

**Department of Environmental Science**  
**University School of Vocational Studies and Applied Sciences**  
**Guatam Buddha University**

**Ph.D. Programme in Environmental Science**  
**Course Structure and Syllabus**

<b>SEMESTER-I</b>				
<b>S. No.</b>	<b>Subject Code</b>	<b>Course Name</b>	<b>L-T-P</b>	<b>Credit</b>
<b>Theory</b>				
<b>1.</b>	<b>AS 601</b>	Research Methodology	4-0-0	4
<b>2.</b>	<b>CH 601</b>	Physical Methods in Chemistry-I	3-0-0	3
<b>3.</b>	<b>CH 603</b>	Physical Methods in Chemistry-II	4-0-0	4
<b>4.</b>	<b>CH 605</b>	Seminar	0-0-2	2
	<b>Total</b>		<b>11-0-2</b>	<b>13</b>

**Ph.D. Programme in Environmental Science**  
**Course Structure and Syllabus**

**SEMESTER-I**

**AS 601: RESEARCH METHODOLOGY**

**CREDIT: (L-T-P): 4 (4-0-0)**

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**OBJECTIVE**

To explain the concept of research, steps in and methods of research, report writing, presentation and research ethics

**OUTCOME**

The knowledge of research and research methodology could be applied by the learners for doing research and presentation of research output in an ethical manner

**CONTENTS**

**Unit-I Basics of Research**

Research: Definition, Objectives, Types and Characteristics; Hypothesis: Meaning and types; Research methods vs Methodology. Positivism and post- positivistic approaches to research

**Unit –II Research Formulation**

Research Formulation – Defining and formulating the research problem; Characteristics of a good research problem; Selecting the problem; Literature review: Primary and secondary sources; Web as a literature source, searching the web; Organizing the literature and identifying gap areas from literature review; Research proposal or synopsis

**Unit –III Research Design and Methods**

Research Design: Basic principles, Need of research design, Features of a good research design; Important concepts relating to research design; Observations and Facts; Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models; Developing a research plan-Exploration, Description, Diagnosis, Experimentation. Determining experimental and sample designs

**Unit –IV Data Collection and Analysis**

Observations and collection of data; Sample and sampling methods; Data processing and analysis, Statistical packages of data analysis; Hypothesis testing, Generalization and interpretation; Role of ICT in research

**Unit –V Research Report**

Types of report-Technical reports and thesis; Structure and components of a scientific report, Steps in report writing; Layout, structure and language of typical reports, illustrations and tables; Bibliographic

entries, referencing and footnotes; Oral presentation: Planning and practice, use of visual aids, Importance of effective communication

Commercialization of knowledge and technologies and academic ethics; Intellectual property rights; Plagiarism, paraphrasing and copywrite violation, consequences of plagiarism; Reproducibility and accountability; Citation counting and impact factor, Scientific citation index (SCI), Scientific citation index-expanded (SCI-E), H-index

## SUGGESTED READINGS

- Anthony, M., Graziano, A.M. and Raulin, M.L. 2009. *Research Methods: A Process of Inquiry*, Allyn and Bacon, New York.
- Banerjee, S. and Ramendu, Roy. 2017. *Fundamentals of Research Methodology*, (3<sup>rd</sup> Edition), Kitab Mahal, New Delhi.
- Cooper, D. R. and Schindler, P. S. 2006. *Business Research Methods*, Tata McRraw Hill Publishing P. Ltd., New Delhi.
- Fisher R. A. 2004, *Statistical Methods for Research Workers*, Cosmo Publications, New Delhi.
- Freedman, D., Pisani, R. and Purves, R. 2007. *Statistics*, 4<sup>th</sup> Edition, W. W. Norton and Company, New York.
- Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K. 2002. *An Introduction to Research Methodology*, RBSA Publishers., New Delhi.
- Gupta, S.P. 2014. *Statistical Methods*. S. Chand and Sons, New Delhi.
- Hart, C. 2015. *Doing Your Masters Dissertation*, Sage Publication India P. Ltd., New Delhi-, 481 p.
- Kothari, C.R. 1990. *Research Methodology: Methods and Techniques*. New Age International, New Delhi, 418p.
- Kumar, R. 2014. *Research Methodology: A Step – by – Step Guide for Beginners*, Sage Publications India P. Ltd., New Delhi.
- Montgomery D.C. 2001. *Design and Analysis of Experiments*, John Wiley and Sons, New York.
- Sinha, S.C. and Dhiman, A.K. 2002. *Research Methodology*, 2 Volumes, Ess Ess Publications, New Delhi.
- Snedecor, G.W. and Cochran, G.W. 1989. *Statistical Methods*, 8<sup>th</sup> Edition; Iowa State University Press, Ames, Iowa.
- Trochim, W.M.K. 2005. *Research Methods: The Concise Knowledge Base*, Atomic Dog Publishing, New Delhi, 270p.
- Wadehra, B.L. 2000. *Law Relating to Patents, Trade-marks, Copyright, Designs and Geographical indications*. Universal Law Publishing, New Delhi.

