

**Department of Environmental Sciences and
Technology
School of Environment and Earth Sciences**

**Course Structure of Ph.D.
(Environmental Sciences and Technology)**

Academic Session 2026 – 27 onwards

**Central University of Punjab,
Bathinda**

Semester I

S. No	Paper Code	Course Title	Course Type	Contact Hours			Credit
				L	T	P	C
1	EVS.701	Research Methodology	CC	2	0	0	2
2	EVS.751	Research and Publication Ethics	CC	2	0	0	2
3	EVS.752	Teaching Assistantship	S	0	0	2	1
4	UNI.753	Curriculum, Pedagogy and Evaluation		1	0	0	1
5	EVS.708	Analytical Techniques	CC	4	0	0	4
6	EVS.709	Instrumental Methods of Analysis – I	S	0	0	4	2
7	EVS.710	Instrumental Methods of Analysis – II	S	0	0	4	2
		Total		9		10	14

L: Lectures; P: Practical; T: Tutorial; C: Credits; CC: Core courses; S: Skill

Evaluation criteria:

End Semester Exam: Subjective Type Test: **50 marks**

Total Marks: **50**

Course Title: Research Methodology**Paper Code: EVS.701**

L	T	P	C
2	0	0	2

Total teaching hours: 30 h**Course Learning Outcomes**

Student will be able to

CLO1: Differentiate and apply different research approaches in their research

CLO2: Search most appropriate research references from different search engines

CLO3: Formulate their research hypothesis, design and data collection

CLO4: Format their write-ups as per publication types and journal/publisher guidelines

CLO5: Apply statistical and graphical tools in presentations and publications

Units/ Hours	Contents	Mapping with Course Learning Outcome
I 7 Hours	Introduction Meaning and importance of research, Types of Research- Descriptive and Analytical, Applied and. Fundamental, Conceptual and. Empirical, Qualitative and Quantitative Research, Research Process, Criteria of Good Research, Research problem- definition, scope, Limitations of researchers	CLO1
II 8 Hours	Research formulation and Research Design Formulation of research; Review of Literature, identifying gap areas for literature review, hypothesis testing, Qualities of a good Hypothesis – Null Hypothesis & Alternative Hypothesis, Research Design: Features of a good research design, Basic principles of experimental designs, Important Experimental designs.	CLO2 and CLO3
III 7 Hours	Data Collection and Sampling Methods of data collection- primary and secondary data, Sampling: Concepts, Sampling Error, Sample Size, Features of a good sample, Types of sampling- Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling	CLO3
IV 8 Hours	Data interpretation and scientific writing Data Interpretation- Meaning, Techniques; Report Writing - Significance; Scientific writing, Writing research/review paper and book chapter, Poster preparation and presentation, Dissertation. writing, Reference writing and management. Patents, IPR	CLO4 and CLO5

Suggested Readings:

1. Paltridge, B., Starfield, S. (2019). *Thesis And Dissertation Writing In A Second Language*, Routledge Publisher.
2. Hofmann, A. H. (2019). *Scientific Writing and Communication: Papers, Proposals, and Presentations*, Oxford Univ Pr; 4th edition, USA.
3. Kothari, C. R., Garg, G. (2019). *Research Methodology: Methods And Techniques*, New Age International Publishers; Fourth edition, India.
4. Prathapan, K. (2019). *Research Methodology for Scientific Research*, Dreamtech Press, India
5. Kothari, C. R. (2008). *Research methodology(s)*. New Age International, New Delhi.
6. Patnaik, P. (2010). *Handbook of environmental analysis*, CRC Press, UK.
7. Skoog D. A., Holler F. L. Crouch, S. R. (2007). *Principles of instrumental analysis*, Thomson Brooks/Cole Publishers, Australia.
8. Eaton, A. D., Clesceri, L. S., Rice, E. W., Greenberg, A. E. (2005). *Standard methods for examination of water and wastewater 21st Edition*. American Public Health Association, American Water Worker Association, Water Environment Federation, USA.
9. Gupta, S. (2005). *Research methodology and statistical techniques*, Deep and Deep Publications (P) Ltd. New Delhi.
10. Wiersma, G. (2004). *Environmental monitoring*, CRC Press, UK.
11. Katz, M. (1977). *Methods of air sampling and analysis, 2nd edition*, American Public Health Association, USA.
12. Shukla, S. K., Srivastava, P. R. (1992). *Methodology for environmental monitoring and assessment*, Commonwealth Publishers, New Delhi.
13. Svehla, G. (1996). *Vogel's qualitative inorganic analysis, 7th Edition*, Prentice Hall, USA.
14. Ewing, G. W. (1985), *Instrumental methods of chemical analysis, 5th edition*, McGraw Hill Publications, USA.

