FACULTY OF SCIENCES

SYLLABUS

FOR

P. G. Diploma
in
Analytical Chemistry
Course Code: PGDAC

(Semester I-II)

Session: 2022-23 Onwards

ESTD. 1892

KHALSA COLLEGE
AMRITSAR

(An Autonomous College)

COURSE NAME: P. G. Diploma in Analytical Chemistry
COURSE CODE: PGDAC

PROGRAMME OBJECTIVE:

The objective of the programme is to develop educationally and professionally skilled staff for working as Research Labs in various Educational Institutes, Analytical Labs, Research Labs, and Create the Instrumental proficiency in students for handling of Sophisticated Instruments and learn advance scientific techniques

PROGRAMME OUTCOMES

PO1	Developing a understanding in the safe handling of chemical.
PO2	Recognizing the needs of staff for the Research Labs for the handling and working of the sophisticated of higher importance.
PO3	Creating the awareness about the maintenance of research data and its presentation.
PO4	Recognizing the needs of lab staff with thinking rationally about how to develop environmental friendly labs.

PROGRAMME SPECIFIC OUTCOMES

PSO1	Learning about the working, data handling, data presentation of sophisticated instruments and principles of different lab techniques
PSO2	Understanding the various softwares used for the research purposes. Theoretical aspects of chemistry.
PSO3	Learning chemical laboratory techniques. Solution preparation, purification and extraction techniques.
PSO4	Learning various volumetric, gravitational, analytical, spectroscopic, micro and macro analysis of chemicals and use of instruments
PSO5	Develop practical skills for the analytical labs

Eligibility: The Eligibility of the Post Graduation Diploma in Analytical Chemistry (PGDAC) Course is that the candidates must have B. Sc (Medical, Non- Medical, B. Sc. (Honors) Chemistry, Physics or Maths or any other equivalent degree (with 50% marks) in which student had studied Chemistry as one of the subject in at least four semesters.

Admission Process

The admission to Post-Graduation Diploma in Analytical Chemistry Course is Merit Based

Scheme of Courses

Semester-I			
Subject Code	**Subject**	**Credit Hours/ week**	**Marks**
DAC 111	Basic of Analytical Chemistry	6	100
DAC 112	Electroanalytical Methods	6	100
DAC 113	Basic Analytical Chemistry Lab-I	4	100
DAC 114	Basic Analytical Chemistry Lab-II	4	100
TOTAL			**400**
Semester-II			
Subject Code	**Subject**	**Credit Hours/ week**	**Marks**
DAC 121	Spectroscopic and other Techniques	6	100
DAC 122	Research Softwares Lab	6	100
DAC 123	Basic Analytical Chemistry Lab-III	4	100
DAC 124	Basic Analytical Chemistry Lab-IV	4	100
	TOTAL		400

Semester-I

P. G. Diploma in Analytical Chemistry (Semester-I)

DAC 111

Basic of Analytical Chemistry

Credit Hours: 6 Hrs/week
Total Hours: 80
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. Examiner will make four sections of paper namely Section-I, II, III and IV
II. Examiner will set total of TEN questions comprising ONE compulsory question of short answer type covering whole syllabi and THREE questions from each unit.
III. Section-I will consist of ten short questions carrying 1.5 Marks each.
IV. Section-II, III and IV of paper will consist of NINE questions in total having THREE questions from each unit of the syllabus and each question carry 10 Marks.
V. The students are required to attempt SEVEN questions in all, taking ONE Compulsory question of section-I and TWO questions from each section i.e. II, III and IV.
VI. Section II, III and IV of question paper should be from Unit I, II, and III respectively of syllabus

COURSE OBJECTIVES

To introduce the concepts of .

COURSE CONTENTS

UNIT-I

Solution Preparation and dilutions:

Methods of expressing concentrations of solutions, strength, normality, molarity, molality, formality, mole fraction, mass fraction, parts per million, activity and activity coefficient, ideal and non-ideal solutions, Dilute solution, general introduction to colligative properties, molecular weight determination. Experimental methods for determining various colligative properties. Abnormal molar mass degree of dissociation and association of solutes.

