diazonium chloride, determination of energy of activation and thermodynamic parameters.
6. Kinetics of decomposition of diacetone alcohol by NaOH-determination of energy of activation.
7. To determine the eutectic point of a two component system (Naphthalene-*m*-dinitrobenzene system).
8. Study of phase diagram of a three component system (e.g. acetic acid-chloroform water and system).Construction of binodal curve and indicating tie line.
9. Determination of heat of solution and lattice energy of calcium chloride.
10. Determination of partition co-efficient of acetic acid in water and butanol.
11. Study of kinetics of reaction between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and E_a.
12. To determine the rate constant for the reaction glycine and CAT.

PART IV (INSTRUMENTAL)

1. Kinetics of saponification of ethyl acetate by conductivity method and study the effect of dielectric constant of the medium (using CH_3OH).
2. Simultaneous spectrophotometric determination ofmanganese and chromium in $KMnO_4$ and $K_2Cr_2O_7$ mixture.
3. Determination of ionic product of water and study the effect of temperature.
4. Coulometric titration I_2 *vs* $Na_2S_2O_3$.
5. Conductometric study of charge transfer complex of p-phyenylenediamine with phthalic acid.
6. Determination of mean ionic activity coefficient of a weak electrolyte (acetic acid) by conductometric measurements.
7. Conductometric determination of the degree of hydrolysis and hydrolysis constant of aniline hydrochloride.
8. Conductometric titration of potassium iodide with mercuric perchlorate.
9. Determination of pK value of an indicator (methyl orange).
10. Potentiometric titration of mixture of KCl+KBr+KI*vs* $AgNO_3$.
11. Conductometric titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against NaOH.
12. Thermometric titration of HCl and H_3BO_3 with NaOH.
13. Determination of quantum yield for the photolysis of Chloramine-T.
14. Determination of quantum yield for the photolysis of Chloramine-B.

References

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry – F. Daniels *et al*.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments – J. Rose.
7. Practical Physical Chemistry – S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry – Das. R.C. and Behera B, Tata Mc Graw Hill.

FOURTH SEMESTER

THEORY – HARD CORE

BIOINORGANIC CHEMISTRY

Course Code: CHD 010

Course Outcomes:

After studying this course, the student to:

CO1: Get knowledge on structural and molecular biology.

CO2: Know about the meaning, classification and characteristic features bioenergetics.

CO3: Learn about biochemistry of calcium, sodium and potassium-channels and pumps.

CO4: Acquire better knowledge on Vitamin B_{12} and electron transport proteins, redox Enzymes and metal complexes as drugs and therapeutic agents.

UNIT – I

Structural and molecular biology: Introduction, The structural building blocks of proteins, the structural building block of nucleic acids. Metal ion interactions with nucleosides and nucleotides.

General features of DNA - metal complex interaction.

Bioenergetics: Introduction, Redox reactions in metabolism, the central role of ATP in metabolism. Kinetic stability of ATP, Mitochondrial flow of electrons from NADH to O_2. Oxidative phosphorylation and respiratory chain.

Sodium and potassium-channels and pumps: Introduction, transport across membranes. Potassium and sodium channels, The sodium-potassium ATPase, Macro cyclic crown ether compounds, cryptands and ionophores.

Biochemistry of calcium: Introduction - comparison of Ca^{2+} and Mg^{2+}. Biological roles of calcium, binding sites of calcium and proteins, storage of calcium, calcium in muscle contraction, calcium in blood clotting process.

Vitamin B_{12} and Coenzymes: Structural feature, names of different forms, chemistry of cobalamin, biochemical functions of cobalamins, model compounds. Special characteristics of B_{12} co-enzyme.

[16 HOURS]

UNIT – II

Metal ion transport and storage:

Iron storage and transport: Transferrin, ferratin, phosvitin and gastroferrin.

Iron transport in microbes: siderophores, *in vivo* microbial transport of iron

Oxygen transport and oxygen uptake proteins: Properties of dioxygen (O_2): Thermodynamic and kinetic aspects of dioxygen as an oxidant, activation of dioxygen through complexation with metal ions.

Haemoglobin (Hb) and Myoglobin (Mb) in oxygen transport mechanism: Introduction to porphyrin system, substituent effects on porphyrin rings, functions of Hb and Mb. Characteristics of O_2^- binding interaction with Hb and Mb. Model compounds for oxygen carriers (Vaska's complex and cobalt(III) – Schiff base complexes). Hemerythrin and hemocyanin.

Electron transport proteins and redox enzymes: Iron – sulfur proteins (rubredoxins and ferredoxins) and cytochromes including cytochrome P450. Catalase and peroxidase: Structure and reactivity.

Superoxide dismutase: Structure and reactivity.

Molybdenum containing enzymes: Aspects of molybdenum chemistry, Xanthine oxidase, aldehyde oxidase, sulfite oxidase, nitrogenase and nitrite reductase.

Non-redox metalloenzymes - Structure and reactivity: Carboxypeptidase-A, alcohol dehydrogenase, leucine aminopeptidase and carbonic anhydrase.

[16 HOURS]

UNIT - III

Therapeutic uses of Metals - Metals in medicine: Introduction, metals and human biochemistry, general requirements.

Disease due to metal deficiency and treatment: Iron, zinc, copper, sodium, potassium, magnesium, calcium and selenium.