Suggested Websites:

1. <https://www.open.edu/openlearn/money-management/understanding-different-research-perspectives/content-section-8>
2. <https://www.modares.ac.ir/uploads/Agr.Oth.Lib.17.pdf>
3. <https://research-methodology.net/>

Mode of Transaction: Class room teaching, assignment, Lectures, Group discussions, presentation, quiz competition.

Course Title: Research Ethics

Paper Code: EVS.751

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Course Learning Outcomes

Student will be able to

CLO1 Apply basics of philosophy of science and ethics

CLO2 Identify research misconduct and predatory publications

CLO3 Examine open access publications and research metrices

CLO4 Analyze plagiarism tools

Units/Hours	Contents	Mapping with Course Learning Outcome
I 8 Hours	Philosophy and Ethics Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgments and reactions. Scientific Conduct: Ethics with respect to science and research; Intellectual honesty and research integrity; Scientific misconducts: Falsification, Fabrication, and Plagiarism (FFP); Redundant publications: duplicate and overlapping publications, salami slicing; Selective reporting and misrepresentation of data.	CLO1
II 7 Hours	Publication Ethics Publication ethics: definition, introduction and importance; Best practices/ standards setting initiatives and guidelines: COPE, WAME, etc.; Conflicts of interest; Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa, types; Violation of publication ethics, authorship and contributorship; Identification of publication misconduct, complaints and appeals; Predatory publishers and journals	CLO1 and CLO2
III 8 Hours	Open Access Publishing Open access publications and initiatives; SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies; Software tool to identify predatory publications developed by SPPU; Journal finder/journal suggestion tools viz, JANE, Elsevier Journal Finder, Springer Journal Suggester, etc. Publication Misconduct: Group Discussions - Subject specific ethical issues, FFP, authorship; Conflicts of interest; Complaints and appeals: examples and fraud from India and abroad Software tools: Use of plagiarism software like	CLO3 and CLO4

	Turnitin, Urkund and other open-source software tools.	
IV 7 Hours	Databases and Research Metrics Databases - Indexing databases, Citation databases: Web of Science, Scopus, etc. Research Metrics: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite score; Metrics: h-index, g index, i10 index, altmetrics	CLO3

Suggested Readings:

1. John, W. C. (2011). Research Design: Qualitative, Quantitative and Mixed Methods Approaches by, Sage Publications, Thousand Oaks.
2. Lester, James, D. and Lester Jr. J. D. (2007). Principles of Writing Research Papers, Longman, New York.
3. Silverman D. (2000). Analyzing talk and text. In N. Denzin and Y. Lincoln, eds. Handbook of Qualitative Research by, Sage Publications, Thousand Oaks, CA.1993, Longman U.K.
4. Seale C. (2004). Social Research Methods: A Reader. Routledge, London.

Suggested Websites:

1. <https://www.niehs.nih.gov/research/resources/bioethics/whatis/index.cfm>
2. <https://www.apa.org/monitor/jan03/principles>
3. <https://www.who.int/activities/ensuring-ethical-standards-and-procedures-for-research-with-human-beings>

Mode of Transaction: Class room teaching, assignment, Lectures, Group discussions, presentation, quiz competition.

Course Title: TEACHING ASSISTANTSHIP
Course Code: EVS 752

L	T	P	C
0	0	2	1

Total Hours: 30

Course Learning Outcome:

At the end of this skill development course, the scholars shall be able to

CLO1 familiarize themselves with the pedagogical practices of effective class room delivery and knowledge evaluation system

CLO2 manage large and small classes using appropriate pedagogical techniques for different types of content

Activities and Evaluation:

- The scholars shall attend Master degree classes of his/her supervisor to observe the various transaction modes that the supervisor follows in the class room delivery or transaction process one period per week.
- The scholars shall be assigned one period per week under the direct supervision of his/her supervisor to teach the Master degree students adopting appropriate teaching strategy(s).
- The scholars shall be involved in examination and evaluation system of the Master degree students such as preparation of questions, conduct of examination and preparation of results under the direction of the supervisor.
- At the end of the semester, the supervisor shall conduct an examination of teaching skills learned by the scholar as per the following **evaluation criteria**:
 - The scholars shall be given a topic relevant to the Master degree course of the current semester as his/her specialization to prepare lessons and deliver in the class room before the master degree students for one hour (45 minutes teaching + 15 minutes interaction).
 - The scholars shall be evaluated for a total of 50 marks comprising *content knowledge* (10 marks), *explanation and demonstration skills* (10 marks), *communication skills* (10 marks), *teaching techniques employed* (10 marks), and classroom interactions (10).

