MASTER OF SCIENCE IN CHEMISTRY

III & IV SEMESTER

SYLLABUS

NEP 2020

Session 2025-26

अध्ययन मंडल बैठक दिनांक 18.07.2025

विषय – रसायन शास्त्र

राष्ट्रीय शिक्षा नीति 2020 के अनुरूप विश्वविद्यालय अन्तर्गत संचालित एम.एस.सी– रसायन शास्त्र प्रोग्राम में अध्ययन मंडल द्वारा तैयार किये गये तृतीय एवं चतुर्थ सेमेस्टर के पाठ्यक्रम को निम्नानुसार लागू करने की अनुशंसा की जाती है:–

Master of Science in Chemistry III & IV Semester Syllabus (NEP-2020)

Academic Session 2025-26

Course Nature	Course Code	Course Title	Course Type (T/P)	HRS.	Credits	Marks		
						CIA	ESE	Total
Semester III								
DSC	CHSC-09T	Research Methodology for Chemistry	T	60	4	30	70	100
DSE	CHSE-13T	Industrial Chemicals and Environment	T	45	3	30	70	100
DSE	CHSE-13P	Industrial Chemicals and Environment Lab Course	P	30	1	15	35	50
DSE	CHSE-14T	Polymer Chemistry	T	60	4	30	70	100
DSE	CHSE-15T	Thermodynamics	T	60	4	30	70	100
DSE	CHSE-16T	Analytical Methods in Chemistry	T	45	3	30	70	100
DSE	CHSE-16P	Analytical Methods in Chemistry Lab Course	p	30	1	15	35	50
			Total		20			600
Semester IV								
DSC	CHSC-10	Research Work & Dissertation						
	A	Introduction, Literature Review & Synopsis preparation	P	-	2	50	-	50
	B	Sampling/ Data Collection/ Experimental work	P	-	8	200	-	200
	C	First Synopsis progress report	P	-	2	50	-	50
	D	Research Writing	P	-	4	100	-	100
	E	Research Presentation and Viva-voce	P	-	4	-	200	200
			Total		20			600

टीप :– परीक्षा योजना एवं प्रश्न पत्र के प्रारूप को भी यथावत् लागू करने की अनुशंसा की जाती है।

आज दिनांक 18.07.2025 को रसायन शास्त्र अध्ययन मंडल की बैठक में निम्नलिखित अध्यक्ष/सदस्य उपस्थित हुये।

क्र.	नाम	पदनाम	अध्यक्ष/सदस्य	हस्ताक्षर
1	Dr. K. INDIRA	Professor	Chairman	Indira
2.	Surendra Kumar Singh	Asst Prof.	member	
3.	Dr. Sumit Srivastava	Assistant Professor	member	Sumit
4	Dharna Thakur	Asst. Prof.	member	
5.	Dr. Manoj Kumar	— " —	— " —	

PART - A	Introduction		
Program : M.Sc. Chemistry	Semester - III		Session : 2025-26
1	Course Code	CHSC–09T	
2	Course Title	RESEARCH METHODOLOGY FOR CHEMISTRY	
3	Course Type	DSC	
4	Pre-requisite (if any)	As per Program	
5	Course Learning Outcomes (CLO)	**By the end of the course, students will be able to:** • Identify and use print and digital sources for chemical literature and research. • Access and evaluate scientific information using online tools and databases. • Write literature reviews and scientific papers with proper structure and ethics. • Present research effectively through posters and oral presentations. • Follow chemical safety protocols and handle hazardous materials responsibly. • Apply scientific methods and analyse experimental data using statistics	
6	Credit Value	4 Credits	Credit = 15 Hours - Learning and Observation
7	Total Marks	Max Marks : 100	Min. Passing Marks : 40

PART - B	Content of the Course	
Total No. of Teaching - Learning Periods (1 Hrs. per Period) = 60 Period (60 Hours)		
Module/ Unit	Topics (Course contents)	No. of Period
I	**Literature Surveys :** **Print:** Sources of infromation: Primary, secondary, tertiary souces; Jounals: Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. **Digital :** Web resources, E-Journals, Journal access, TOC alerts, Hot articles, Citation index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, Preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-Databases, ChemSpider, Science Direct, SciFinder, Scopus. **Information Technology and Library Resources:** The Internet and World Wide Web, Internet resources for chemistry; Finding and citing published information.	20

