

Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	II		
Nomenclature of the Course	Rasshastra		
Sub-Nomenclature of the Course (if any)	-		
Course Code	25PN-CHE-RAS		
Course Type	IKS		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO 1: Compare Vedic atomic theory (<i>Paramanu</i>) with modern molecular science. CLO 2: Explain the chemical necessity of <i>Shodhana</i> (purification) in metallurgy. CLO 3: Identify the functions of ancient lab tools like the <i>Dola</i> and <i>Damaru Yantras</i>. CLO 4: Evaluate the role of <i>Bhasmas</i> as early forms of nanotechnology.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per Week	2	0	2
Internal Assessment Marks	15	0	15
End Term Examination Marks	35	0	35
Maximum Marks	50	0	50
Examination Hours for End Term Examinations	2	0	2
Examination Hours for Internal Examinations	1	0	1

Part B - Contents of the Course

Instructions for Paper Setter: The examiner will set 5 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 7 parts covering entire syllabus and consists of 1 mark each. The examinee will be required to attempt 3 questions, selecting one question from each unit and the compulsory question. All other questions will carry equal marks i.e. 14 marks.

Unit	Topics	Contact Hours
I	Theoretical Foundations & The Atomic Vision Philosophical Framework: The Vaisheshika School: Deep dive into the Vaisheshika Sutras of Acharya Kanad. Paramanu (The Atom): The definition of the atom as indivisible, eternal, and the cause of the perceptible world. Chemical Combination: The concept of Dvyanuka (diatomic molecules) and Tryanuka (triatomic molecules). States of Matter (Pancha Mahabhuta): Understanding the five-element theory not as "elements" in the modern periodic sense, but as phases of matter: Solid (Prithvi), Liquid (Ap), Plasma/Energy (Tejas), Gas (Vayu), and Space/Ether (Akasha). Properties & Changes: Paka-Vada: The theory of chemical change through heat.	15

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Pilupaka vs. Pitharapaka: Debates between different schools on whether chemical change happens at the atomic level or the molecular level.

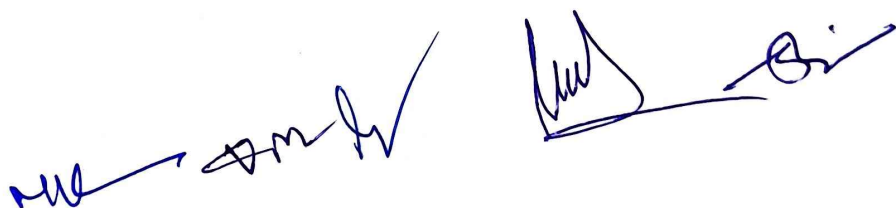
II	Applied Rasashastra & Experimental Metallurgy The Ancient Laboratory (Rasashala): Setup and Safety: Traditional protocols for handling toxic substances. Yantras (Equipment): Mechanics of the Vidyadhara Yantra (for extraction) and Patala Yantra (sublimation/distillation). Mineralogy & Purification (Shodhana): The Rasa-Varga: Classification of minerals into Maharasa (primary), Uparasa (secondary), and Sadharana Rasa. Purification Science: The chemical logic behind using organic acids (citrus juices) and bases (cow urine) to neutralize heavy metal toxicity. Advanced Metallurgy (The Bhasma Process): Marana (Calcination): Turning metals into "ash" or nanoparticles. Case Study - Zinc & Steel: The history of Zinc distillation in Zawar and the creation of Wootz Steel (the high-carbon Damascus steel). Iatrochemistry: The transition of chemistry from "gold-making" (Alchemy) to "body-saving" (Medicine/Ayurveda).	15
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment Marks: 15		End Term Examination Marks: 35	
➤ Theory	15	➤ Theory:	35
● Class Participation:	4	Written Examination	
● Presentation/Assignment/Quiz/Class Test/ Seminar	4		
● Mid-Term Examination	7		

Part C - Learning Resources

1. The Positive Sciences of the Ancient Hindus, Brijendra Nath Seal (2016).
2. Fine Arts & Technical Sciences in Ancient India (with reference to Mānasollāsa), Dr. Shiv Shekhar Mishra (1982).
3. Mints and Minting in India, Upendra Thakur (1972).
4. A Concise History of Science in India, ed. DM Bose, S N Sen, and B V Subbarayappa (2009).
5. Science and Technology in Medieval India, A Rahman et al. (1982).
6. History of Technology in India, Vol. I (ed. A K Bag), Vol. II (Harbans Mukhia), and Vol. III (ed. K V Mital).