Metal complexes as drugs and therapeutic agents: Introduction, antibacterial agents, antiviral agents, metal complexes in cancer therapy, metal complexes for the treatment of rheumatoid arthritis, vanadium diabetes, metal complexes as radio diagnostic agents.

Treatment of toxicity due to inorganics: General aspects of mechanism of metal ion toxicity,

(i) Mechanism of antidote complex with poison, rendering it inert: arsenic, lead, mercury, iron, copper.

(ii) Antidote accelerated metabolic conversion of poison to non-toxic product: cyanide and carbon monoxide.

[16 HOURS]

References:

1. The Inorganic Chemistry of Biological Process- 2nd edition, M. N. Hughes, John Wiley and Sons, (1988).
2. Bioinorganic Chemistry - R.W. Hay, Ellis Horwood Ltd., (1984).
3. Biological Inorganic Chemistry – An Introduction, R.R. Crichton, Elsevier, (2008).
4. Bioinorganic Chemistry - A.K. Das, Books and Allied (P) Ltd, (2007).
5. Bioinorganic Chemistry - K. Hussain Reddy, New Age International Ltd. (2003).
6. Bioinorganic Chemistry: A Survey - Eiichiro Ochiai, Academic Press, (2008).
7. Bioinorganic Chemistry: A Short Course - 2nd edition, R.M. Roat-Malone, Wiley Interscience, (2007).
8. Medicinal Applications of Coodination Chemistry - Chris Jones and John Thornback, RSC Publishing, (2007).
9. Transition Metal Complexes as Drugs and Chemotherapeutic Agents - N. Farrell, Kluwer Academic Publishers (1989).
10. The Biological Chemistry of the Elements: The Inorganic Chemistry of Life - 2nd edition, J.J.R. Frausto da Silva and R.J.P. Williams, Oxford University Press,(2001).

ADVANCED PHYSICAL CHEMISTRY

Course Code: CHD 020

Course Outcomes:

After studying this course, the student to:

CO1: Learn about different concepts of polymers, solid state chemistry, photodegradation, hydrogen over voltage, oxygen overvoltage, corrosion, etc

CO2: Differentiate between different types of overvoltage.

CO3: Learn about the determination of molecular weight of the polymers.

CO4: Explain Jablonski diagram which include, fluorescence, phosphorescence etc.

CO5: Learn about types of corrosion and various methods that are used to prevent corrosion.

CO6: Explain photodegradation of dyes, pesticides and industrial effluents by using photocatalyst.

UNIT – I

Kinetics and Thermodynamics of Polymerization: Kinetics of addition, condensation and radiation induced polymerization. Thermodynamics of polymer solutions, The Flory-Huggins Theory, Flory Krigbaum and modified Flory-Huggins Theory.

Copolymerization: Kinetics of copolymerization, Copolymer equation, Monomer reactive ratios. Properties of Polymers: Crystalline melting point and the glass transition temperature.

Polymer molecular weights: Molecular weight distribution, Number average and Weight average molecular weight. Methods for determination of molecular weight – Osmometry-membrane osmometry, vapour pressure osmometry, light scattering, viscosity, ultracentrifugation.

Conducting Polymers: Structure, properties, characterization and applications.

Polymer Degradation, Stability and Environmental Issues: Types of degradation, Thermal degradation, Mechanical degradation, Photodegradation, Degradation by high energy radiation. Chemical, hydrolytic and UV stability. Recycling and biodegradation.

[16HOURS]

UNIT – II

Photochemistry: Introduction to photochemistry, quantum yield and its determination, factors affecting quantum yield, Actinometry - Uranyloxalate and potassium ferrioxalate actinometers, acetone and diethylketone actinometers. Photosensitization: by mercury, dissociation of H_2. Photochemical kinetics of: Decomposition of CH_3CHO, formation of HCl. Photodegradation: Photocatalyst – ZnO, TiO_2, principle, application of ZnO/ TiO_2 in the photo degradation of dyes (IC), pesticides (DDT) and in industrial effluents. Effect of photo degradation on COD value.

Mechanism of absorption and emission of radiation: Einstein's treatment, selection rules, Life times of excited electronic states of atoms and molecules Types of electronic transitions in organic molecules photochemical pathways, Jablonski diagram, Fluorescence, Phosphorescence. Fluorescence emission, factors affecting fluorescence, viz. structure, solvent, pH, temperature etc. Triplet state and phosphorescence**.**

Photophysical kinetics: kinetics of unimolecular processes, delayed fluorescence mechanisms, kinetics of collisional quenching, Stern-Volmer equation, quenching by added substances charge transfer mechanism, energy transfer mechanism.

[16 HOURS]

UNIT – III

Nuclear Chemistry: Radioactive decay – General characteristics, decay kinetics, parent – daughter decay growth relationships, determination of half-lives, Nuclear stability – packing fraction, binding energy, Brief survey of alpha, beta and gamma decays. Nuclear reactions – Bethe's notation, types of nuclear reactions – specific nuclear reactions, photonuclear reactions, Oppenheimer – Phillips process, spallation reactions. Definition of Curie and related calculations. Szilard-Chalmers process. Geiger-Muller counters – G.M. Plateau, dead time, coincidence loss, determination of dead time.