Course Title: CURRICULUM, PEDAGOGY AND EVALUATION
Course Code: UNI 753

L	T	P	C
1	0	0	1

Total Hours: 15

Course Learning outcomes:

After completion of the course, scholars shall be able to:

CLO1 analyze the principles and bases of curriculum design and development

CLO2 examine the processes involved in curriculum development

CLO3 develop the skills of adopting innovative pedagogies and conducting students' assessment

CLO4 develop curriculum of a specific course/programme

Units/ Hours	Contents	Mapping with Course Learning Outcome
I 4 hours	Bases and Principles of Curriculum 1. Curriculum: Concept and Principles of curriculum development, Foundations of Curriculum Development. 2. Types of Curriculum Designs- Subject centered, learner centered, experience centered and core curriculum. Designing local, national, regional and global specific curriculum. Choice Based Credit System and its implementation.	CLO1
II 4 hours	Curriculum Development 1. Process of Curriculum Development: Formulation of graduate attributes, course/learning outcomes, content selection, organization of content and learning experiences, transaction process. 2. Comparison among Interdisciplinary, multidisciplinary and trans-disciplinary approaches to curriculum.	CLO2
III 3 hours	Curriculum and Pedagogy 1. Conceptual understanding of Pedagogy. 2. Pedagogies: Peeragogy, Cybergogy and Heutagogy with special emphasis on Blended learning, Flipped learning, Dialogue, cooperative and collaborative learning 3. Three e- techniques: Moodle, Edmodo, Google classroom	CLO3
IV 4 hours	Learners' Assessment 1. Assessment Preparation: Concept, purpose, and principles of preparing objective and subjective questions. 2. Conducting Assessment: Modes of conducting assessment – offline and online; use of ICT in conducting assessments. 3. Evaluation: Formative and Summative assessments, Outcome based assessment, and scoring criteria.	CLO4

Transaction Mode

Lecture, dialogue, peer group discussion, workshop

Evaluation criteria

There shall be an end term evaluation of the course for 50 marks for duration of 2 hours. The course coordinator shall conduct the evaluation.

Suggested Readings

- Allyn, B., Beane, J. A., Conrad, E. P., & Samuel J. A., (1986). *Curriculum Planning and Development*. Boston: Allyn & Bacon.
- Brady, L. (1995). *Curriculum Development*. Prentice Hall: Delhi. National Council of Educational Research and Training.
- Deng, Z. (2007). Knowing the subject matter of science curriculum, *Journal of Curriculum Studies*, 39(5), 503-535.
<https://doi.org/10.1080/00220270701305362>
- Gronlund, N. E. & Linn, R. L. (2003). *Measurement and Assessment in teaching*. Singapore: Pearson Education
- McNeil, J. D. (1990). *Curriculum: A Comprehensive Introduction*, London: Scott, Foreman/Little
- Nehru, R. S. S. (2015). *Principles of Curriculum*. New Delhi: APH Publishing Corporation.
- Oliva, P. F. (2001). *Developing the curriculum* (Fifth Ed.). New York, NY: Longman
- Stein, J. and Graham, C. (2014). *Essentials for Blended Learning: A Standards-Based Guide*. New York, NY: Routledge.

Web Resources

- https://www.westernsydney.edu.au/__data/assets/pdf_file/0004/467095/Fundamentals_of_Blended_Learning.pdf
- <https://www.uhd.edu/academics/university-college/centers-offices/teaching-learning-excellence/Pages/Principles-of-a-Flipped-Classroom.aspx>
- <http://leerwegdialoog.nl/wp-content/uploads/2018/06/180621-Article-The-Basic-Principles-of-Dialogue-by-Renate-van-der-Veen-and-Olga-Plokhooij.pdf>

Course Title: Analytical Techniques

Paper Code: EVS.708

L	T	P	C
4	0	0	4

Total teaching hours: 60 h

Course Learning Outcomes

Student will be able to:

CLO1 Introduce acid base equilibria

CLO2 Apply principles and steps in precipitation, complexation and titrations

CLO3 Explain principle, instrumentation and application of various sophisticated instruments