II	**Methods of Scientific Research and Writing Scientific Papers :** Reporting practical and project work. Writing literature surveys and reviews. Organizing a postar display. Giving on oral presentation. Writing Scientific papers - justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of scientific work. Writing ethics. Avoiding plagiarism.	**20**
III	**Chemical Safety and Ethical Handling of Chemicals:** Safe working procedure and protective environment, protective apparel, emergency procedure and first aid, laboratory ventilation. Safe storage and use of hazardous chemicals, procedure for working with substances that pose hazards, flammable or explosive hazards, procedures for working with gases at pressures above or below atmospheric - safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals, procedure for laboratory disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	**10**
IV	**Data Analysis** **The Investigative Approach:** Making and Recording Measurements. SI Units and their use. Scientific method and design of experiments. **Analysis and Presentation of Data:** Descriptive statistics. Choosing and using statistical tests. Chemometrics. Analysis of variance (ANOVA), Correlation and regression, Curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, General polynomial fitting, linearizing transformations, exponential function fit, r and its abuse. Basic aspects of multiple linear regression analysis.	**10**

PART C	**Learning Resources**

Text Books, Reference Books & Others

- Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J. & Jones, A. (2011) *Practical skills in chemistry.* 2nd Edition Prentice-Hall, Harlow.
- Hibbert, D. B. & Gooding, J. J. (2006) *Data analysis for chemistry.* Oxford University Press.
- Topping, J.(1984) *Errors of observation and their treatment.* Fourth Edition, Chapman Hall, London.
- Harris, D. C. *Quantitative chemical analysis.* 6th Edition, Freeman (2007) Chapters 3-5.
- Levie, R. de, *How to use Excel in analytical chemistry and in general scientific data analysis.* Cambridge University Press (2001)
- Chemical safety matters – IUPAC – IPCS, Cambridge University Press, 1992.

PART D	**Assessment and Evaluation**
Suggested Continuous Evaluation Methods :	
Maximum Marks :	**100 Marks**
Continuous Internal Assessment (CIA) :	**30 Marks**
End Semester Exam (ESE) :	**70 Marks**

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Continuous Interanal Assessment (CIA) : (By Course Teacher)	**Internal Test/Quiz-(2) : 20/20 Assignment / Seminar - 10 Total Marks - 30**	**Better marks out of the two Test/Quiz + obtained marks in Assignment shall be considered against 30 Marks**
End Semester Exam (ESE) :	**Two section - A & B** **Section A: Q1. Objective -10 x 1 = 10 Marks; Q2. Short Answer type - 5 x4 = 20 Marks** **Section B: Descriptive answer type qts 1 out of 2 from each unit - 4 x 10 = 40 marks**	

PART-A : Introduction			
Program : M.Sc. Chemistry		**Semester -III**	**Session : 2025-26**
1	**Course Code**	**CHSE-13T**	
2	**Course Title**	**INDUSTRIAL CHEMICALS AND ENVIRONMENT**	
3	**Course Type**	**DSE**	
4	**Pre- requisite**	**As per program**	
5	**Course Learning Outcomes (CLO)**	• Understand the different toxic gases and their toxicity hazards • Safe design systems for large scale production of industrial gases • The requirement of ultrapure metals for semiconducting technologies. • Different industrial effluents and their treatment methods • Understanding of biocatalysis and its importance .	
6	**Credit Value**	3 Credit	Credit = 15 Hours
7	**Total Marks**	Max. Marks:100	Minimum Passing Marks :40

PART-B : Content of the Course

Total No. of Teaching – learning Periods (01 Hr. per period) - 45 Periods (45 Hours)

UNIT	Topics (Course contents)	No. of periods
I	**Industrial Gases and Inorganic Chemicals** *Industrial Gases:* Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene. *Inorganic Chemicals:* Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt,borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome alum, potassium dichromate and potassium permanganate.	**10**
II	**Industrial Metallurgy** Preparation of ultrapure metals for semiconductor technology.	**3**

III	**Environment and its segments** Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone, Major sources of air pollution.Pollution by SO2, CO2, CO, NOx, H2S and other foul smelling gases. Methods of estimation of CO, NOx, SOx and control procedures. Effects of air pollution on living organisms and vegetation. *Water Pollution*: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems. Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, agro, fertilizer, etc. Sludge disposal. Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.	**22**
IV	**Energy & Environment** Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc. Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.**Biocatalysis :**Introduction to biocatalysis.	**10**

PART-C: Learning Resources	
	1.E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK. 2. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi. 3. J. A. Kent: *Riegel's Handbook of Industrial Chemistry, CBS Publishers, New Delhi.* *4. S. S. Dara: A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi. 5. K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi. 6. S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi. 42 7. S.E. Manahan, *Environmental Chemistry*, CRC Press (2005). 8. G.T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006). 9. A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).
PART-D : Assessment and Evaluation	
Suggested Continuous Evaluation Methods: **Maximum Marks : 100 Marks** **Continuous Internal Assessment (CIA) :30 Marks**	