UNIT-II

Isolation and Purification Techniques

Filtration (simple, micro, etc.), recrystallization (in aqueous & non-aqueous solutions, at low temperature, in inert atmosphere, semi-micro & micro), use of decolourising carbon, difficulties in recrystallization, drying of liquids, freezing, sublimation, distillation (simple, steam, fractional, vacuum, high vacuum or molecular, etc.), nucleation and crystal growth, crystal

hydrates and solvates, chemical methods for separation, determination of physical constants (mp, mixed mp, bp, m. wt., density, optical rotator power, RI).

UNIT-III

Micellization

Surface active agents, classification of surface active agents, micellization, hydrophobic interactions, critical micellar concentration (CMC), factors affecting CMC of surfactants, counter ion binding to micelles, thermodynamics of micellization , solubilization, micro emulsion, reverse micelles, applications of microemulsions

S. No.	On completing the course, student will be able to	PSOs addressed	Cognitive levels
CO1	Prepare solutions, carry out dilution as per requirement, ideal and non-ideal nature of solution, activity of solution and colligative properties	2	R, U, Ap, An
CO2	Isolation and purification techniques and determination of some physical constants	2, 3	R, U, Ap, An
CO3	Chemical methods of separation	2, 3	R, U, Ap, An
CO4	Concepts of Micellization, role of surface active agents in micellization	2	R, U, Ap, An
CO5	Emulsion, its types, preparation, stabilization and application	2, 3	R, U, Ap, An

P. G. Diploma in Analytical Chemistry (Semester-I)

DAC 112

Electroanalytical Methods

Credit Hours: 6 Hrs/week
Total Hours: 80
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. Examiner will make four sections of paper namely Section-I, II, III and IV
II. Examiner will set total of TEN questions comprising ONE compulsory question of short answer type covering whole syllabi and THREE questions from each unit.
III. Section-I will consist of ten short questions carrying 1.5 Marks each.

IV. Section-II, III and IV of paper will consist of NINE questions in total having THREE questions from each unit of the syllabus and each question carry 10 Marks.
V. The students are required to attempt SEVEN questions in all, taking ONE Compulsory question of section-I and TWO questions from each section i.e. II, III and IV.
VI. Section II, III and IV of question paper should be from Unit I, II, and III respectively of syllabus

COURSE OBJECTIVES

To introduce good Lab Practices, Lab Safety, Lab maintenance, Stock maintenance, Record and data handling and some general terms related to chemistry labs.

COURSE CONTENTS

UNIT-I

Polarography:

Principles, classification of polarographic techniques, types of polarographic currents, instrumentation, factors affecting polarographic wave, pulse polarography, and differential pulse polarograph. Potentiometry: Metal electrodes for measuring the metal's cation, metal-metal salt electrodes, redox electrodes, calomel electrode, measurement of potential, determination of concentrations, residual liquid-junction potential, accuracy on direct potentiometric, glass pH electrode, ion-selective electrodes.

UNIT-II

Voltammetry:

Voltammetric principles, hydrodynamic voltammetry, stripping voltammetry, cyclic voltammetry, criteria of reversibility of electrochemical reactions, quasi-reversible and irreversible processes, qualitative and quantitative analysis

UNIT-III

Amperometry:

Principles and amperometric titration techniques: Dropping mercury electrode, rotating platinum microelectrode and dead stop, biamperometric titrations.

S. No.	On completing the course, student will be able to	PSOs addressed	Cognitive levels
CO1	Principle, instrumentation, factors affecting	1,2	R, U, Ap

	polarograph, pulse and differential polarography.		
CO2	Potentiometry and its application in terms of glass and ion-selective electrodes	2, 3	R, U, Ap
CO3	Principle, instrumentation and working of voltametry and cyclic voltametery for qualitative and quantitative analysis.	1, 2, 3	R, U, Ap, An
CO4	Learning the Amperometric titration techniques, use of dropping mercury and rotating platinum microelectrodes	2, 3	R, U, Ap, An
CO5	Performing Biamperometric titrations	2, 4	R, U, Ap, An

P. G. Diploma in Analytical Chemistry (Semester-I)

DAC 113

Basic Analytical Chemistry Lab-I

Credit Hours: 4 Hrs/week
Total Hours: 60
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted in one Session
II. Students will perform one practicals.
III Students will be asked to complete write up of practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 25, Performance = 25, Viva-Voce = 20, Practical notebook = 5)

COURSE OBJECTIVES

To introduce good Lab Practices, Lab Safety, Lab maintenance, Stock maintenance, Record and data handling and some general terms related to chemistry labs.