CLO4 Distinguish steps and working principle of spectrometric and thermogravimetric methods

CLO5 Describe the types, principle and applications of chromatographic techniques

Units/ Hours	Contents	Mapping with Course Learning Outcome
I 15 Hours	Quantitative analysis Acid-base, complexometric, precipitation and redox titrimetry; Gravimetric analysis – total solids, suspended solids and volatile solids.	CLO1, CLO2
II 15 Hours	Instruments Ion selective electrode methods; pH meter, Conductivity meter, TDS meter, DO meter, Salinity meter, Ion Selective Coulometry, Anode and cathode stripping voltammetry, dropping mercury electrode (DME), merits and demerits of DME, TOC analyzer.	CLO3
III 15 Hours	Spectrometric and Thermogravimetric Methods U.V. spectrophotometer, fluorescence, Flame photometry, Atomic absorption and atomic emission spectrophotometry, molecular structure determination using X- ray, fluorescence and X-ray diffraction, Microwave-plasma Atomic Emission Spectroscopy (MP-AES); Inductive Coupled Plasma Mass Spectroscopy (ICP-MS), Inductive Coupled Plasma Atomic Emission Spectroscopy (ICP-AES), X-ray Fluorescence Spectrometer, Thermogravimetric Analysis, Differential Scanning Calorimetry. MPAES, TOC analyser	CLO4
IV 15 Hours	Separation/ Chromatographic Techniques Partition coefficient, chromatography, general chromatography, chromatographic methods: Paper, Thin Layer chromatography, Column, High Performance Thin Layer Chromatography (HPTLC), Gas Chromatography (GSC and GLC), GC-MS, High Pressure Liquid Chromatography, Ion Exchange chromatography, Ion/Size Exclusion Chromatography and Electrophoresis.	CLO5

Suggested readings:

1. Hussain, C. H., Kecili, R (2020). *Modern Environmental Analysis Techniques for Pollutants*, Elsevier Book, ISBN: 9780128169346.
2. Ahluwalia V. K. (2015). *Instrument Methods of chemical analysis*, Ane Books Pvt. Ltd.
3. Holler F. J., Crouch, S. R. (2014). *Skoog & West's Fundamental of Analytical Chemistry*, 9th edition, CENGAGE learning.
4. Chatwal, G. R., Anand, S. K. (2013). *Instrumental Methods of Chemical Analysis*, Himalaya Publishing House, New Delhi
5. Patnaik, P. (2010). *Handbook of environmental analysis*, CRC Press, USA
6. Rouessac, F., Roussac, A. (2008). *Chemical analysis: modern instrumentation and techniques*, Wiley, England.
7. Skoag, D. A., Holler, F. J., Crouch, S. R. (2007). *Principles of Instrumental Analysis*, CENGAGE Learning.
8. Skoog D. A., Holler, F. L., Crouch, S. R. (2007). *Principles of instrumental analysis*, USA: Thomson Brooks/Cole Publishers.
9. Rajvaidya, N., Markandey, D. (2005). *Environmental Analysis and Instrumentation*, APH Publisher.
10. Eaton, A. D., Clesceri, L. S., Rice, E. W., Greenberg, A. E. (2005). *Standard methods for examination of water and wastewater*, 21st Edition. American Public Health Association, American Water Worker Association, Water Environment Federation, USA.
11. Wiersma, G. (2004). *Environmental monitoring*, CRC Press, UK.
12. Svehla, G. (1996). *Vogel's qualitative inorganic analysis*, 7th Edition, Prentice Hall, USA
13. Shukla, S. K., Srivastava, P. R. (1992). *Methodology for environmental monitoring and assessment*, New Delhi: Commonwealth Publishers.
14. Ewing, G. W. (1985). *Instrumental methods of chemical analysis*, 5th edition, USA: McGraw Hill Publications
15. Harris, D. C. (1948). *Exploring Chemical Analysis*, 3rd edition. W. H Freeman & Company.

Suggested Websites:

1. <https://www.agilent.com/>
2. https://chem.libretexts.org/Bookshelves/Environmental_Chemistry
3. <https://www.shimadzu.com/>

Mode of Transaction: Demonstration, Lecture, E-tutoring, Hands on training, discussion, assignments, Practical

Course Title: Instrumental Methods of Analysis - I**Paper Code: EVS.709**

L	T	P	C
0	0	4	2

Total teaching hours: 60 h**Course Learning Outcomes**

Student will be able to

CLO1 Apply principles and steps in precipitation, complexation and titrations

CLO2 Explain principle, instrumentation and application of instruments (MP-AES, IC, TOC, TGA, DTA)

CLO3 Distinguish steps and working principle of spectrometric and thermogravimetric methods

CLO4 Know to the methods/instruments to be used for various chemical analysis of soil and water samples.