End Semester Exam (ESE) : 70 Marks		
Continuous Internal Assessment (CIA)	**Internal test/ Quiz-2 : 20 Marks** **Assignment / Seminar :10 Marks** **Total Marks : 30 Marks**	**Better marks out of the two test/quiz + obtained marks in Assignment shall be considered against 30 Marks**
End Semester Exam (ESE)	**Two section – A& B** **Section A:** **Q1. Objective- 10x 1 =10 Marks. Q2. Short answer type -5x4=20 Marks.** **Section –B:** **Descriptive answer type qts,1 out of 2 from each unit -4 x 10 = 40 Marks**	

PART - A	Introduction		
Program : M.Sc. Chemistry		Semester - III	Session : 2025-26
1	Course Code	CHSE – 13P	
2	Course Title	INDUSTRIAL CHEMICALS & ENVIRONMENT LAB COURSE	
3	Course Type	DSE	
4	Pre-requisite (if any)	As per Program	
5	Course Learning Outcomes (CLO)	• Learn the following aspects of chemistry through practical exercises. • Gain advanced abilities that can be applied to a range of careers. • Use their degree to specialize in a chemical science, environmental science or as a scientist.	
6	Credit Value	1 Credits : Practical	1 Credit = 30 Hours Laboratory or Field Learning/Training
7	Total Marks	Practical Maximum Marks : 50	Practical Minimum Passing Marks : 20

PART - B	Content of the Course	
Total No. of Teaching - Learning Periods (1 Hrs. per Period) = 30 Period (30 Hours) : Practical		
	List of Experiments	No. of Period
	1. Determination of dissolved oxygen in water. 2. Determination of Chemical Oxygen Demand (COD). 3. Determination of Biological Oxygen Demand (BOD). 4. Percentage of available chlorine in bleaching powder. 5. Measurement of chloride, sulphate and salinity of water samples by simple titration method. 6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3^-) using double titration method. 7. Measurement of dissolved CO_2. 8. Study of some of the common bio-indicators of pollution. 9. Estimation of SPM in air samples. 10. Preparation of borax/boric acid.	30

PART C	Learning Resources
Text Books, Reference Books & Others	

- E. Stocchi: *Industrial Chemistry,* Vol-I, Elllis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes,* Wiley Publishers, New Delhi.
- J. A. Kent: Riegel's *Handbook of Industrial Chemistry,* CBS Publishers, New Delhi.
- S. S. Dara: *A textbook of Engineering Chemistry,* S. Chand & Company Ltd. New Delhi.
- K. De, *EnvironemtalChemistry,*New Age International Pvt. Ltd., New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis* : Wiley Eastern Ltd., New Delhi.

PART D	Assessment and Evaluation	
Suggested Continuous Evaluation Methods :		
Maximum Marks : (Practical)		**50 Marks**
Continuous Internal Assessment (CIA) : (Practical)		**15 Marks**
End Semester Exam (ESE) : (Practical)		**35 Marks**
Continuous Interanal Assessment (CIA) : (By Course Teacher)	**Internal Test/Quiz-(2) : 10/10 Assignment / Seminar - 05 Total Marks - 15**	**Better marks out of the two Test/Quiz + obtained marks in Assignment shall be considered against 15 Marks**
End Semester Exam (ESE)	**Laboratory/ Field Skill Performance : On spot Assessment** **Perform** the task based on the lab. work=**20 Marks** **A. Spotting based on tools and technology(Written)=10Marks** **Viva-Voce (Based on prninciple/technology)= 05 Marks**	

PART-A : Introduction			
Program : M.Sc. Chemistry		Semester -III	Session : 2025-26
1	Course Code	CHSE-14T	
2	Course Title	POLYMER CHEMISTRY	
3	Course Type	DSE	
4	Pre- requisite	As per program	
5	Course Learning Outcomes (CLO)	• Learn the techniques of polymerization. • Understand kinetics of polymerization. • Understand morphology of polymers. • Understand thermodynamics of polymer solution. • Learn about the molecular weight of polymer and its calculations. • Understand theconformation of polymer chain.	
6	Credit Value	4 Credit	1 Credit = 15 Hours
7	Total Marks	Max. Marks:100	Minimum Passing Marks:40

PART-B : Content of the Course

Total No. of Teaching – learning Periods (01 Hr. per period) - 60 Periods(60 Hours)

UNIT	Topics (Course contents)	No. of periods
I	**POLYMERIZATION:** • Types of polymerization. • Mechanism and kinetics of chain growth polymerization – Radical chain growth, ionic chain growth (Both cationic & anionic). • Mechanism and kinetics of stepgrowth (condensation) polymerization • Mechanism of coordination polymerization. • Ring opening polymerization (ROP) - mechanismof ROP of cyclic ethers, cyclic amide and cyclosiploxanes. • Techniques of polymerization- Homogeneous (Bulk&Solution)and Heterogeneous (Emulsion & Suspension)	15