Radiation Chemistry: Introduction, units, interaction of electromagnetic radiation with matter, G-value, LET of radiation, dosimetry, Fricke dosimeter. Radiolysis - cysteine, and biphenyl. Radioisotopes as tracers, use of isotopic tracers in the elucidation of reaction mechanism, structure determination and solubility of sparingly soluble substances. ^{14}C dating, medical applications of isotopic tracers. Hazards in radiochemical work and radiation protection.

[16 HOURS]

References

1. Polymer Science and Technology by Joel R. Fried Third edition, 2002.
2. Polymer Science, V.R.Gowarikar , N.V.Vishwanathan and Jaydev Sreedhar Reprint edition, 2002.
3. Text book of Polymer Science, Fred W. Billmeyer Jr. Third edition, 2000.
4. Principles of Polymerization, George Odian, Third edition 2002.
5. Handbook on Conducting Polymers – T.A.Skotheim, Ed Marcel Dekker Inc, New York, 1 and 2, 1986.
6. Essentials of Nuclear Chemistry, H. J Arnikar, Wiley Eastern Limited, 4th Edition, (1995).
7. Nuclear and Radiochemistry, G. Friedlander, J. W. Kennedy and J. M. Miller, John Wiley (1981).
8. Introduction to Radiation Chemistry, J. W. T. Spinks and R. J. Woods, John Wiley (1990)
9. Introduction to Nuclear Physics and Chemistry, B.G. Harvey, Prentice hall (1963).
10. Sourcebook on Atomic Energy-S. Glasstone, Van Nostrand Company (1967).
11. Radiochemistry and Nuclear methods of analysis-W.D.Ehman and D.E. Vance, John Wiley (1991).

12. Fundamentals of photochemistry by K.K.Rohatgi-Mukherjee, New Age International Publishers Revised Edition (Reprint 2003).
13. Chemistry and light by Paul Suppan, The Royal Society of Chemistry.
14. Nuclear Chemistry by Friedlander and Kennedy, John Wiley and Sons (1987).
15. Nuclear Physics and Chemistry by G. Harvey.
16. Essentials of Nuclear Chemistry by H.J. Arnikar, Eastern Wiley (1990).
17. Nuclear Chemistry by U.N. Dash, Sultan Chand and Sons (1991).
18. Source Book on Atomic Energy by S. Glasstone, 3rd edition Van Nonstrand (1967).
19. Nuclear Chemistry by Friedlander and Kennedy, John Wiley and Sons (1987).
20. Essentials of Nuclear Chemistry by H.J. Arnikar, Eastern Wiley (1990).
21. Fundamentals of Radiochemistry by D.D. Sood, A.V.R. Reddy and N. Ramamoorthy

THEORY – SOFT CORE

APPLIED ANALYSIS II

Course Outcomes:

After studying this course, the student to:

CO1: Acquire knowledge on fertility and essential minor and major nutrients of soil for better growth of plants

CO2: Learn meaning, classification, characteristic features and components of fuels.

CO3: Describe feasible analytical methods for the quantitative analysis of fuels

CO4: Learn importance of analysis of different components of body fluids with adequate knowledge and skills to employ a suitable analytical method

CO5: Know background on forensic analysis with reference to its importance and analytical Methods.

UNIT – I

Soil Analysis: Inorganic and organic components of soil, collection and preparation of soil samples for analysis. Measurement of soil *p*H and conductivity. Determination of organic carbon, total nitrogen, 53 available nitrogen, ammonia nitrogen, nitrate nitrogen and nitrite nitrogen. Available phosphorus and sulphur-their determination. Analysis of soil for sodium, potassium and calcium and magnesium. Micronutrient elements and their analysis. Pesticide residues in soil, their separation and determination.

Fuel analysis- Fuels and their classification. Solid fuels and their classes - natural, artificial and industrial solid fuels. Coal and its analysis - proximate analysis and ultimate analysis. Liquid fuels and their types. Aniline point, flash point and fire point and their determination, octane number of liquid fuels. Gaseous fuels and their classes, advantages. Combustion of a carbonaceous fuel – flue gas. Analysis of flue gas or automobile exhaust for CO_2, CO, O_2 and N_2 by Orsat's apparatus. Calorific value of fuel - net and gross calorific values. Determination of calorific value of solid and liquid fuels by bomb calorimeter method.

[16 HOURS]

UNIT - II

Biomedical and forensic analysis: Composition of body fluids and detection of abnormal levels of certain constituents leading to diagnosis of disease. Sample collection and preservation of physiological fluids. Analytical methods for the constituents of physiological fluids (blood, serum, urine).

Blood - estimation of glucose, cholesterol, urea, haemoglobin and bilirubin.

Urine - urea, uric acid, creatinine, calcium phosphate, sodium, potassium and chloride.

Biological significance, analysis and assay of enzymes (pepsin, monoaminoxidase, tyrosinase); and hormones (progesterone, oxytocin, insulin). Chemical, instrumental and biological assays to be discussed wherever necessary.

Forensic analysis: General discussion of poisons with special reference to mode of action of cyanide, organophosphates and snake venom. Estimation of poisonous materials such as lead, mercury and arsenic in biological materials.

[16 HOURS]

APPLIED ANALYSIS III

Course Outcomes:

After studying this course, the student to:

CO1: Learn meaning, laws and techniques of chemical kinetics.

CO2: Know importance of chemical kinetics in enzyme catalysed and non-enzyme catalysed reactions.

