

KadiSarvaVishwavidhyalaya

M.Sc. Chemistry

Syllabus

(Analytical Chemistry)

SemIII and SemIV

w.e.f. June 2013

Analytical Chemistry Semester-III

Paper –Analytical Chemistry-3 (CH-AC 301)

Credit 04

Rationale of the Paper: To provide the basic knowledge of very important concepts of the Analytical chemistry. To provide overview of the applications of these concepts in applied field to the students is also an objective.

Learning Outcome:

- This study is useful to furnish students with the advanced technical skills and knowledge base that is required in the field of instrumental analysis and which will enable them to pursue careers as analysts in the chemical and/or pharmaceutical industry.
- Understand the essential concepts used in nanotechnology, syntheses and fabrication
- Appreciate the development of modern nanotechnology
- Discuss the application of nanotechnology in major scientific fields
- Discuss the challenges nanotechnology poses to our environment

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-AC-301	Analytical Chemistry-3	4	4	--	70	30	100

Unit	Topics of Paper CH-AC-301	Marks	Teaching Hrs
	Section A		
1	<p>Pharmaceutical Analysis Instrumental and titrimetric assays for anti-diabetic, anti-cancer, anti-tuberculosis, anti-malarial, anti-hypertensive and anti-HIV drugs based on USP/BP/IP. Heavy metal ion, Dissolution, Loss on drying and Karl fisher analysis in pharmaceuticals. Importance of UV-Visible spectrophotometry, IR spectroscopy and HPLC with UV, fluorescence and photodiode array detection in pharmaceutical industry</p>	15	15
2	<p>Introduction and Classification of Nano What is nanotechnology? Classification of Nanostructured materials – Nanoscale Architecture. Synthesis of Nanomaterials: Top down – ball milling; Bottom up – co-precipitation – sol-gel – electrodeposition – using natural nanoparticles – chemical vapor deposition. The Carbon Nanotube – New Forms of Carbon – Types of Nanotubes – Formation of Nanotubes – Uses for nanotubes – Biological Applications.</p>	15	15
	Section B		
3	<p>Analysis of pesticides, soaps and detergents, fertilizers Classification of pesticides. Analysis of different pesticides by classical and instrumental methods. Classification of soaps and detergents with suitable examples. Characterization of soaps and detergents. Types of fertilizers and analysis of different elements like, nitrogen, phosphates, calcium, sodium, potassium and ammonia.</p>	15	15
4	<p>Food Analysis Introduction to food analysis, regulations and international standards related to food analysis, nutritional labeling, sample and sample preparation. Compositional analysis of foods for moisture, proteins, fat, fiber, ash, vitamins and minerals. Adulteration of fats and oils; milk and milk products</p>	15	15
	Objectives from all units	10	

References:

1. NANOTECHNOLOGY: Basic science and emerging technologies, Mick Wilson, KamaliKannagara, Geoff Smith, Michelle Simmons , BurkhardRaguse, Overseas Press, 2005, First Indian Edition.
2. Nanoscale Science and Technology, Robert Kelsall, Ian Hamley, Mark Geoghegan, John Wiley & Sons, Ltd., 2005.
3. "Analytical Chemistry" by Gary D. Christian, 6thEdition, John Wiley and Sons Inc. New Jersey.
4. "Principles of Instrumental Analysis" by Douglas A. Skoog, 3rdEdition, Holt-Saunders International Edition.
5. Flow injection analysis of pharmaceuticals: automation in the laboratory by Jose Martinez Calatayud, Taylor and Francis, 1996.
6. "Food Analysis" by S. Suzanne Nielsen, 3rdedition, Springer 2003.
7. "Food Analysis Laboratory Manual" by S. Suzanne Nielsen, 3rdedition, Springer 2003.
8. Quantitative Analysis of Drugs inPharmaceutical Formulation, 3rdedition, P.D. Sethi, CBS Publishers, 2008.
9. "Handbook of Modern Pharmaceutical Analysis" by SatinderAhuja and Stephen
10. Scypinski, Volume 3, Academic Press, 2001.
11. Standard Method of Chemical Analysis by F.J. Welcher, sixth edition, volume 1,2& 3, Part two, Van Nostrand Reinhold Company.

Rationale of the Paper:

Separation techniques are the basis of instrumental analysis widely applied in industry, chemistry, biochemistry, environment science. These techniques are based on principles of chemistry. Therefore in this module we shall study the principles on which these techniques are based and acquire the basic skills necessary to use the techniques. Studying this depends on the understanding of the underlying chemistry principles making the learner better able to teach them.