Part A - Introduction			
Name of Programme	M.Sc. Chemistry		
Semester	II		
Nomenclature of the Course	Environmental Science		
Sub-Nomenclature of the Course (if any)	-		
Course Code	25PN-CHE-EVS		
Course Type	VAC		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO 1: Describe the fundamental chemical processes governing major environmental compartments (air, water, soil) and analyze the sources, transformations, and impacts of key environmental pollutants (e.g., SO_x, NO_x, heavy metals, pesticides) with relevance to regional issues in Haryana. CLO 2: Outline the chemical and biological principles behind various techniques used for controlling air pollution and treating wastewater and drinking water, recognizing their application in addressing environmental challenges. CLO 3: Explain the major types of solid and hazardous waste, their management strategies, and identify the chemical aspects of soil contamination, particularly from agricultural and industrial activities. CLO 4: Demonstrate an understanding of the principles of green chemistry and propose how chemical knowledge can be leveraged for environmental monitoring, impact assessment, and the development of sustainable solutions to local and global environmental problems.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per Week	2	0	2
Internal Assessment Marks	15	0	15
End Term Examination Marks	35	0	35
Maximum Marks	50	0	50
Examination Hours for End Term Examinations	2	0	2
Examination Hours for Internal Examinations	1	0	1
Part B - Contents of the Course			
Instructions for Paper Setter: The examiner will set 5 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 7 parts covering entire syllabus and consists of 1 mark each. The examinee will be required to attempt 3 questions, selecting one question from each unit and the compulsory question. All			

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Unit	Topics		Contact Hours
I	Introduction to Environmental Science and Basic Chemical Principles: Definition and Scope: Environmental science as an interdisciplinary field. Importance for chemists. Components of the Environment: Overview of atmosphere, hydrosphere, lithosphere, and biosphere. Water Chemistry and Water Pollution: Water Resources and Hydrological Cycle: Global and local water availability. Chemistry of Natural Water: pH, dissolved oxygen (DO), alkalinity, hardness, major ions. Water Pollutants: Classification (organic, inorganic, biological, and thermal). Sources of Water Pollution: Industrial effluents (e.g., from textile, sugar, paper industries – relevant to Haryana), agricultural runoff (pesticides, fertilizers), domestic sewage, thermal pollution. Water Quality Parameters: Significance and measurement of BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TDS (Total Dissolved Solids), heavy metals, pesticides, and microbial contamination.		15
II	Wastewater Treatment and Drinking Water Purification: Wastewater Characteristics: Physical, chemical, and biological characteristics of domestic and industrial wastewater. Conventional Wastewater Treatment: Primary Treatment: Screening, grit removal, sedimentation. Secondary Treatment: Biological processes (aerobic – activated sludge process, trickling filters; anaerobic – briefly). Emphasis on the chemical and biological transformations. Tertiary Treatment (Brief Overview): Adsorption (activated carbon), advanced oxidation processes (AOPs), membrane filtration (reverse osmosis, ultrafiltration) for removal of specific pollutants. Drinking Water Purification: Conventional Steps: Coagulation-flocculation, sedimentation, filtration (sand filtration). Disinfection: Chlorination (chemistry of chlorine residuals), UV disinfection, ozonation.		15
Total Contact Hours			30
Suggested Evaluation Methods			
Internal Assessment Marks: 15		End Term Examination Marks: 35	
➤ Theory	15	➤ Theory:	35
● Class Participation:	4	Written Examination	
● Presentation/Assignment/Quiz/Class Test/ Seminar	4		
● Mid-Term Examination	7		
Part C - Learning Resources			
Recommended Books/e-resources/LMS:			
1. "Environmental Chemistry" by Stanley E. Manahan, 10th Edition (CRC Press)			
2. "Environmental Chemistry" by Anil K. De, 8th Edition (New Age International Publishers)			
3. "Introduction to Environmental Sciences" by R.S. Khoiyangbam and Navindu Gupta, Latest Edition (TERI Press)			
4. "Environmental Science: Towards a Sustainable Future" by Richard T. Wright and Dorothy F. Boorse, 13th Edition (Pearson)			
5. "Green Chemistry: An Introductory Text" by Mike Lancaster, 3rd Edition (Royal Society of Chemistry)			
6. "Fundamentals of Air Pollution" by Arthur C. Stern, 5th Edition (Academic Press)			
7. "Water Chemistry" by Patrick L. Brezonik and William A. Arnold, 2nd Edition (Oxford University Press)			