CO3: Acquire knowledge on automated and automatic methods of analysis with choice on instrumental methods

CO4: Distinguish between conventional and radio-chemical methods

CO5: Know about Type of samples subjected to radio-chemical analysis and radioimmunoassay.

UNIT – I

Kinetic methods of analysis: Introduction, basis of kinetic methods, rate law expressions. Classifying chemical kinetic methods – direct-computation integral methods, direct-computation rate methods, curve-fitting methods. Instrumentation. Quantitative applications - enzyme catalyzed reactions, non-enzyme catalyzed reactions, non-catalytic reactions. Determining V_{max}, K_m for enzyme catalyzed reactions. Elucidating mechanism for the inhibition of enzyme catalysis. Determination of enzymes, LDH, GOT and GPT. Determination of substrates – urea, uric acid, blood glucose and blood alcohol. Analysis of closely related compounds - neglect of reaction of slow reacting component method and logarithmic extrapolation method.

Automated methods of analysis: An overview. Principles of automation. Automated instruments: process control. Continuous analyzers. Discrete autoanalyzers. Instruments used in automated process control. Automatic instruments - discrete and continuous flow sampling instruments. Flow injection analysis – principles - dispersion co-efficient. Factors affecting peak height, sample volume, channel length and flow rate, and channel geometry. Applications - limited dispersion applications, medium dispersion applications, stopped flow methods and flow injection titrations. Discrete automatic systems - centrifugal fast scan analyzer, automatic organic elemental analyzers.

Analysis based on multilayer films-general principles, film structures, instrumentation, performance and applications – blood urea nitrogen, blood glucose and potassium.

[16 HOURS]

UNIT – II

Radiometric methods: Radioactive isotopes. Nuclear emissions - α and β-particles, neutrons, gamma rays and miscellaneous nuclear particles. Nuclear reactions, radiochemical decay and activity. Instrumentation and measurement of radioactivity. Radiation detectors - gas ionization, scintillation and semiconductor detectors. Pulse height analysis. Autoradiography. Statistics of radioactive measurements.

Radiochemical analysis: **Neutron activation methods** - neutrons and their sources. Interaction of neutrons with matter. Theory, experimental considerations and applications. **Isotope dilution methods -** direct isotope dilution and inverse isotope dilution methods and their applications. Radiometric titrations. Radiorelease methods. Radioactive tracers.

Radio immunoassay: Principles of immunoassay. Specificity of immuno assays. Preparation of the antibody, incubation period for the assay, separation of the bound and free antigen. Fluorescence immunoassay. Enzyme immunoassay.

[16 HOURS]

References:

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8th edition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993 Prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D. Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson Education Pvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders College Publishing, California, 1990.
6. Instrumental Methods of Analysis by H.H. Willard, L.L. Merritt and J.A. Dean, 7th edition, (1988).
7. Principles and Practice of Analytical Chemistry, F.W. Fifield and Kealey, 3rd edition, 2000, Blackwell Sci., Ltd. Malden, USA.
8. Modern Analytical Chemistry, David Harvey, McGraw Hill, New Delhi, 2000.
9. Introduction to Instrumental Analysis, Braun, Pharm. Med. Press. India.
10. Instrumental Method of Analysis, W. M. Dean and Settle, 7th edition, 1986, CBS Publishers, New Delhi.
11. Instant Notes of Analytical Chemistry, Kealey and Haines, Viva books Pvt. Ltd., 2002.
12. Soil Chemical Analysis, M.L. Jackson, Prentice Hall of India Pvt. Ltd., New Delhi, 1973.
13. Clinical Chemistry, Principles and Procedures, J.S. Annino, 2nd edition, Boston: Little, Brown, 1960.
14. Methods of Geochemical Analysis, D. Click, Ed., A Multi volume series, NewYork, Inter science.
15. Clinical Chemistry, Principles and Techniques, R.J. Henry, D.C. Cannon and J.W. Winkleman, Eds., 2nd edition, Hagerstorm, M.D: Harper and Row, 1974.
16. Fundamentals of Clinical Chemistry, N.W. Tietz, Ed., 2nd edition, Philaddphia: W.B. Saunders, 1976.

RETROSYNTHESIS AND ORGANOMETALLIC CHEMISTRY

Course Outcomes:

After studying this course, the student to:

CO1: Acquire knowledge of protection and deprotection in organic synthesis.

CO2: Learn about different named reactions which are highly useful for competitive exams and interviews.

CO3: Learn disconnection approach, their principles and terminologies.

CO4: Learn retrosynthesis of different complex organic molecules.

UNIT – I

Protecting groups: Protection of hydroxyl, carboxyl, carbonyl, thiol and amino groups. Illustration of protection and deprotection in synthesis.

Named reactions: Keto-enol tautomerism, mechanism and synthetic applications of aldol condensations, Claisen reaction, Schmidt reaction, Perkin reaction, Knoevenagel, benzoin and Stobbe condensation, Darzens glysidic ester condensation, Cannizaros reaction, Tischenko reaction. Michael addition, Robinson's annulation reaction.

Retrosynthesis: Introduction to disconnection approach: Basic principles and terminologies used in disconnection approach. One group C-X and two group C-X disconnections. Synthons and synthetic equivalents.

Retrosynthesis and synthesis of benzofurans, *p*-methoxy acetophenone, saccharine, α-bisabolene, nuciferal, penicillin-V.