COURSE CONTENTS

(i) Determine the end point of the following titrations by the conductometric methods. Strong acid-Strong base Strong acid-Weak base Weak acid-Strong base Weak acid-Weak base

(ii) Determine the composition of a mixture of acetic acid and the hydrochloric acid by conductometric titration.

(iii) Determination of CMC of various surfactants

(iv) Molecular Weight Determination of acetanilide, napthalane, using camphor as solvent (Rast's methods).

(v) To determine the molecular weight of a polymer by viscosity measurements

(vi) Extraction of Caffeine from tea leaves

(vii) Isolation of casein from milk (try some typical colour reactions proteins).

(viii) Isolation of essential oils from Caraway seeds and orange peels – (S) – Carvone and (R) – Limonene

(ix) Column Chromatography Separation of o & p nitrophenol

(x) Separation of Leaf pigments from Spinnach leaves

(xi) Separation of o & p nitro aniline Separation of dyes.

S. No.	On completing the course, student will be able to	PSOs addressed	Cognitive levels
CO1	Perform the conductometric titrations for the various purposes	3, 4, 5	R, U, Ap, An
CO2	Study the surface properties of surfactants through their CMC determination	3, 5	R, U, Ap, An
CO3	Molecular weight determination through various methods	3, 4, 5	R, U, Ap, An
CO4	Perform extraction and isolation procedures on the natural products.	3, 4, 5	R, U, Ap, An
CO5	Separation of components of mixture through	3, 4, 5	R, U, Ap, An

	chromatographic techniques		

P. G. Diploma in Analytical Chemistry (Semester-I)

DAC 114

Basic Analytical Chemistry Lab-II

Credit Hours: 4 Hrs/week
Total Hours: 60
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted in one Session
II. Students will perform one practical.
III Students will be asked to complete write up of practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 25, Performance = 25, Viva-Voce = 20, Practical notebook = 5)

COURSE OBJECTIVES

To introduce good Lab Practices, Lab Safety, Lab maintenance, Stock maintenance, Record and data handling and some general terms related to chemistry labs.

COURSE CONTENTS

1. To determine the strength of given acid by pH metrically.
2. To determine dissociation constant of given acid pH metrically
3. Determine the activity coefficient of an electrolyte at different molalities by e.m.f. measurements.
4. Compare the cleansing powers of samples of two detergents from surface tension measurements.
5. Determine the specific refraction, molar refraction and atomic parachor with the help of Abbe's refractometer.
6. To study the distribution of benzoic acid between benzene and water.

7. Compare the relative strength of: i) HCl ii) H_2SO_4 by following the kinetics of inversion of cane sugar polarimetrically.
8. Determination of standard electrode potential (E_o) value of the ferrous-ferric system by titrating ferrous ammonium sulphate against potassium dichromate potentiometrically.
9. To determine the basicity of an organic acid by conductometric measurements.
10.To determine the solutbility of AgCl in water electrometrically.
11. Determination of ionic product of water by emf method.

S. No.	On completing the course, student will be able to	PSOs addressed	Cognitive levels
CO1	Learn the practical use of pH meter for the qualitative and quantitative analysis	4,5	R, U, Ap, An
CO2	Learn the practical use of Conductometer for the qualitative and quantitative analysis	4,5	R, U, Ap, An
CO3	Learn the practical use of potentiometer for the qualitative and quantitative analysis	4,5	R, U, Ap, An
CO4	Learn the practical use of polarimeter and Abbe's refractometer for the qualitative and quantitative analysis	4,5	R, U, Ap, An
CO5	Compare the cleansing power of surfactants and the distribution phenomenon	4,5	R, U, Ap, An

Semester-II

P. G. Diploma in Analytical Chemistry (Semester-II)

DAC 121

Spectroscopic and other Techniques

Credit Hours: 6 Hrs/week
Total Hours: 80
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. Examiner will make four sections of paper namely Section-I, II, III and IV
II. Examiner will set total of TEN questions comprising ONE compulsory question of short answer type covering whole syllabi and THREE questions from each unit.
III. Section-I will consist of ten short questions carrying 1.5 Marks each.
IV. Section-II, III and IV of paper will consist of NINE questions in total having THREE questions from each unit of the syllabus and each question carry 10 Marks.
V. The students are required to attempt SEVEN questions in all, taking ONE Compulsory question of section-I and TWO questions from each section i.e. II, III and IV.
VI. Section II, III and IV of question paper should be from Unit I, II, and III respectively of syllabus

COURSE OBJECTIVES

To introduce good Lab Practices, Lab Safety, Lab maintenance, Stock maintenance, Record and data handling and some general terms related to chemistry labs.