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II	**Morphology of Polymers :** • Crystalline and amorphous phase • Factors affecting polymer crystallinity. • XRD analysis for polymer crystallinity. • Determination of crystalline melting point and degree of crystallinity. • Glass transition temperature (Tg) • Factors affecting Tg of polymer. • Determination of Tg. • WLF theory. • Free volume theory. • Application of Tg and degree of crystallinity.	**15**
III	**Polymer solutions:** • Criteria for polymer solubility. • Solubility parameters. • Thermodynamics of polymer solutions- Entropy, Enthalpy and Free energy change of mixing of polymers solutions. • Flowry- Huggins theory. • Flowry- Krigbaum theory. • Huggins and Kraemer equation. • Phase equilibria in polymeric systems. • Viscosity of dilute solution • Lower and Upper critical solution temperature.	**15**
IV	**POLYMER MOLECULAR WEIGHT:** • Number average molecular weight $\overline{Mn}$ • Weight average molecular weight $\overline{Mw}$ • Viscosity average molecular weight $\overline{Mv}$ • Z- average molecular weight $\overline{Mz}$ • Poly dispersity index (PDI) • Determination of molecular weight of polymer – Viscometry, Osmometry, Light scattering, Ultracentrifugation, Gel permeation chromatography (GPC) • Molecular weight distribution. • Polymer conformation and chain dimensions • Characteristic ratio of polymer	15

PART-C: Learning Resources		
	Reference Books: • Seymour, R.B. & Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981. • Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004. • Billmeyer, F.W. *Textbook of Polymer Science*, 2nd Ed. Wiley Inter science, 1971. • Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991. • Lenz, R.W. *Organic Chemistry of Synthetic High Polymers.* Inter science Publishers, New York, 1967.	
PART-D : Assessment and Evaluation		
Suggested Continuous Evaluation Methods: **Maximum Marks : 100 Marks** **Continuous Internal Assessment (CIA) :30 Marks** **End Semester Exam (ESE) : 70 Marks**		
Continuous Internal Assessment (CIA) (By Course Teacher)	**Internal test/ Quiz-2 : 20 Marks** **Assignment / Seminar :10 Marks** **Total Marks : 30 Marks**	**Better marks out of the two test/quiz + obtained marks in Assignment shall be considered against 30 Marks**
End Semester Exam (ESE)	**Two section – A& B** **Section A:** **Q1. Objective- 10x 1 =10 Marks.** **Q2.Short answer type -5x4=20 Marks.** **Section –B: Descriptive answer type qts 1 out of 2 from each unit- 4 x 10= 40 Marks**	

PART - A	Introduction		
Program: M. Sc. Chemistry		Semester - III	Session: 2025-26
1	Course Code	CHSE-15T	
2	Course Title	THERMODYNAMICS	
3	Course Type	DSE	
4	Pre-requiste (if any)	As per Program	
5	Course Learning Outcomes (CLO)	• To know the basics principles of thermodynamics, equilibrium criteria, and free energy. • To explore the concept of partial molar quantities, chemical potential, and Gibbs-Duhem equation. • To learn about reaction in progress, reaction potential, dynamic equilibrium, standard equilibrium, effect on equilibrium, and chemical equilibrium. • To understand basics principles of statistical thermodynamics such as MB statistics, BE statistics, FD statistics and applications. • To understand the partition functions and heat capacities.	
6	Credit Value	4 Credits	Credit = 15 Hours - Learning & Observation
7	Total Marks	Max. Marks : 100	Min. Passing Marks : 40

PART B	Content of the Course	
Total No. of Teaching - learning Periods (1 hrs. per period) = 60 period (60 hours)		
Module/unit	Topics (Course contents)	No. of Period
I	**THIRD LAW OF THERMODYNAMICS** The Third Law of Thermodynamics, Entropy of Reaction and its Temperature and Pressure Dependence,Entropy and Probability, **EQUILIBRIUM CRITERIA, A AND G FUNCTIONS** Criteria for Equilibrium Under Different Conditions, Relation Between ΔG and ΔStotal for an Isothermal and Isobaric Processes, Gibbs Free-Energy Change of A Chemical Equation, Thermodynamic Relations Involving Functions A and G, Relationship Between ΔG° and ΔA°, Pressure Dependence of Free Energy, Fugacity Function and Its Determination for Real Gases, Temperature Dependence of Free Energy, Resume Concerning U, H, S, A and G, Derivations of Some Thermodynamic Relations, Bridgman Formulae to Write the Expressions of First Partial Derivatives	15