[16 HOURS]

UNIT - II

Chemistry of organometallic compounds: Synthesis and reactions of organolithium (n-BuLi, PhLi) and organomagnesium (Grignard reagent) compounds.

Organoaluminium reagents: Preparation, site selective and stereoselctive additions of nucleophiles mediated by organoaluminum reagents, reaction with acid chlorides, allyl vinyl ethers, 1,2-addition to imines and application in the synthesis of natural products.

Organopalladium compounds: Suzuki coupling, Heck reaction.

Organotin reagents: Barton decarboxylation reaction, Barton deoxygenation reaction, Stille coupling, Stille-Kelley coupling reactions, Barton McCombie reaction, Keck stereoselective allylation and other applications.

Organozinc reagents: Preparation - oxidative addition and transmetallation, addition reactions of alkyl, aryl, allylic and propargylic zinc reagents, diastereoselective and enantioselective addition reaction with aldehydes, Reformatsky reaction.

[16 HOURS]

References:

1. H. Pine, Hendrickson, Cram and Hammond, Organic Chemistry, Mac Grow Hill, New York, 1987.
2. Organic Chemistry - Morrison and Boyd
3. Organic Chemistry- Crabtree
4. Organic Chemistry- Clayden
5. I.L. Finar, Organic Chemistry, ELBS Longmann, Vol. 1 & II, 1984.
6. J. March, Advanced Organic Chemistry, Wiley Interscience, 1994.
7. E.S. Gould, Mechanism and Structure in Organic Chemistry, Halt, Rinhart & Winston, New York, 1964.
8. F.A. Carey and Sundberg. Advanced Organic Chemistry – Part A & B, 3rd edition, Plenum Press, New York. 1990.
9. Principles of Organic Synthesis - ROC Norman and Coxon.
10. S.K. Ghosh, Advanced General Organic Chemistry, Book and Allied (P) Ltd. 1998.

BIOMOLECULES AND NATURAL PRODUCTS

Course Outcomes:

After studying this course, the student to:

CO1: Know about amino acids, peptides, proteins: their structure, function and properties.

CO2: Learn structural determination of the proteins which are called as energy of the body.

CO3: About the chemistry lying behind the heredity.

CO4: Learn nomenclature, classification and biological importance of other natural Products.

UNIT - I

Amino Acids: General structure, Physiological properties

Peptides: Structure and conformation of peptide bond, peptide synthesis: Solution phase and Merrifield's solid phase synthesis, Racemization and use of HOBt, Synthesis of oxytocin and

vasopressin, biological importance of insulin, selective cleavage of polypeptide bonds (chemical and enzymatic).

Proteins: Structure determination: *C* and *N* terminal residue determination, primary, secondary, tertiary and quartenary structure determination, denaturing and renaturing of proteins.

Nucleic acids: Introduction, structure and synthesis of nucleosides and nucleotides, Solid phase synthesis of oligonucleotides, Structure of RNA and DNA, Crick-Watson model, role of nucleic acids in the biosynthesis of proteins.

[16 HOURS]

UNIT – II

Carbohydrates: Synthesis, industrial and biological importance of glycosides, amino sugars, sucrose, maltose and lactose. General methods of structure elucidation. Industrial importance and biological importance of cellulose, starch, glycogen, dextran, hemicellulose, pectin, agar-agar. Photosynthesis and biosynthesis of carbohydrates.

Carbohydrates Metabolism: Glycolysis and Krebs cycle.

Lipids: Nomenclature, classification, purification, synthesis of lipids, phospholipids, sphingolipids, biological importance of lipids: Lecithin, sphingolipids, oils and fats.

Terpenoids: Introduction, classification (natural and essential oils), isoprene rule and biological importance of terpenoids.

Steroids: Introduction, classification and biological significance of Testosterone, Progesterone, Estrogen

[16 HOURS]

References:

1. I. L. Finar, Organic Chemistry, ELBS Longmann, Vol. I & II, 1984.
2. Essentials of physiological chemistry – Anderson, John Wiley & Sons, New York, 1953.
3. K. Albert, L. Lehninger, D.L. Nelson, M.M. Cox, Principles of Biochemistry, CBZ publishers, 1st edition, New Delhi, 1993.
4. Harper's Biochemistry, Ed. R.Harper, 22nd edition, Prenctic Hall Press, New York, 1990
5. Carbohydrates – Chemistry and Biochemistry by Pigmann and Harton.
6. An introduction to carbohydrate chemistry by Guthri and Honeymon.
7. Protein chemistry by Neurth, Vol. I, II and III.
8. Peptide chemistry by Bodanski, Vol. I, II and III.
9. Introduction to the chemistry of fats and fatty acids by F. D. Gunstone.

PRACTICALS – SOFT CORE

ANALYTICAL CHEMISTRY PRACTICALS

Course Code: CHD 210

Course Outcomes:

After studying this course, the student to:

CO1: Get experience on analysis of various complex mixtures by following multistep reactions.

CO2: Acquire the knowledge on handling instruments and to overcome the general problems.

CO3: Acquire industrial skills required for sampling, analytical and interpretation and presentation of results.

CO4: Possess adequate knowledge on literature search for developed analytical methods.