Learning Outcome:

- Understanding the principles of chromatographic techniques, with the emphasis on the application in biochemistry.
- Students can be able to design, perform, and interpret chromatographic experiments for biochemical applications.

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal Marks	Total marks
CH-AC-302	Analytical Chemistry-4	4	4	.....	70	30	100

Unit	Topics of Paper CH-AC-302	Marks	Teaching Hrs
	Section A		
1	Chromatography-1 Fundamentals of chromatography (Resolution, Capacity Factor, Selectivity Factor, Dead time, Dead volume)	15	15
2	Chromatography-2 TLC, HPTLC, Ion exchange, Ion chromatography (Working Applications in separation, purification and identification)	15	15
	Section B		
3	Chromatography-3 HPLC, Gas Liquid Chromatography (types of columns, packed columns, Capillary columns, Silylation, Bonded phase columns, Advanced applications)	15	15
4	Extraction Techniques Sample preparation techniques (Working, Methodology and Applications) LLE, SPE, SPME, Protein precipitation	15	15
	Objective question from above four units	10	-----

Methodology of Teaching:

Classroom Sessions
Explanation using multimedia projector
Surprise Test

References:

1. Thin Layer chromatography, E. Stahi
2. Chromatography, Heptman
3. HPTLC, Dr. P.D. Sethi
4. High performance liquid chromatograpgy, Dr. P. D. Sethi
5. Principles of Instrumental Analysis, D. A. Skoog and J. L. Loary, W. B. Saunders.
6. Fundamentals of Analytical Chemistry, D.A. Skoog, D. M. West and F. J. Holler, W. B. Saunders.
7. Principles of Instrumental analysis, D. A. Skoog and W. B. Saunders
8. Analytical Chemistry by G. D. Christian

Rationale of the Paper:

Oxidation & Reduction reactions occur in many chemical systems. In the different reactions involve the transfer of electrons from one chemical species to another. Because “electrons” are involved in all these reactions, these changes are described as electrochemical changes.

Learning Outcome:

At the end of his unit, the student should be able to:

- Draw and identify the basic components of a cell.
- Define: anode, cathode, oxidation, reduction.
- Draw and identify the basic components of an electrolytic cell.
- Define electrode selectivity and describe what makes it possible.
- Describe reference electrodes.
- Describe indicator or measuring electrodes.

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-AC-303	Analytical Chemistry-5	4	4	.....	70	30	100

Unit	Topics of Paper CH-AC-303	Marks	Teaching Hrs
	Section A		
1	Electroanalytical Measurements Voltage, Impedance, The electric double layer, Electrocapillarity. Current, Diffusion transport.	15	15
2	Electrochemical and Bio-sensors Potentiometric sensors. Potentiometric biosensors. Amperometric sensors. Conductometric sensors. Applications of Field-Effect Transistors sensors.	15	15
	Section B		
3	Electrodeposition and Coulometry Electrolysis. Current-Voltage relation. Electrogravimetric analysis at constant current, constant potential and at controlled potential. Coulometric analysis	15	15
4	Electrophoresis Principles of electrophoresis, theory and applications of Poly acrylamide gel electrophoresis, capillary zone electrophoresis, micelles electrokinetic electrophoresis, Iso-electric focusing. Efficiency and resolution. Applications	15	15
	Objectives from all units	10	

References:

- (1) Peter T. Kissinger, William R. Heineman, "Laboratory Techniques in Electroanalytical Chemistry", Marcel Dekker Inc., New York.
- (2) Basil H. Vassos, Galen W. Ewing, "Electroanalytical Chemistry", John Wiley & Sons, New York.
- (3) Allen J. Bard, Larry R. Faulkner, "Electrochemical Methods – Fundamentals and Applications", John Wiley & Sons, New York.
- (4) Daniel C. Harris, "Quantitative Chemical Analysis", W.H. Freeman and Company, New York.
- (5) I. M. Kolthoff, and P.J. Elving, "Treatise on Analytical Chemistry", Wiley-Interscience, New York.
- (6) Brian R. Eggins, "Chemical Sensors and Biosensors", John Wiley & Sons, New York
- (7) Skoog, D.A.; Holler, F.J.; Crouch, S.R "Principles of Instrumental Analysis" 6th ed. Thomson Brooks/Cole Publishing: Belmont, CA **2007**.
- (8) Skoog, D.A.; Holler, F.J.; Nieman, T.A. "Principles of Instrumental Analysis, 5th ed." Saunders college publishing: Philadelphia, **1998**.