8. Central Pollution Control Board (CPCB), India: www.cpcb.nic.in
9. Ministry of Environment, Forest and Climate Change (MoEF&CC), India: moef.gov.in
10. Haryana State Pollution Control Board (HSPCB): www.hspcb.gov.in

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Part A - Introduction

Name of Programme	M.Sc. Chemistry		
Semester	II		
Nomenclature of the Course	Laboratory Skills and Safety		
Sub-Nomenclature of the Course (if any)	-		
Course Code	25PN-CHE-LSS		
Course Type	VAC		
Level of the course	500-599		
Pre-requisite for the course (if any)	Chemistry as a subject at UG level		
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	CLO 1: Comply with Indian statutory regulations (BMW 2016) and NABL safety standards. CLO 2: Prepare accurate chemical reagents and calibrate instruments to industry QC levels. CLO 3: Manage lab emergencies, including chemical spills and fire hazards, effectively. CLO 4: Document experimental data according to global data integrity (ALCOA+) standards.		
Credits	Theory	Practical	Total
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Teaching Hours per Week	2	0	2
Internal Assessment Marks	15	0	15
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Part B - Contents of the Course

Instructions for Paper Setter: The examiner will set 5 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of 7 parts covering entire syllabus and consists of 1 mark each. The examinee will be required to attempt 3 questions, selecting one question from each unit and the compulsory question. All other questions will carry equal marks i.e. 14 marks.

Unit	Topics	Contact Hours
I	Safety Protocols and Regulatory Compliance The Regulatory Landscape: Overview of NABL (ISO 15189/17025) and its importance in Indian diagnostic and research labs. Introduction to GLP (Good Laboratory Practices) and OECD guidelines followed by Indian Pharma. Chemical & Biological Hazards: Classification of hazardous chemicals; interpreting MSDS (Material Safety Data Sheets). Bio-safety levels (BSL-1 to BSL-4) with reference to Indian institutes like NIV Pune.	15

	Waste Management: Deep dive into the Biomedical Waste Management Rules, 2016 (and subsequent amendments). Segregation protocols: Yellow, Red, White, and Blue categories. Treatment of chemical effluents before drainage. Emergency Preparedness: Fire safety (Types of extinguishers: A, B, C, and D), use of spill kits (acid vs. base), and first aid for lab-specific injuries (hydrofluoric acid burns, bromine exposure).		
II	Technical Skills and Lab Operations Precision Measurement: Volumetric Analysis: Calibration and handling of micropipettes, burettes, and volumetric flasks. Gravimetric Analysis: Correct usage of analytical balances; effects of buoyancy and static electricity. Solution Chemistry: Practical calculations for Molarity, Normality, and Molality. Understanding v/v, w/v, and ppm—essential for industry quality control (QC). Common Instrumentation (SOPs): Principles and "Do's & Don'ts" for pH meters, Centrifuges, Incubators, and Autoclaves. Prevention of cross-contamination in PCR and Microbiology hoods. Digital & Physical Documentation: Maintaining the Laboratory Notebook (LNB) as per Indian patent law requirements. Data integrity: Introduction to ALCOA+ principles (Attributable, Legible, Contemporaneous, Original, Accurate). Glassware & Consumables: Selection of Borosilicate glassware; cleaning protocols (chromic acid vs. detergent cleaning).	15	
Total Contact Hours		30	
Suggested Evaluation Methods			
Internal Assessment Marks: 15		End Term Examination Marks: 35	
➤ Theory	15	➤ Theory:	35
● Class Participation:	4	Written Examination	
● Presentation/Assignment/Quiz/Class Test/ Seminar	4		
● Mid-Term Examination	7		
Part C - Learning Resources			
1. "Hand Book of Laboratory Safety" by A. Keith Furr (CRC Press) – The global gold standard for safety protocols. 2. "Biomedical Waste Management Rules, 2016" – Published by the Ministry of Environment, Forest and Climate Change, Government of India (Essential for compliance). 3. "Vogel's Textbook of Quantitative Chemical Analysis" – For foundational measurement and solution preparation skills. 4. "NABL 160" – Guide for Internal Audit and Management Review for Laboratories (Available on the NABL India website). 5. CSIR-National Chemical Laboratory (NCL) Safety Manuals: Excellent localized resources for chemical handling. 6. CDSCO Guidelines: For students aiming for the Pharmaceutical industry (Central Drugs Standard Control Organization). 7. WHO Laboratory Biosafety Manual: For standardized biological risk assessment.			