[128 HOURS]

PART – III

1. Determination of calcium in limestone by redox, acid-base and complexation titrations.
2. Determination of vitamin C in orange juice by titration with cerium(IV) and with 2,6-dichlorophenol indophenol.
3. Determination of mercury in an algaecide by EDTA titration; and arsenic in ant control preparation by redox titration.
4. Determination of aluminium and magnesium in antacids by EDTA titration.
5. Analysis of a copper-nickel alloy sample for copper and nickel by EDTA titration using masking and selective demasking reactions.
6. Determination of saccharin in tablets by precipitation titration.
7. Determination of iodine value and saponification value of edible oils.
8. Determination of ascorbic acid in goose berry/bitter gourd by titrimetry and spectrophotometry using *N*-bromosuccinimide (NBS).
9. Analysis of a mixture of iron(II) and iron(III) by EDTA titration using *p*H control.
10. Determination of sulpha drugs by potentiometry using $NaNO_2$ and iodometric assay of penicillin.
11. Solvent extraction method for determination of silver as ion-associate with 1,10-phenanthroline and bromopyragallol red.
12. Electrolytic determination of copper and lead in brass.
13. Polarographic determination of copper and zinc in brass.

14. Determination of sodium, potassium and calcium in mineral waters by atomic emission spectrometry.
15. Determination of iron in mustard seeds and phosphorus in peas by spectrophotometry.
16. Analysis of waste water for anionic detergents and phenol by spectrophotometry.
17. Fluorimetric determination of riboflavin (vit.B_2) in tablets.
18. Colorimetric analysis of procaine by diazotization and coupling reaction.
19. Determination of manganese in steel by extraction-free spectrophotometry and molybdenum in steel by extractive spectrophotometry.
20. Determination of ethanol in wine by titrimetric and spectrophotometric dichromate methods

PART – IV

1. Analysis of waste waters for DO and COD by titrimetry.
2. Analysis of a ground water sample for sulphate by titrimetry (EDTA) and turbidimetry.
3. Potentiometric determination of formula and stability constant of a silver-ammonia complex ion.
4. Determination of aspirin, phenacetin and caffeine in mixture and APC tablets by solvent extraction and UV spectrophotometry.
5. Kinetic determination of urinary creatinine and purity of a commercial H_2O_2 sample.
6. Determination of chromium(III) and iron(III) in a mixture by kinetic masking methods.
7. Catalytic determination of traces of selenium in biological materials and iodide in blood serum.
8. Photometric and potentiometric titration of iron(III) with EDTA.
9. Photometric and potentiometric titration of copper with EDTA.
10. Determination of copper(II) and iron(III) in mixture by photometric titration with EDTA.
11. Analysis of brackish water for chloride content by a**)** spectrophotometry (mercuric thiocyanate method), b) conductometry (silver nitrate) and c**)** potentiometry (silver nitrate).
12. Conductometric titration of sodium acetate with HCl and NH_4Cl with NaOH.
13. Ascorbic acid determination in natural orange juice by coulometry.
14. Spectrophotometric determination of iron in natural waters using thiocyanate and 1,10-phenanthroline as reagents.
15. Determination of fluoride in drinking water/ground water by spectrophotometry(alizarin red lake method).

16. Analysis of waste water for
    a) phosphate by molybdenum blue method
    b) ammonia-nitrogen by Nessler's method
    c) nitrite-nitrogen by NEDA method

15. Analysis of a soil sample for
    a) calcium carbonate and organic carbon by titrimetry.
    b) calcium and magnesium by EDTA titration.

16. Analysis of a soil sample for
    a) Nitrogen content by Kjeldahl method
    b) Available phosphorus by spectrophotometry.
    c) Nitrate-nitrogen/nitrite nitrogen/ammonia nitrogen by spectrophotometry.
    d) sodium and potassium by flame photometry.

17. Analysis of urine for
    a) urea and uric acid by titrimetrysnd spectrophotometry.
    b) Sulphate by precipitation titration after ion-exchange separation.
    c) Sugar by Benedict's reagent.

18. Analysis of blood for
    a) cholesterol by spectrophotometry
    b) bicarbonate by acid-base titration.

19. Fluorimetric determination of quinine in an antimalarial tablet.

References

1. Fundamental of Analytical Chemistry, D.A. Skoog, D.M. West, Holler and Crouch 8thedition, 2005, Saunders College Publishing, New York.
2. Analytical Chemistry, G.D. Christian, 5th edition, 2001 John Wiley & Sons, Inc. India.
3. Quantitative Analysis, R.A. Day and A.L. Underwood, 6th edition, 1993, prentice Hall, Inc. New Delhi.
4. Vogel's Textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J.D.Barnes and M.J.K. Thomas, 6th edition, Third Indian Reprint, 2003 Pearson EducationPvt. Ltd., New Delhi.
5. Analytical Chemistry Principles, John H. Kennedy, 2nd edition, Saunders CollegePublishing, California, 1990.
6. Quantitative Analysis of Drugs in Pharmaceutical Formulations, P. D. Sethi, 3rdedition, CBS Publishers & Distributors, New Delhi, 1997.

7. Practical Clinical biochemistry methods and interpretations, R. Chawla, J.P. BothersMedical Publishers (P) Ltd., 1995.
8. Laboratory Manual in Biochemistry, J. Jayaraman, New Age International Publishers,New Delhi, 1981.
9. Experiments on Water Pollution, D.I.Williams and D. Anglesia, Wayland Publishers Ltd., England, 1978.
10. Experiments on Land Pollution, D.I. Williams and D. Anglesia, Wayland PublishersLtd., England, 1978.
15. Experiments in Environmental Chemistry, P.D. Vowler and D.W. Counel, Pergamon Press,Oxford 1980.
16. Manual Soil Laboratory Testing, vol.I, K.H. Head, Pentech Press, London 1980.