Paper – Analytical Chemistry-6 (CH-AC-304)**Credit 04****Rationale of the Paper:**

The purpose of this lesson is for students to investigate the characteristics of matter. The students will investigate mixtures and spectroscopic methods. Students will understand the concepts of solute, solvent, compound, element, and mixture based on their chemical and physical properties.

Learning Outcome:

- Students can describe the principles of lasers
- Describe and explain the principle of operation of modern chromatographic instrumentation.
- Students can explain the principle and applications of atomic spectroscopy.

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-AC-304	Analytical Chemistry-6	4	4	.....	70	30	100

Unit	Topics of Paper CHE-AC-304	Marks	Teaching Hrs
	Section A		
1	Lasers Principle of laser operation; Stimulated emission Population inversion, Single level and multi level laser systems, Properties of laser light and its general and analytical applications; ruby laser, nitrogen laser, dye laser, Use of laser radiation in absorption and fluorescence spectroscopic methods	15	15
2	Specialized chromatographic techniques Principle, separation process on special columns, instrumentation and applications of counter current chromatography. Flash chromatography	15	15
	Section B		
3	Atomic Absorption Spectrometry Introduction, Basic Principles, Instrumentation, Interferences. Techniques for Quantification of Elements, Recent Developments Applications	15	15
4	ICP (Inductive coupled Plasma) ICP-AES, ICP-MS, Operation and Applications	15	15
	Objectives from all units	10	

Reference

- (1) Quantitative Chemical Analysis” by Daniel C. Harris, 5th Edition, W.H. Freeman and Company, New York.
- (2) Analytical Chemistry” by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.
- (3) Chiral Separation Techniques: A Practical Approach, 2nd edition, edited by Ganapathy Subramanian, Wiley-VCH, 2001.
- (4) Chiral Separations by Chromatography by Satinder Ahuja, American Chemical Society, 2000.
- (5) Chiral Chromatography by Thomas E. Beesley, T.E. Beesley, R.P.W. Scott, John Wiley and Sons, 1999.
- (6) A Practical handbook of preparative HPLC by Donald Wellings, Elsevier, 2006.
- (7) Ion-pair chromatography: Theory and Biological and Pharmaceutical Applications (Chromatographic Science), Milton Hearn (editor), Marcel and Dekker Inc. (1985).
- (8) Advances in Electrophoresis (Volume 2) by Andreas Chrembach, Michael J. Dunn, Bertold J. Radola, Wiley-VCH, 1989.
- (9) High Performance Capillary Electrophoresis: An Introduction by David N. Heiger. Hewlett Packard GmbH, 1992.
- (10) High-speed counter current chromatography by Yoichiro Ito and Walter D. Conway, John Wiley and Sons, 1995.
- (11) Practical Aspects of Gas Chromatography/Mass Spectroscopy by Gordon M. Message, John Wiley & Sons, 1984.
- (12) Modern Practice of Gas Chromatography by Robert L. Grob and Eugene F. Barry, 3rd edition, Wiley-Interscience, 1995.
- (13) Basic Gas Chromatography by Harold M. McNair, James M. Miller, John Wiley and Sons, 2008.
- (14) Analytical gas Chromatography by Walter Jennings, Eric Mittlefehldt and Philip Stremple, second edition, Elsevier Science, 1997.
- (15) Modern HPLC for practicing scientists by Michael W. Dong, Wiley Interscience, 2006.

M.Sc. Semester III

CH-AC-305 Practicals

Credit: 08

Rationale of the Paper:

To enhance practical skills of the students in qualitative and quantitative analysis. They also can do instrumental methods of analysis. To provide overview of the applications of these experiments in applied field to the students is also an objective.

Teaching and Evaluation Scheme:

Each practical's listed in the syllabus will be explained and demonstrated in the laboratory. Students are evaluated based on the marks obtained in writing part as well as performance in the laboratory. Viva voce will be conducted based on practical performed by the students during the examinations.

Practical: (Minimum -10)

1. To determined Riboflavin from the given unknown sample.
2. Determination of saponification value of given oil samples.
3. To determine the amount of Iron in milk.
4. To determined % purity of the given sample of Aspirin.
5. Detection of Caffeine in commercial products by TLC.
6. Separation of chlorinated insecticides by paper chromatography.
7. To determine Iodine value of an oil.
8. To determine the acidity of lubricating oil sample.
9. To determine the amount of Chloroquine phosphate from given tablets (By solvent Extraction)
10. Determination of Cl & Br by ion-exchange methods.
11. Determination of Cd & Zn by ion-exchange methods.
12. Determination of Ni & Zn by ion-exchange methods.