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II	**SYSTEMS OF VARIABLE COMPOSITION** Partial Molar Quantities, Experimental Determination of Partial Molar Volumes, Chemical Potential, Expressions of dU, dH, dA and dG for Multicomponent Open System, Thermodynamic Relations Involving Partial Molar Quantities, The Escaping Tendency, Chemical Potential of a Gas, Chemical Potential of a Gas in a Mixture of Ideal Gases, Partial Molar Quantities of a Gas in a Mixture of Ideal Gases, Additivity Rules, Gibbs-Duhem Equation	15
III	**THERMODYNAMICS OF CHEMICAL REACTION** Description of a Reaction in Progress, thermodynamics of Chemical Reactions (Reaction Potential), Homogeneous Ideal Gas Reaction, Expression of KP for a Reaction Involving Heterogeneous Phases, Dynamic Equilibrium (Law of Mass Action), General Rules to Write QP and KP for any Reaction, Standard Equilibrium Constant in Units Other Than Partial Pressures, Pinciple of Le Chatelier and Braun, Temperature Dependence of Standard Equilibrium Constant Kp, Pressure Dependence of Equilibrium Constants, Effect of an Inert Gas on Equilibrium, General Treatment of a Reaction in Progress, Characteristics of Homogeneous Gaseous Reactions, Study of a Few Important Homogeneous Gaseous Reactions	15
IV	**STATISTICAL THERMODYNAMICS** Introduction, Types of statistics, Maxwell-Boltzmann statistics, Bose-Einstein statistics, Fermi-Dirac statistics, Evaluation of Lagrange's undertermined multipliers, Molecular partition function foe an ideal gas, Translational partition function, Rotational partition function, Vibrational partition function, Electronic partition function, Nuclear Partition function, Thermodynamic properties in terms of the partition function, Thermodynamic properties of an ideal monoatomic gas, Thermodynamic properties of an ideal diatomic gas, Rotational partition function of homonuclear diatomic molecule and the nuclear spin, Statiatical thermodynamics of ortho- and para-hydrogen, Application of BE statistics to black body radition, Quantum statistics: ideal Bose-Einstein gas (Bose-Einstein distribution, Bose-Einstein condensation, Thermodynamics properties of an ideal BE gas), Quantum statistics: ideal Fermi-Dirac gas (Fermi-Dirac distribution,Thermodynamics properties of an ideal FD gas),	15

PART C	Learning Resources

Test Books, Refrence Books & Others

1. Kapoor, K. L. (2015). *A Textbook of Physical Chemistry, Thermodynamics and Chemical-Equilibrium*(Vol. 2, 5th Ed.). Mcgraw-Hill.

2. Puri, B. R., Sharma, L. R., & Pathania, M. S. (2013). *Principles of Physical Chemistry*(46th Ed.). Vishal Publishing Co.

3. Raj, G. (2012). Advanced *Physical Chemistry* (37th Ed.). GOEL Publishing House.

4. Negi, A. S., Anand, S. C. (1997). *A Textbook of Physical Chemistr*(5th Ed.). New Age International (P) Limited, Publishers.

5. Atkins, P., & Paula, J. D. (2010). *Physical Chemistry*(9th Ed.). Oxford University Press.

PART D	Assesment and Evalution	
Suggested Continuous Evaluation Methods:		
Maximum Marks:		**100 Marks**
Continuous Internal Assessment (CIA):		**30 Marks**
End Semester Exam (ESE):		**70 Marks**
Continuous Internal Assessment (CIA): (By Course Teacher)	**Internal Test/ Quiz-(2): 20/20 Assignment / Seminar -10 Total Marks - 30**	**Better marks out of the two Test/Quiz + obtained marks in Assignment shall be considered against 30 Marks**
End Semester Exam (ESE):	**Two section - A & B Section A: Q1. Objective - 10 x 1 = 10 Marks; Q2. Short Answer type - 5 x 4 =20 Marks Section B: Descriptive answer type qts 1 out of 2 from each unit- 4 x 10= 40 Marks**	

PART-A : Introduction			
Program : M.Sc. Chemistry		Semester - III	Session : 2025-26
1	Course Code	CHSE-16T	
2	Course Title	ANALYTICAL METHODS IN CHEMISTRY	
3	Course Type	DSE	
4	Pre- requisite	As per program	
5	Course Learning Outcomes (CLO)	• Understand sampling techniques and statistical data analysis. • Apply principles of spectroscopy in chemical analysis. • Use UV-Visible spectrometry for quantitative estimations. • Interpret IR spectra for structural analysis. • Analyze samples using atomic absorption/emission techniques. • Apply thermal analysis for quantitative estimations. • Perform electroanalytical titrations and determine pKa values. • Use solvent extraction and chromatography for separation. • Analyze stereoisomers using chiral techniques. • Understand the role of computers in instrumental analysis.	
6	Credit Value	3 Credit	1 Credit = 15 Hours
7	Total Marks	Max. Marks:100	Minimum Passing Marks :40