INORGANIC CHEMISTRY PRACTICALS

Course Code: CHD 220

Course Outcomes:

After studying this course, the student to:

CO1: Get experience on analysis of various complex mixtures by multistep reactions.

CO2: Acquire knowledge on handling instruments and to overcome the general problems.

CO3: Acquire skills required for sampling, analytical and interpretation and presentation of results.

CO4: Possess adequate knowledge on literature search for developed preparative methods.

CO5: Synthesize and characterization of complexes.

[128 HOURS]

PART – III

1. Determination of aluminium and bismuth by complexometric titration.
2. Determination of lead and tin in a mixture.
3. Determination of calcium and lead in a mixture by pH control and complexation method.
4. Determination of zinc, manganese and magnesium in a mixture using fluoride as a demasking agent.
5. Quantitative analysis of copper(II) and iron(II) in a mixture:
   a) Copper gravimetrically as CuSCN and

b) Iron volumetrically using cerium(IV) solution

6. Determination of iron as the 8-hydroxyquinolate by solvent extraction method.
7. Determination of the composition of iron-phenanthroline complex by:
   a) Job's method
   b) Mole-ratio method and
   c) Slope-ratio method.
8. Polarographic estimation of cadmium and zinc.
9. Spectrophotometric determinations of:
   a) Titanium using hydrogen peroxide
   b) Chromium using diphenyl carbazide in industrial effluents
   c) Nickel using dimethylglyoxime in steel solution
10. Solvent extraction of ferric thiocyanate complex and determination by colorimetry.

PART – IV

1. Preparation of hexaamminecobalt(III) chloride and estimate cobalt ion.
2. Preparation and characterization of Chloropentaamminecobalt(III) chloride and estimate cobalt ion.
3. Using chloropentaamminecobalt(III) chloride, prepare nitro and nitritopentamamine cobalt(III) chloride. Record the IR spectra of the isomers and interpret.
4. Preparation of potassium tris-oxolatochromate(III) trihydrate.
5. Preparation of mercurytetrathiocyanatocobaltate(II) and estimation of mercury by gravimetry.
6. Preparation of tetraamminecopper(II) sulphate terahydrate
7. Preparation and characterization of manganese dioxide nano-particles
8. Preparation of bis-dichlorotriphenyl phosphine nickel (II).
9. Preparation and characterization of hexaamminenickel(II) chloride.
10. Demonstration Experiments:
    a) Recording and interpretation of IR and NMR spectra of complexes.
    b) Spectrochemical series - Evaluation of Dq value.
    c) DNA interaction with metal complexes by UV-visible absorption and viscosity methods.

References

1. Basic principles of Practical Chemistry – V. Venkateswaran, R. Veeraswamy and A.R. Kulandraivelu
2. Instrumental Analysis Manual - Modern Experiments for Laboratory – G.G. Guilbault and L.G. Hargis.
3. A Text Book of Quantitative Inorganic Analysis – A.I. Vogel, 5th edition.
4. Experimental Inorganic Chemistry – G. Palmer.
5. Inorganic Synthesis – O. Glemser.
6. Experimental Inorganic/ Physical Chemistry- Mounir A. Malati.
7. Quantitative Chemical Analysis – Daniel C. Harris, (2006) 7th edition.
8. Spectrophotometric Determination of Elements – Z. Marczenko

ORGANIC CHEMISTRY PRACTICALS

Course Code: CHD 230

Course Outcomes:

After studying this course, the student to:

CO1: Develop experience in multistep synthesis and also mechanisms.

CO2: Learn different kinds of reactions under multistep synthesis.

CO3: Learn isolation experiments, preliminary identification and separation.

CO4: Acquire knowledge of various estimations like sugars, enol content, ketones, nitro, protein etc.

[128 HOURS]

PART – III

Multi step synthesis

1. Oxidation of cyclohexanol to adipic acid via cyclohexanone
2. Preparation of benzoccaine from *p*-nitrotoluene
3. Preparation of *p*-chlorobenzoic acid from *p*-toluidine (Sandmeyer's reaction)
4. Molecular rearrangement:
    a. Preparation of *o*-chlorobenzoic acid from phthalic anhydride
    b. Preparation benzilic acid from benzaldehyde
    c. Preparation of *o*-hydroxy benzophenone from phenyl benzoate via Fries rearrangement
    d. Prepartion of benzanilide from benzophenone (Beckmann rearrangement).

5. Grignard reaction: Prepearation of triphenyl carbinol
6. Preparation of luminol from phthalic anhydride
7. Synthesis of isoxazolines and pyrazolines via 1,3-dipolar cycloaddition.
8. Synthesis of tetralones from aryl aldehydes.
9. Synthesis of *m*-chloroiodobenzene from *m*-dinitrobenzene
10. Synthesis of Schiff base from nitro compound.