COURSE CONTENTS

UNIT I

SPECTROSCOPY-I

Electromagnetic Spectrum: Absorption Spectroscopy Ultraviolet (U.V.) absorption spectroscopy introduction- (Beer-Lambert law), molar absorptivity, analysis of UVspectra, types of electronic transitions effect of conjugation. Concept of chromophores and auxochrome, Bathochrome, hypsochrome, hyperchrome, hypochromic shiftsUV spectra of conjugated compounds, Infrared (IR) Absorption spectroscopy-introduction, Hooke's law, Selection rules, intensity and IR bands, measurement of IR spectrum time characteristic absorption of various fundamental band interpretation of IR spectra of simple organic compounds.

UNIT II

SPECTROSCOPY-II

Nuclear Magnetic Resonance (NMR) spectroscopy. Proton Magnetic Resonance (1H NMR) spectroscopy, nuclear shielding and deshielding, chemical shift and molecular structure, spin-spin splitting and coupling constants, areas of signals, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethanol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone.

UNIT III

TITRATION METHODS

Principle, Applications- acid base, complexometric, redox measurement of dielectric constant and analysis of mixture of organic compounds. Advantages and disadvantages of these methods. Volumetric and gravimetric analysis.

S. No.	On completing the course, student will be able to	PSOs addressed	Cognitive levels
CO1	Understand the Concept of UV-Visible spectroscopy, Related terms and factors affecting spectrum and apply on chemical structures.	1, 2, 4	R, U, Ap, An
CO2	Understand the Concept of IR spectroscopy, Related terms and factors affecting spectrum and functional group detection.	1, 2, 4	R, U, Ap, An
CO3	Nuclear magnetic resonance and related terms like shielding, deshielding, coupling constant, pear area and proton counting.	1, 2, 4	R, U, Ap, An
CO4	Theoretical interpretation of NMR spectra of some compounds.	1, 2, 4	R, U, Ap, An
CO5	Principle and application of volumetric and gravimetric analysis.	1, 2, 4	R, U, Ap, An

P. G. Diploma in Analytical Chemistry (Semester-II)

DAC 122

Research Softwares Lab

Credit Hours: 6 Hrs/week
Total Hours: 80
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. Examiner will make four sections of paper namely Section-I, II, III and IV
II. Examiner will set total of TEN questions comprising ONE compulsory question of short answer type covering whole syllabi and THREE questions from each unit.
III. Section-I will consist of ten short questions carrying 1.5 Marks each.
IV. Section-II, III and IV of paper will consist of NINE questions in total having THREE questions from each unit of the syllabus and each question carry 10 Marks.
V. The students are required to attempt SEVEN questions in all, taking ONE Compulsory question of section-I and TWO questions from each section i.e. II, III and IV.
VI. Section II, III and IV of question paper should be from Unit I, II, and III respectively of syllabus

COURSE OBJECTIVES

To introduce good Lab Practices, Lab Safety, Lab maintenance, Stock maintenance, Record and data handling and some general terms related to chemistry labs.

COURSE CONTENTS

UNIT I
BASIC SOFTWARES
Introduction to Chem Draw, Gaussian, Sigma Plot, Origin 6, Schrodinger

UNIT II
PROJECT
Project on basic softwares.

S. No.	On completing the course, student will be able to	PSOs addressed	Cognitive levels
CO1	Draw chemical structures using ChemDraw software.	2	R, U, Ap, An, C
CO2	Study the molecular interaction and its thermodynamics using Guassian software	2	R, U, Ap, An, C
CO3	Use the Origin6 for the data plotting and interpretation.	2	R, U, Ap, An, C

CO4	Use the Sigma Plot for the data plotting and interpretation.	2	R, U, Ap, An, C
CO5	Use of Schoedinger Software for the molecular modelling.	2	R, U, Ap, An, C

P. G. Diploma in Analytical Chemistry (Semester-II)

DAC 123

Basic Analytical Chemistry Lab-III

Credit Hours: 4 Hrs/week
Total Hours: 60
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted in one Session
II. Students will perform one practical.
III Students will be asked to complete write up of practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 25, Performance = 25, Viva-Voce = 20, Practical notebook = 5)

COURSE OBJECTIVES

To introduce good Lab Practices, Lab Safety, Lab maintenance, Stock maintenance, Record and data handling and some general terms related to chemistry labs.