Semester-IV

Paper –I Analytical Chemistry- 7 (CH-AC-401)

Credit 04

Rationale of the Paper:

Chromatography is the technique used to perform qualitative and quantitative analysis. From this technique students can explain how partition of an analyte between stationary phase and mobile phase effects separation.

Learning Outcome:

- Define and explain the theory underpinning chromatography.
- To be able to identify and explain the factors influencing chromatographic separation in terms of resolution and specificity.
- Identify the factors influencing different sample injection techniques and be able to discuss the advantages and disadvantages of each type.
- Identify the factors influencing different analyte detection systems and be able to discuss the advantages and disadvantages of each type.

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-AC-401	Analytical Chemistry-7	4	4	..... .	70	30	100

Unit	Topics of Paper CH-AC-401	Marks	Teaching Hrs
	Section A		
1	<p>Automation and Flow injection analysis Principles of automation, automatic and automated devices, Process control: off-line, at-line and on-line analysis. Continuous and discrete analyzers, feedback mechanism. Flow injection analysis, principles, dispersion coefficient, factors affecting peak height-sample volume, channel length, flow rate and channel geometry. Applications of FIA, stopped flow measurements and gradient FIA.</p>	15	15
2	<p>Clinical Chemistry Composition of blood, collection and preservation of samples, common determinations- serum electrolytes, blood glucose, blood urea nitrogen, uric acid, albumins and globulins, acid and alkaline phosphatases, barbiturates. Principles of immunoassays, radioimmunoassay, fluorescence immunoassay, enzyme immunoassay.</p>	15	15
	Section B		
3	<p>Analytical Drug discovery and Development Discovery of new chemical entity, Identity and purity assessment, bioavailability/dissolution requirement, high-throughput screening, degradation and impurity analysis of drug substances, residual solvent and its classification, stability studies, pre-formulation studies, method development and validation.</p>	15	15
4	<p>Bioanalytical Chemistry Components of bioanalytical methodology: extraction from biological matrices, chromatography and detection systems. Bioanalytical method validation parameters: sensitivity, selectivity, accuracy and precision, linearity (calibration curves), recovery, matrix effect and stability. Bioavailability and bioequivalence study, incurred sample reanalysis test for subject samples. USFDA guidelines for bioanalytical method validation and the acceptance criteria.</p>	15	15
	Objective question from above four units	10	-----

Methodology of Teaching:

Classroom Sessions

Explanation using multimedia projector

Surprise Test

ReferenceBooks:

- (1). "Analytical Chemistry" by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.
- (2). "Principles of Instrumental Analysis" by Douglas A. Skoog, 3rd Edition, Holt-Saunders International Edition.
- (3). Flow injection analysis of pharmaceuticals: automation in the laboratory by Jose Martinez Calatayud, Taylor and Francis, 1996.
- (4). "Quantitative Chemical Analysis" by Daniel C. Harris, 5th Edition, W.H. Freeman and Company, New York.
- (5). "Handbook of Modern Pharmaceutical Analysis" by SatinderAhuja and Stephen Scypinski, Volume 3, Academic Press, 2001.
- (6). "Handbook of Modern Pharmaceutical Analysis" (Drug and the Pharmaceutical Sciences) by Lena Ohannesian and Anthony Streeter, Marcel Dekker Inc., New York, 2001.
- (7). Quantitative Analysis of Drugs in Pharmaceutical Formulation, 3rd edition, P.D. Sethi, CBS Publishers, 2008.
- (8). Bioanalytical Chemistry by S. Mikkelsen and E. Corton, John Wiley and Sons, 2004.
- (9). Clinical Chemistry: Principles, Procedures, Correlations, 4th edition by Michael L. Bishop, Janet L. Duben-Engelkrik, Edward P. Fody, Lippincott Williams and Wilkins, 2000.

Paper –II Analytical Chemistry- 8 (CH-AC-402)**Credit 04****Rationale of the Paper:**

Chromatography is the technique used to perform qualitative and quantitative analysis. From this technique students can explain how partition of an analyte between stationary phase and mobile phase effects separation.