PART-B : Content of the Course

Total No. of Teaching – learning Periods (01 Hr. per period) - 45 Periods (45 Hours)

UNIT	Topics (Course contents)	No. of periods
I	**Analytical Principles and Optical Methods** • **Qualitative and quantitative aspects of analysis**: o Sampling, evaluation of analytical data o Errors, accuracy, precision, and methods of their expressions o Normal distribution of indeterminate errors o Statistical tests: F, Q, t-tests; data rejection; confidence intervals • **Optical methods of analysis**: o Origin of spectra and interaction of radiation with matter o Fundamental laws of spectroscopy; selection rules o Beer-Lambert's law and its validity o **UV-Visible Spectrometry**: ▪ Instrumentation (sources, monochromators, detectors) ▪ Single and double beam instruments ▪ Quantitative analysis: metal ions, isomers, tautomers ▪ Job's method, mole ratio method for metal complex composition	12

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II	**Molecular Spectroscopy and Atomic Spectrometry** • **Infrared Spectrometry**: o Instrumentation, sampling techniques o Structural interpretation o Isotope substitution effects o • **Flame Atomic Absorption and Emission Spectrometry**: o Instrumentation: sources, flames, burners o Atomization and sample introduction o Background correction, chemical interferences o Quantitative estimation of trace metals (e.g., water samples	11
III	**Thermal and Electroanalytical Techniques** • **Thermal Methods of Analysis**: o Theory and instrumentation of Thermogravimetry (TG) o Quantitative estimation of Ca and Mg in mixtures o • **Electroanalytical Methods**: o Classification of electroanalytical techniques o Principles of pH-metric, potentiometric, and conductometric titrations o Determination of equivalence points and pKa values	10
IV	**Separation Techniques and Advanced Analytical Tools** • **Solvent Extraction**: o Principles, classification, and efficiency o Solvation and chelation mechanisms o Extraction techniques: batch, continuous, counter-current o Metal and organic species extraction from various media o • **Chromatographic Methods**: o Principles, classification, and efficiency o Mechanisms: adsorption, partition, ion exchange o Chromatogram development: frontal, elution, displacement o Techniques: IC, GLC, GPC, TLC, HPLC o • **Stereoisomeric Separation & Chiral Analysis**: o Optical rotation, enantiomeric/diastereomeric excess o NMR with chiral solvents/shift reagents o Chiral GC and HPLC columns o • **Role of Computers in Instrumental Analysis**	12

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PART-C: Learning Resources

ReferenceBooks:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
- Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- Christian, G.D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
- Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

Online Resources :

- https://www.chemistrybyguptasir.in/chapter-2-optical-methods-of-analysis/
- https://en.wikipedia.org/wiki/Confidence_interval
- https://en.wikipedia.org/wiki/Student%27s_t-test
- https://byjus.com/chemistry/principle-of-uv-visible-spectroscopy/
- https://en.wikipedia.org/wiki/Beer%E2%80%93Lambert_law
- https://byjus.com/chemistry/infrared-spectroscopy/
- https://en.wikipedia.org/wiki/Spectroscopy
- https://en.wikipedia.org/wiki/Atomic_absorption_spectroscopy
- https://en.wikipedia.org/wiki/Atomic_emission_spectroscopy
- https://www.chemistrybyguptasir.in/chapter-2-optical-methods-of-analysis/
- https://www.sciencedirect.com/topics/chemical-engineering/chromatography
- https://chemistai.org/public/topic/5655

PART-D : Assessment and Evaluation

Suggested Continuous Evaluation Methods:
Maximum Marks : 100 Marks
Continuous Internal Assessment (CIA) :30 Marks
End Semester Exam (ESE) : 70 Marks

Continuous Internal Assessment (CIA)	Internal test/ Quiz- 2 :20 Marks Assignment / Seminar :10 Marks Total Marks :30 Marks	Better marks out of the two test/quiz + obtained marks in Assignment shall be considered against 30 Marks
End Semester Exam (ESE)	Two section – A& B **Section A:** Q1. Objective Type **- 10 x 1 =10 Marks** Q2. Short Answer Type **-05 x 4 =20 Marks** **Section –B:** Descriptive Answer Type Questions, 1 out of 2 from each unit- **04 x 10 = 40 Marks**	