COURSE CONTENTS

Basic Analytical Chemistry Lab III

I. Oxidation-Reduction Titrations

1. Standardization with sodium oxalate of KMnO4and determination of Ca2+ion.
2. Standardization of ceric sulphate with Mohr's salt and determination of Cu2+, NO3 -1and C2O4 -2 ions.
3. Standardization of K2Cr2O7with Fe2+and determination of Fe3+(Ferric alum)
4. Standardization of hypo solution with potassium iodate / K2Cr2O7and determination of available Cl2in bleaching powder, Sb3+and Cu2+ .
5. Determination of hydrazine with KIO3titration.

II. Precipitation Titrations

1. AgNO3standardization by Mohr's method by using adsorption indicator.
2. Volhard's method for Cl-determination.
3. Determination of ammonium / potassium thiocyanate.

III. Complexometric Titrations

1. Determination of Cu2+and Ni2+by using masking reagent by EDTA titration.
2. Determination of Ni2+(back titration).
3. Determination of Ca2+(by substitution method).

IV. Gravimetric Analysis

1. Determination of Ba2+as its chromate.
2. Estimation of lead as its lead molybdate.
3. Estimation of chromium (III) as its lead chromate.
4. Estimation of Cu2+using Ammonium/ Sodium thiocyanate.

Book: Vogel's book on Inorganic Quantitative Analysis.

S. No.	On completing the course, student will be able to	PSOs addressed	Cognitive levels
CO1	Carry out redox titrations for the analytical purposes.	3, 4, 5	

CO2	Carry out Complexometric titrations for the analytical purposes.	3, 4, 5	
CO3	Carry out precipitation titrations for quantitative analysis.	3, 4, 5	
CO4	Carry out Gravimetric analysis for the quantitative purposes.	3, 4, 5	

P. G. Diploma in Analytical Chemistry (Semester-II)

DAC 124

Basic Analytical Chemistry Lab-IV

Credit Hours: 4 Hrs/week
Total Hours: 60
Maximum Marks: 100
Theory: 75
Internal Assessment: 25

INSTRUCTIONS FOR PAPER SETTERS AND CANDIDATES:

I. The exam will be conducted in one Session
II. Students will perform one practical.
III Students will be asked to complete write up of practical within first 30 minutes on the first sheet provided.
IV. On the second sheet provided after 30 minutes, students will perform and note the record on during the conduct of practical exam
V. The split of marks will be as under:
(Write-up = 25, Performance = 25, Viva-Voce = 20, Practical notebook = 5)

COURSE OBJECTIVES

To introduce good Lab Practices, Lab Safety, Lab maintenance, Stock maintenance, Record and data handling and some general terms related to chemistry labs.

COURSE CONTENTS

1. Preparation of Co(acac)3, its characterization using NMR, IR, UV-Vis and analysis of Cobalt (ref. J. Chem. Edu., 1980, 57, 7, 525)
2. Preparation of Co. (acac-NO2)3, its characterization using NMR, IR, UV-Vis and analysis of Cobalt. (ref. J. Chem. Edu., 1980, 57, 7, 525)
3. Preparation of [Fe(H2O)6][Fe(N-salicyldeneglycinato)2]2.3H2O, its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Iron.(ref. InorganicaChimicaActa, 1977, 23, 35).
4. Preparation of [Ni(NH3)6]Cl2its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Nickel and NH3. (ref. Marr and Rockett, 1972).
5. Preparation of [Ni(ethylenediamine)3]Cl2 its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Nickel. (ref. Marr and Rockett, 1972, page 270).