## SEMESTER-I

### CH601: PHYSICAL METHODS IN CHEMISTRY-I

CREDIT: (L-T-P): 3 (3-0-0)

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#### OBJECTIVE

To impart knowledge on physical methods

#### OUTCOME

The learners would be able to utilize the knowledge for experimental work

#### CONTENTS

##### UNIT-1

**Spectral Methods in Analytical Chemistry:** Ultraviolet and visible spectrophotometry (UV-VIS): Introduction, Beer Lambert's law, instrumentation, calculation of absorption maxima of dienes, dienones and polyenes, applications

**Infrared Spectroscopy (IR):** Introduction, instrumentation, sampling technique, selection rules, types of bonds, absorption of common functional groups; Factors affecting frequencies, applications

**Nuclear Magnetic Resonance (NMR):** Magnetic and non-magnetic nuclei, Larmor frequency, absorption of radio frequency. Instrumentation (FT-NMR); Sample preparation, chemical shift, anisotropic effect, spin-spin coupling, coupling constant, applications to simple structural problems

**Mass Spectroscopy (MS):** Principle, working of mass spectrometer (double beam); Formation of different types of ions. McLafferty rearrangements, fragmentation of alkanes, alkyl aromatics, alcohols and ketones, simple applications, simple structural problems based on IR, UV, NMR and MS

**Atomic Absorption Spectroscopy (AAS):** Introduction, Principle, Difference between AAS and FES; X-ray photoelectron microscopy

##### UNIT-II

**Electro-analytical Techniques:** Conductometry and high frequency titrations; Potentiometry, pH-metry, Ion selective electrodes; Electrogravimetry and coulometry; Voltammetry-polarography, amperometric titrations, anodic stripping voltammetry; cyclic voltammetry principles, practice and applications

#### SUGGESTED READINGS

Christian, G. D. 1994. *Analytical Chemistry*, 5<sup>th</sup> Edition, John Wiley and Sons, New York.

Kennedy, J. H. 1990. *Principles of Analytical Chemistry*, 2<sup>nd</sup> Edition, Saunders Holt, London.

Pecsok, R. L., Shields, L. D., Cairns, T. and Mc William, L. C. 1976. *Modern Methods of Chemical Analysis*, 2<sup>nd</sup> Edition, John Wiley, New York.

Skoog, D. A., West, D. M., Holler, F. J. and Crouch, S. R. 2004. *Fundamentals of Analytical Chemistry*, 8<sup>th</sup> Edition, Thomson Brooks/Cole Pub., Singapore.

Willard, H. H., Merritt, L. L., Dean, J. A. and Settle, F. A. 2004. *Instrumental Methods of Analysis*, 7<sup>th</sup> Edition, CBS Pub., New Delhi.

## SEMESTER-I

### CH 603 PHYSICAL METHODS IN CHEMISTRY-II

CREDIT: (L–T–P) : 4 (4-0-0)

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#### OBJECTIVE

To impart knowledge on physical methods

#### OUTCOME

The learners would be able to utilize the knowledge for experimental work

#### CONTENTS

##### UNIT – I

**Separation Techniques :** Chromatographic methods – Principles; Classification – Column chromatography, liquid chromatography, paper chromatography, HPLC, thin layer chromatography, ion exchange chromatography, gas chromatography, GC – mass chromatography, electro chromatography, supercritical fluid chromatography; Capillary electrophoresis – principles, instrumentation and applications

##### UNIT – II

**Thermal Methods of Analysis:** Thermal analytical techniques – TGA, DTA; DSC – Principles, instrumentation and applications

##### UNIT – III

**Chemical Sensors:** Principles, Types of chemical sensor based on the modes of transductions, Types of chemical sensor based on the chemically-sensitive materials (solid electrolyte, gas, semi-conductor), Humidity sensors, Biosensors; Electrochemical sensors (Potentiometric sensors, Ion-selective electrodes, Membrane electrodes, Amperometric sensors, Clark and Enzyme electrodes)

##### UNIT – IV

**Structural Investigation Methods:** Diffraction from crystalline materials, X-ray and neutron sources, powder diffraction methods; Transmission electron microscopy (TEM), Scanning transmission electron microscopy (STEM)

**Surface Probing Techniques:** Scanning electron microscopy (SEM), Atomic force microscopy

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Christian, G. D. 1994. *Analytical Chemistry*, 5<sup>th</sup> Edition, John Wiley and Sons, New York.  
Kennedy, J. H. 1990. *Principles of Analytical Chemistry*, 2<sup>nd</sup> Edition, Saunders Holt, London.

- Pecsok, R. L., Shields, L. D., Cairns, T. and Mc William, L. C. 1976. *Modern Methods of Chemical Analysis*, 2<sup>nd</sup> Edition, John Wiley, New York.
- Skoog, D. A., West, D. M., Holler, F. J. and Crouch, S. R. 2004. *Fundamentals of Analytical Chemistry*, 8<sup>th</sup> Edition, Thomson Brooks/Cole Pub., Singapore.
- Willard, H. H., Merritt, L. L., Dean, J. A. and Settle, F. A. 2004. *Instrumental Methods of Analysis*, 7<sup>th</sup> Edition, CBS Pub., New Delhi.