PART-A : Introduction			
Program : M.Sc. Chemistry		Semester - III	Session : 2025-26
1	Course Code	CHSE-16P	
2	Course Title	ANALYTICAL METHODS IN CHEMISTRY LAB COURSE	
3	Course Type	DSE	
4	Pre- requisite	As per program	
5	Course Learning Outcomes (CLO)	➢ Understand sampling techniques and statistical data analysis. ➢ Apply principles of spectroscopy in chemical analysis. ➢ Use UV-Visible spectrometry for quantitative estimations. ➢ Interpret IR spectra for structural analysis. ➢ Analyze samples using atomic absorption/emission techniques. ➢ Apply thermal analysis for quantitative estimations. ➢ Perform electroanalytical titrations and determine pKa values. ➢ Use solvent extraction and chromatography for separation. ➢ Analyze stereoisomers using chiral techniques. ➢ Understand the role of computers in instrumental analysis.	
6	Credit Value	1 Credit	*1 Credit = 30 Hours Laboratory or Field Learning/Training*
7	Total Marks	Max. Marks:50	Minimum Passing Marks :20

PART-B : Content of the Course		
Total No. of Learning-Training/Performance Periods - 30 Periods (30 Hours)		
Module	**Topics (Course contents)**	**No. of periods**
Lab./Field/Training/ Experiment Content of Course	**I. Separation Techniques** **1. Chromatography** • (a) Separation of mixtures: o Paper chromatographic separation of Fe^{3+}, Al^{3+}, and Cr^{3+}. o Separation and identification of monosaccharides (glucose & fructose) by paper chromatography; report Rf values. • (b) Separate a mixture of Sudan Yellow and Sudan Red using TLC; identify based on Rf values. • (c) Chromatographic separation of active ingredients from plants, flowers, and juices using TLC. **2. Solvent Extractions** • Separation of Ni^{2+} and Fe^{2+} by complexation with DMG; extract Ni^{2+}-DMG complex in chloroform and determine concentration by spectrophotometry.	30

- Solvent extraction of zirconium with Amberlite LA-1; separation from a mixture containing iron and gallium.

II. Other Analytical Techniques

3. pH Determination

- Determine the pH of aerated drinks, fruit juices, shampoos, and soaps.

4. Flame Photometry

- Determine Na, Ca, and Li in cola drinks and fruit juices using flame photometric techniques.

5. Analysis of Soil

- Determine the pH of soil.
- Measure total soluble salts.
- Estimate calcium, magnesium, phosphate, and nitrate content.

6. Ion Exchange

- Determine exchange capacity of cation and anion exchange resins.
- Separate metal ions from binary mixtures.
- Separate amino acids from organic acids using ion exchange chromatography.

III. Spectrophotometry

1. Determine pKa values of indicators using spectrophotometry.
2. Perform structural characterization of compounds using infrared spectroscopy (IR).
3. Determine dissolved oxygen in water.
4. Determine chemical oxygen demand (COD).
5. Determine biological oxygen demand (BOD).
6. Determine the composition of Ferric-salicylate or Ferric-thiocyanate complex using Job's method of continuous variation.

PART-C: Learning Resources

Reference Books:

- Jeffery, G.H., Bassett, J., Mendham, J. & Denney, R.C. *Vogel's Textbook of Quantitative Chemical Analysis*, John Wiley & Sons, 1989.
- Willard, H.H., Merritt, L.L., Dean, J. &Settoe, F.A. *Instrumental Methods of Analysis*, 7th Ed. Wadsworth Publishing Company Ltd., Belmont, California, USA, 1988.
- Christian, G.D; *Analytical Chemistry*, 6th Ed. John Wiley & Sons, New York, 2004.
- Harris, D. C. *Exploring Chemical Analysis*, Ed. New York, W.H. Freeman, 2001.
- Khopkar, S.M. *Basic Concepts of Analytical Chemistry*. New Age, International Publisher, 2009.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Mikes, O. *Laboratory Hand Book of Chromatographic & Allied Methods*, Elles Harwood Series on Analytical Chemistry, John Wiley & Sons, 1979.
- Ditts, R.V. *Analytical Chemistry; Methods of Separation*, van Nostrand, 1974.