6. Preparation of [Fe(NO)(S2CN(Et)2)2] its characterization using IR, UV-Vis, magnetic susceptibility and analysis of Fe(II). (ref. Marr and Rockett, 1972, page 262, J. Chem. Soc. 1962, 84, 3404).
7. Preparation of octahedral and tetrahedral complexes of dichlorodipyridylcobalt(II), differentiate them using IR, UV and magnetic properties. Estimate Co(II) from one of them. (ref. Marr and Rockett, 1972, page 375, Inorganic Chemistry, 1966, 5, 615).
8. Preparation of VO(acac)2and its piperidine complex, characterize using IR, UV and magnetic moment. Estimate for V(IV). (ref. Marr and Rockett, 1972, 243).
9. Preparation of diaquotetraacetataocopper(II), magnetic susceptibility IR and UV-Vis, analysis of Copper(II).
10. Preparation of cis- and trans- potassium dioxalatodiaquochromate(III). Interpretation of IR, UV and magnetic properties.Estimation of Chromium. (ref. Marr and Rockett, 1972, page 386).
11. Preparation of HgCo(NCS)4, its IR and measure its magnetic moment. (ref. Marr and Rockett, 1972, page 365).
12. Preparation of sodium tetrathionate, interpretation of its IR and analysis using potassium iodate. (ref. Marr and Rockett, 1972, page 214). Academic Session: 2021-22 54
13. Preparation of Potassium dithionate, interpretation of its IR and analysis using potassium iodate. (ref. Marr and Rockett, 1972, page 214).
14. Preparation of bis(acetylacetonato)copper(II), UV-Vis, and IR, magnetic studies, Demonstration of Jahn Teller effect by solution spectral studies. (ref. Bull. Chem. Soc. Japan, 1965, 29, 852).
15. Preparation of salicylamide complexes of Copper(II). IR, UV, magnetic data and analysis of Cu(II). (ref. Indian J. of Chem., 1977, 15A, No. 5, 459; ibid, 1971, 9, 1396).
16. To prepare a macrocyclic ligand 5,7,7,12,14,14-hexamethyl-1,4,8,11-tetraazacyclotetradeca4,11-dienedi(hydrogeniodide) and its complex with Ni(II). Study IR, NMR and UV-Vis of ligand and complex and magnetic properties of complex. To analyze for Ni and I. (J. Chem. Edu. 1977, 79, 581).
17. Preparation and resolution of tris (ethylenediamine) cobalt (III). UV-Vis, NMR, IR, optical rotation of the resolved complexes. ((ref. Marr and Rockett, 1972, page 386).

S. No.	**On completing the course, student will be able to**	**PSOs addressed**	**Cognitive levels**
CO1	Preparation of some COBALT based co-ordination complexes and their characterization through UV, IR, NMR analysis.	3, 4, 5	

CO2	Preparation of some IRON based co-ordination complexes and their characterization through UV, IR, NMR analysis.	3, 4, 5	
CO3	Preparation of some NICKEL, COPPER AND CHROMIUM based co-ordination complexes and their characterization through UV, IR, NMR analysis.	3, 4, 5	
CO4	Preparation of some MERCURY based co-ordination complexes and their characterization through UV, IR, NMR analysis.	3, 4, 5	
CO5	Preparation of sodium tetrathionate and its analysis.	3, 4, 5	

Reference Books:

1. D. A. Skoog and D. M. West, Fundamentals of Analytical Chemistry, Holt Rinehart and Winston Publications, IV Edn, 1982.

2. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Fundamentals of Analytical Chemistry, Thomson Asia Pte Ltd., Singapore, Viiith Edn., 2004.

3. D.A. Skoog, Principles of Instrumental Analysis, Saunders College Pub.Co, III Edn., 1985.

4. J.G. Dick, Analytical Chemistry, McGraw Hill Publishers, 1974.

5. Willard, Merit, Dean and Settle, Instrumental Methods of Analysis, CBS Publishers and Distributors, IV Edn.,1989

6. G. D. Christian and J.E.O Reilly, Instrumental Analysis, Allyn and Bacon Inc, II Edn., 1986.

7. G.W. Ewing, Instrumental Methods of Chemical Analysis, McGraw Hill Pub, 1975.

8. Dr. B.K.Sharma, Instrumental method of Chemical analysis, Goel Publishing House, Meerut 2000

9. Gurdeep R Chatwal, Sham K Anand, Instrumental Methods of Chemical Analysis, Himalaya Pub House, New Delhi 2011.