PART – IV

Isolation of natural products

1. Fractional crystallization: separation of mixture of naphthalene and biphenyl
2. Fractional distillation: Separation of mixture of hexane and toluene.
3. Thin layer chromatography: Separation of plant pigments
4. Column chromatography: Separation of mixture of *o* and *p*-nitro anilines
5. Isolation of piperine from pepper
6. Isolation of caffeine from tea
7. Isolation of azeleic acid from castor oil
8. Isolation of clove oil from clove
9. Estimation of sugars by Fehlings method
10. Determination of enol content by Meyer's method
11. Estimation of ketones by haloform reaction
12. Estimation of sugars by Bertrand's method
13. Estimation of nitro groups
14. Estimation of protein by biuret method

Spectral analysis: Structural elucidation of some simple organic compounds by UV, IR, NMR and mass. The spectra have to be provided by the teachers.

References

1. Manual of Organic Chemistry - Dey and Seetharaman.
2. Modern Experimental Organic Chemistry by John H. Miller and E.F. Neugil, p 289.
3. An Introduction to Practical Organic Chemistry - Robert, Wingrove etc.
4. A Text Book of Practical Organic Chemistry – A.I. Vogel, Vol.III
5. Practical Organic Chemistry - Mann & Saunders
6. Semimicro Qualitative Organic Analysis by Cheronis, Entrikin and Hodnet .
7. R.K. Bansal, Laboratory Manual of Organic Chemistry, New Age International (P) Ltd. London, 3rd edition, 1996.

PHYSICALCHEMISTRY PRACTICALS

Course Code: CHD 240

Course Outcomes:

After studying this course, the student to:

CO1: Acquire knowledge on handling instruments and to overcome the general problems arises during the analysis.

CO2: Learn concepts of rate constants, energy of activation, order of the reaction and also thermodynamics parameters.

CO3: Learn concepts of kinetics experiments.

[128 HOURS]

PART – III (NON-INSTRUMENTAL)

1. Determination of energy of activation for reaction between sodium formate and iodine.
2. To study the kinetics of reaction between acetone and iodine-determination of order of reaction w.r.t. iodine and acetone.
3. Determination of rate of decomposition of hydrogen peroxide with manganese dioxide.
4. Determination of order and rate constant of hydrolysis of ethyl acetate in acid medium.
5. Kinetics of decomposition of benzene diazonium chloride, determination of energy of activation and thermodynamic parameters.
6. Kinetics of decomposition of diacetone alcohol by NaOH-determination of energy of activation.
7. To determine the eutectic point of a two component system (Naphthalene-*m*-dinitrobenzene system).
8. Study of phase diagram of a three component system (e.g. acetic acid-chloroform water and system).Construction of binodal curve and indicating tie line.
9. Determination of heat of solution and lattice energy of calcium chloride.
10. Determination of partition co-efficient of acetic acid in water and butanol.
11. Study of kinetics of reaction between $K_2S_2O_8$ and KI, first order, determination of rate constants at two different temperatures and E_a.
12. To determine the rate constant for the reaction glycine and CAT.

PART IV (INSTRUMENTAL)

1. Kinetics of saponification of ethyl acetate by conductivity method and study the effect of dielectric constant of the medium (using CH_3OH).
2. Simultaneous spectrophotometric determination ofmanganese and chromium in $KMnO_4$ and $K_2Cr_2O_7$ mixture.
3. Determination of ionic product of water and study the effect of temperature.
4. Coulometric titration I_2 *vs* $Na_2S_2O_3$.
5. Conductometric study of charge transfer complex of p-phyenylenediamine with phthalic acid.
6. Determination of mean ionic activity coefficient of a weak electrolyte (acetic acid) by conductometric measurements.
7. Conductometric determination of the degree of hydrolysis and hydrolysis constant of aniline hydrochloride.
8. Conductometric titration of potassium iodide with mercuric perchlorate.
9. Determination of pK value of an indicator (methyl orange).
10. Potentiometric titration of mixture of KCl+KBr+KI*vs* $AgNO_3$.
11. Conductometric titration of a mixture of HCl, CH_3COOH and $CuSO_4$ against NaOH.
12. Thermometric titration of HCl and H_3BO_3 with NaOH.
13. Determination of quantum yield for the photolysis of Chloramine-T.
14. Determination of quantum yield for the photolysis of Chloramine-B.

References

1. Practical Physical Chemistry – A.J. Findlay.
2. Experimental Physical Chemistry – F. Daniels *et al*.
3. Selected Experiments in Physical Chemistry – Latham.
4. Experiments in Physical Chemistry – James and Prichard.
5. Experiments in Physical Chemistry – Shoemaker.
6. Advanced Physico-Chemical Experiments – J. Rose.
7. Practical Physical Chemistry – S.R. Palit.
8. Experiments in Physical Chemistry – Yadav, Geol Publishing House.
9. Experiments in Physical Chemistry – Palmer.
10. Experiments in Chemistry – D.V. Jahagirdar, Himalaya Publishing House, Bombay, (1994).
11. Experimental Physical Chemistry – Das. R.C. and Behera B, Tata Mc Graw Hill.

PROJECT WORK/ DISSERTATION– SOFT CORE

Course Code: CHD 250

Course Outcomes

After studying this course, the student to:

CO1: Carry out literature survey on the problem/s to be solved.

CO2: Learn and follow suitable research methodologies to propose and to perform Experiments.

CO3: Attain the state of ability to take up research work.

CO4: Better understanding about research articles, patents, book chapters or books on relevant research problem

CO5: Acquire skills of writing research reports in the form of articles or thesis.