Online Resources :

- https://www.chromatographyonline.com
- https://edu.rsc.org/resources/chromatography-techniques/4010255.article
- https://www.excedr.com/resources/chromatography-techniques
- https://www.aurorabiomed.com/liquid-liquid-vs-solid-liquid-extraction
- https://www.fairorganic.com/solvent-extraction
- https://www.classcentral.com/subject/spectrophotometry
- https://chem.libretexts.org/Bookshelves/Analytical_Chemistry/Supplemental_Modules_(Analytical_Chemistry)/Spectrophotometry

PART-D : Assessment and Evaluation

Suggested Continuous Evaluation Methods:
Maximum Marks : 50 Marks
Continuous Internal Assessment (CIA) :15 Marks
End Semester Exam (ESE) : 35 Marks

Continuous Internal Assessment (CIA) (By Course Teacher)	Internal test/ Quiz- 2 :10 Marks Assignment / Seminar :05 Marks Total Marks :15 Marks	Better marks out of the two test/quiz + obtained marks in Assignment shall be considered against 15 Marks
End Semester Exam (ESE)	**Laboratory/ Field Skill Performance : On spot Assessment** **A. Perform** the task based on the lab. work=**20 Marks** **B. Spotting based on tools and technology(Written)=10Marks** **C. Viva-Voce (Based on prninciple/technology)= 05 Marks**	Managed by Course Teacher as per Lab. Status

Part – A: Introduction			
Program: Master In Chemistry		Semester - IV	Session: 2025-26
1	Course Code	CHSC-10	
2	Course Title	Research Work & Dissertation	
3	Course Type	DSC	
4	Prerequisite (If Any)	As per Program	
5	Course Learning Outcome (CLO)	• To develop independent research skills and scientific inquiry among students. • To train students in experimental design, data collection, analysis, and interpretation. • To promote critical thinking and problem-solving in real-world research contexts. • To strengthen students' abilities in scientific writing, reporting, and communication. • To inculcate ethical research practices, teamwork, and professional conduct.	
6	Credit Value	20 Credits	Credit = 15 Hours – Learning and Observation
7	Total Marks	Max. Marks: 600	Minimum Pass marks – 240

PART B: CONTENT OF THE COURSE

Total No. of Teaching/Learning Periods: IV Semester

Unit	TOPIC (Course Contents)	No. of Periods
A	**Introduction, Literature Review & Synopsis Preparation** Identifying the research problem,collect research paper and Literature Review,Framing objectives and hypotheses, Research design and techniques, Materials, tools, instruments, Ethical considerations, Prepare a synopsisand submit it	-
B	**Sampling/Data Collection/Experimental Work** Problem Selection and Formulation, Data Sampling Methods, Hands-On Laboratory/Field Work, Primary or Secondary Data Generation, Observations and Record Maintenance. Data Analysis and Interpretation - Statistical Methods / Software Tools, Graphical and Tabular Representation, Discussion in Relation to Objectives	-
C	**First Synopsis Progress Report** A two months progress report have been submit and present it through power point presentation	
D	**Research Writing** Dissertation Structure: Introduction, Methodology, Results, Discussion, Conclusion, Citations and References (APA/MLA/Vancouver Style), Annexures (Plagiarism Report, Raw Data, Photographs, Etc.)	-
E	**Research Presentation and Viva-voce** Power point presentation and Viva-voce of dissertation in the end of the semester.	-

Part – C : Learning Resources	
Text Books, Reference Books and Others	
Text Book Recommended : • **Zar, J.H.** – *Biostatistical Analysis* • **Norman &Streiner** – *Biostatistics: The Bare Essentials* • **Rosner, B.** – *Fundamentals of Biostatistics* **Reference Books :** • **Kothari, C.R.** – *Research Methodology: Methods and Techniques* • **Wayne Goddard & Stuart Melville** – *Research Methodology: An Introduction* • **Robert V. Hogg & Johannes Ledolter** – *Applied Statistics for Engineers and Physical Scientists* • **Day, R.A. & Gastel, B.** – *How to Write and Publish a Scientific Paper*	
Online Resources – e-Resources/e-Books and e-learning portals ➢ https://scholar.google.com ➢ https://pubmed.ncbi.nlm.nih.gov ➢ https://www.sciencedirect.com ➢ https://www.researchgate.net ➢ https://shodhganga.inflibnet.ac.in ➢ https://www.scopus.com ➢ https://link.springer.com	
Part – D : Assessment and Evaluation	
Suggested Continuous Evaluation Methods : **Maximum Marks : 600 Marks** **Continuous Internal Assessment :400 Marks** **End Semester Exam :200 Marks**	
Continuous Internal Assessment (CIA): (By Course Teacher)	**Introduction, Literature Review & Synopsis Preparation:** 50 **Sampling/Data Collection/Experimental Work:** 200 **Two Month Progress Evaluation :**50 **Research Writing:**100 **Total Marks -** 400
End Semester Exam (ESE) :	**Two Section – A & B** **Section A : Q1. Experimental Work & Diligence=** 50Marks **, Q2. Final Dissertation Report –** 50 Marks **Section B :**Presentation & Viva-Voce =100 Marks