Units/Hours	Contents	Mapping with Course Learning Outcome
I 15 Hours	1. Complexometric titration for determination of hardness (Total, Ca, permanent and Temporary). 2. Turbidometry analysis (determination of sulfate)	CLO1
II 15 Hours	Sample preparation and analysis using: 1. Microwave digestion system 2. TOC analyzer	CLO2
III 15 Hours	Sample preparation and analysis using: 1. AAS 2. MP-AES 3. IC chromatography 4. Thermogravimetric Analysis (TGA, DTA)	CLO2, CLO3
IV 15 Hours	1. To determine the pH, EC, TDS of water, soil and sludge sample 2. Determination of Total Kjeldahl Nitrogen (TKN) and ammonical nitrogen, nitrate, nitrite, phosphate in water and soil samples	CLO4

Suggested Readings

1. Hussain, C. H., Kecili, R (2020). *Modern Environmental Analysis Techniques for Pollutants*, Elsevier Book, ISBN: 9780128169346.

2. Ahluwalia V. K. (2015). *Instrument Methods of chemical analysis*, Ane Books Pvt. Ltd.
3. Holler F. J, Crouch S.R. (2014). *Skoog & West's Fundamental of Analytical Chemistry*, 9th edition, CENGAGE learning.
4. Chatwal, G. R., Anand, S. K. (2013). *Instrumental Methods of Chemical Analysis*, New Delhi: Himalaya Publishing House
5. American Public Health Association (APHA) (2012). *Standard method for examination of water and wastewater*, 22nd edn. APHA, AWWA, WPCF, Washington.
6. Gupta, P. K. (2009). *Methods in environmental analysis water, soil and air*, Jodhpur: Agrobios.
7. Yadav, M. S. (2008). *Instrumental methods of chemical analysis*, Campus Books International. Delhi.

Suggested Websites:

1. <https://www.agilent.com/>
2. https://chem.libretexts.org/Bookshelves/Environmental_Chemistry
3. <https://www.shimadzu.com/>

Mode of transaction: Class room teaching, Lectures, Group discussions, Practical

Course Title: Instrumental Methods of Analysis - II**Paper Code: EVS.710**

L	T	P	C
0	0	4	2

Total teaching hours: 60 h**Course Learning Outcomes**

Student will be able to:

CLO1 Describe the types, principle and applications of chromatographic techniques

CLO2 Explain principle, instrumentation and application of instruments (Viscometer, Bomb calorimeter)

CLO3 Demonstrate properties of fuel samples

CLO4 Apply remote sensing and GIS software for mapping and layout and image interpretation

Units/ Hours	Contents	Mapping with Course Learning Outcome
I 15 Hours	1. To analyze the biogas composition by gas chromatography 2. Familiarization with GC, HPLC	CLO1
II 15 Hours	3. Determination of Gross Calorific Value of fuel/straw samples using Bomb Calorimeter. 4. To determine the kinematic viscosity of the sample by viscometer	CLO2
III 15 Hours	5. Determination of flash point of the sample by flash point apparatus 6. To determine the cloud and pour point of the sample	CLO3
IV 15 Hours	7. GIS database mining: point, polygon and line features capture, editing and manipulation, topology building, joining attribute table with spatial data. 8. GIS Mapping and layout: map template design, map layout design based on scale, export and publishing, GPS mapping	CLO4

Suggested Readings

1. Hussain, C. H., Kecili, R (2020). *Modern Environmental Analysis Techniques for Pollutants*, Elsevier Book, ISBN: 9780128169346.
2. Patnaik, P. (2010). *Handbook of environmental analysis*, CRC Press, USA
3. George E. Totten, RJ Shah, SR Westbrook. (2019). *Fuels and Lubricants Handbook: Technology, Properties, Performance, and Testing*, 2nd Edition, ASTM International
4. Kennedy, M. (2010). *The Global positioning system and ArcGIS*. Crc Press.

Suggested Websites:

1. <https://www.agilent.com/>
2. https://chem.libretexts.org/Bookshelves/Environmental_Chemistry
3. <https://www.shimadzu.com/>

Mode of Transaction: Lecture, demonstration, Experimentation, Tutorial, Problem solving, Self-learning