Learning Outcome:

- Define and explain the theory under partition chromatography.
- To be able to identify and explain the factors influencing chromatographic separation in terms of resolution and specificity.
- Identify the factors influencing different sample injection techniques and be able to discuss the advantages and disadvantages of each type

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-AC 402	Analytical Chemistry-8	4	4	.....	70	30	100

Unit	Topics of Paper CH-AC-402	Marks	Teaching Hrs
	Section A		
1	UHPLC and Principle, theory, instrumentation and applications of ultrahigh performance liquid chromatography (UHPLC) and Comparison with HPLC.	15	15
2	SFC Principle, theory, instrumentation and applications of supercritical fluid chromatography (SFC). Comparison with HPLC.	15	15
	Section B		
3	LC-NMR Principle, theory, instrumentation and applications of liquid Chromatography –nuclear magnetic resonance (LC-NMR) and Comparison with NMR.	15	15
4	LC-MS Principle, theory, instrumentation and applications of liquid chromatography-mass spectrometry (LC-MS) and Comparison with Mass Spectroscopy.	15	15
	Objective question from above four units	10	-----

Methodology of Teaching:

Classroom Sessions
Explanation using multimedia projector
Surprise Test

References:

- 1.—Handbook of Instrumental Techniques for Analytical Chemistry II, Frank Settle, published by Prentice Hall PTR, New Jersey, 1997.
- 2.—Spectrochemical Analysis by Atomic Absorption and Emission II, Lajunen LHJ, Cambridge, UK: The Royal Society of Chemistry, 1992.
- 3.—Advances in Atomic Spectroscopy II, Sneddon J, CT : JAI Press, Greenwich, 1992.
- 4.—CRC Handbook of Inductively Coupled Plasma Atomic Emission Spectrometry II, Varma A, FL: CRC Press, Boca Raton, 1991.
- 5.—Multi-element Detection Systems for Spectrochemical Analysis II, Busch K W, Busch M A, Wiley, New York, 1990.
- 6.—Principles and Practice of X – Ray Spectrometric Analysis II, 2nd edition, Bertin, Eugene, Plenum Press, New York, 1975.
- 7.—An Introduction to X-Ray Spectrometry II, Jenkins, Ron, Heyden & Sons, London, 1974.
- 8.—Principles of Quantitative X– Ray Fluorescence II, Tertian R, Claisse F, Heyden, London, 1982
- 9.—Quantitative Chemical Analysis II by Daniel C. Harris, 7th Edition, W.H. Freeman and Company, New York.
- 10.—Analytical Chemistry II by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.
- 11.—On-line LC-NMR and related techniques, Klaus Albert (editor), John Wiley and Sons, 2002.
- 12.—Practical Guide to ICP-MS by Robert Thomas, Marcel Dekker Inc., 2004.
- 13.—Packed columns SFC by T.A. Berger, RSC Chromatography Monographs, RSC, 1995.
- 14.—Introduction to Mass Spectrometry: Instrumentation, Applications, and Strategies for Data Interpretation by J. Throck Watson, O. David Sparkman, Wiley, 2007.
- 15.—Interpretation of Mass Spectra by Fred W. McLafferty, Turecek University Science Books, 1993.
- 16.—Mass Spectrometry-Principles and Applications by Edmond de Hoffmann and Vincent Stroobant, John Wiley and Sons, 2007.

Rationale of the Paper:

Research in common parlance refers to a search for knowledge. One can also define research

as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation. It is actually a voyage of discovery. Research is an academic activity and as such the term should be used in a technical sense.

Learning Outcome:

- To define research and describe the research process and research methods
- To know how to apply the basic aspects of the research process in order to plan and execute a research project
- To understand the process of sampling, the uses of questionnaires as data-gathering instruments, how a survey is carried out in terms of process and method, the uses of surveys and to be able to capture their own data.
- To be able to prepare for and present a conference paper/poster at a national/international conference

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-AC 403	Analytical Chemistry-9	4	4	.....	70	30	100

Unit	Topics of Paper CH-AC-403	Marks	Teaching Hrs
	Section A		
1	Specialized Chromatographic Techniques Flash/ ICE, Counter Current Chromatography	15	15
2	Electro Analytical Techniques Chemiluminescence, Fluorescence, Phosphorescence	15	15
	Section B		
3	Thermal Methods of Analysis Principle, theory, instrumentation and applications of TGA, DTA, DSC	15	15
4	Forensic Applications of Analytical Chemistry Analysis of Narcotic Drugs and Psychotropic Substances such as cocaine, cannabis, barbiturates, benzodiazepines, amphetamines, opiates and hallucinogens. Analysis of Beverages: Alcoholic and non-alcoholic beverages and their composition.	15	15
	Objective question from above four units	10	-----

Methodology of Teaching:

Classroom Sessions

Explanation using multimedia projector

Surprise Test

References:

1. Lundquist & Curry : Methods of Forensic Science, 1963.
2. Sharma, B.R. : Forensic Science in Criminal Investigation & Trials, 1974.
3. Walb & Brouns: Drunks, Drugs & Driving.
4. Hoffman: A Handbook on Drug Alcoholic Abuse.
5. Fundamentals of Analytical Chemistry, D.A. Skoog, D. M. West and F. J. Holler, W B. Saunders
6. Analytical Chemistry II by Gary D. Christian, 6th Edition, John Wiley and Sons Inc. New Jersey.
7. Handbook of Thermal Analysis, T. Hatakeyama, Liu Zhenhai
8. Introduction to Thermal Analysis: Techniques and Applications, by M.E. Brown
9. Chemiluminescence in Analytical Chemistry. By Ana M. Garcia-Campana
10. Fluorescence and Phosphorescence Analysis by David M. Hercules

Rationale of the Paper:

Research in common parlance refers to a search for knowledge. One can also define research

as a scientific and systematic search for pertinent information on a specific topic. In fact, research is an art of scientific investigation. It is actually a voyage of discovery. Research is an academic activity and as such the term should be used in a technical sense.

Learning Outcome:

- To define research and describe the research process and research methods
- To know how to apply the basic aspects of the research process in order to plan and execute a research project
- To understand the process of sampling, the uses of questionnaires as data-gathering instruments, how a survey is carried out in terms of process and method, the uses of surveys and to be able to capture their own data.

- To be able to prepare for and present a conference paper/poster at a national/international conference

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks	Total marks
CH-AC-404	Research Methodology -	4	4	.....	70	30	100

Unit	Topics of Paper CH-AC-404	Marks	Teaching Hrs
Section-A			
1	Sampling design: Census and sample survey, Implications of a sample design. Steps in Sampling design, Criteria of selecting a sampling procedure, Characteristics of good sample design. Different types of sample design, Random sample from an infinite universe.	15	15
2	Measurement and scaling techniques Measurement in research, Measurement research, Measurement scales, Sources of error in measurement, tests of sound measurement, technique of developing Measurement tools, Scaling, meaning of scaling, Scale classification bases, Important Scaling techniques, Scale construction techniques.	15	15
Section-B			
3	Methods of data collection Collection of primary data, observation method, Interview method, Collection of data through Questionnaires, Collection of data through schedules, collection of secondary data, selection of appropriate method for data collection.	15	15
4	Processing and analysis of data Processing operations, statistics in research, measures of dispersion, measures of asymmetry, measures of relationship, Simple regression analysis, Multiple correlation and regression, Partial Correlation, Association in case of Attributes, Other measures.	15	15
	Objective question from above four units	10	-----

Methodology of Teaching:

Classroom Sessions

Explanation using multimedia projector

Surprise Test

Reference:

- (1) Research Methodology, Methods and techniques (Second revised Edition) by C. R. Kothari, New Age International Publishers.

M.Sc.Semester IV

Analytical Chemistry-

Practical

(CH-AC-405)

Credit 08

Rationale of the Paper: To enhance practical skills of the students in qualitative and quantitative analysis. They also can do instrumental methods of analysis. To provide overview of the applications of these experiments in applied field to the students is also an objective.

Teaching and Evaluation Scheme:

Each practical listed in the syllabus will be explained and demonstrated in the laboratory.

Students are evaluated based on the marks obtained in writing part as well as performance in the laboratory. Viva voce will be conducted based on practical performed by the students during the examinations.

Practical:

1. To determine the amount of glucose in blood.
2. To determine sodium and potassium in blood serum and urine by flame photometer
3. Drug method development and validation by UV spectrophotometry. (With Extraction) (Any three Method validation parameters)
4. Drug method development and validation by UV spectrophotometry. (Without Extraction) (Any three Method validation parameters)
5. Determine Nitrogen from soil sample by Kjeldahl method.
6. To determine the percentage of ascorbic acid in a given sample.
7. Synthesis of nanomaterials.
8. IR spectral analysis of Different compounds.

Or

Analytical Chemistry- Dissertation (CH-AC-405)

Credit 8

Course	Subject Title	Credit	Theory (hr/week)	Practical (hr/week)	External marks	Internal marks
CH-AC-405	Dissertation	08	-----	-----	200	-----