

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

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

Academic Session 2021– 22 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		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		8		8	14

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

Course Title: Research Methodology

Paper Code: EVS.701

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Learning Outcomes

Student will be able to

- Formulate research problem and steps involved in research process
- Analyse types of databases and quality of research
- Apply principles and steps in acid base titrations, precipitation and complexation
- Explain principle, instrumentation and application of instruments and techniques

Unit 1: Introduction

(7 Lectures)

Meaning and importance of research, Research approaches; types of journals- open access, hybrid, merits and demerits of publishing in different types of journals, concept of citations, impact factor, *h*-Index, I-10 index etc.

Unit 2: Data Collection and Research Design

(8 Lectures)

Web-based literature search engines- Google Scholar, Scopus, Web of Science etc., Review of Literature, identifying gap areas for literature review, hypothesis testing, types of research design, Basic principles of experimental designs, Important Experimental designs.

Unit 3: Scientific Writing

(7 Lectures)

Scientific writing, Writing research/review paper and book chapter, Poster preparation and presentation, Dissertation. writing, Reference writing and management.

Unit4: Tools in Research

(8 Lectures)

Plagiarism and similarity search, Use of tools like Urkund, Turnatin/Ithenticate, Reference Manager – endnote, Mendeley, Statistical and graphical tools.

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.

Evaluation criteria:

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

Total Marks: **50**

Course Title: Research and Publication Ethics

Paper Code: EVS.751

L	T	P	C
2	0	0	2

Total teaching hours: 30 h

Learning Outcomes

Student will be able to

- Apply basics of philosophy of science and ethics
- Identify research misconduct and predatory publications
- Examine open access publications and research metrics
- Analyze plagiarism tools

Unit 1: Philosophy and Ethics

(8 Lectures)

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.

Unit 2: Publication Ethics

(7 Lectures)

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.

Unit 3: Open Access Publishing

(8 Lectures)

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 Turnitin, Urkund and other open source software tools.

Unit 4: Databases and Research Metrics (7 Lectures)

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

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.

Evaluation criteria:

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

Total Marks: **50**

Course Code: EVS.752

Course Title: TEACHING ASSISTANTSHIP

L	T	P	Credit
0	0	2	1

Total Hours: 30

Learning Outcome:

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

1. familiarize themselves with the pedagogical practices of effective class room delivery and knowledge evaluation system
2. 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	Credit
1	0	0	1

Learning outcomes:

Total Hours: 15

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

- analyze the principles and bases of curriculum design and development
- examine the processes involved in curriculum development
- develop the skills of adopting innovative pedagogies and conducting students' assessment
- develop curriculum of a specific course/programme

Course Content

Unit I Bases and Principles of Curriculum

4 hours

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.

Unit II Curriculum Development

4 hours

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.

Unit III Curriculum and Pedagogy

3 hours

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

Unit IV Learners' Assessment

4 hours

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.

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-learningexcellence/Pages/Principles-of-a-Flipped-Classroom.aspx>
- <http://leerwegdialoog.nl/wp-content/uploads/2018/06/180621-Article-The-BasicPrinciples-of-Dialogue-by-Renate-van-der-Veen-and-Olga-Plokhooij.pdf>

Course Title: Analytical Techniques

L	T	P	C
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Paper Code: EVS.708

4	0	0	4
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Total teaching hours: 60 h

Learning Outcomes

Student will be able to:

- Introduce acid base equilibria
- Apply principles and steps in precipitation, complexation and titrations
- Explain principle, instrumentation and application of various sophisticated instruments
- Distinguish steps and working principle of spectrometric and thermogravimetric methods
- Describe the types, principle and applications of chromatographic techniques

Unit 1: Quantitative analysis

(15 Lectures)

Acid-base, complexometric, precipitation and redox titrimetry; Gravimetric analysis – total solids, suspended solids and volatile solids.

Unit 2: Instruments

(15 Lectures)

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.

Unit 3: Spectrometric and Thermogravimetric Methods

(15 Lectures)

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).

Thermogravimetric Analysis, Differential Scanning Calorimetry. MPAES, TOC analyser

Unit 4: Separation/ Chromatographic Techniques

(15 Lectures)

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.

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

Evaluation criteria:

End Semester Exam: Subjective Type Test: **100 marks**

Total Marks: **100**

Course Title: Instrumental Methods of Analysis - I

Paper Code: EVS.709

L	T	P	C
0	0	4	2

Total teaching hours: 60 h

Learning Outcomes

Student will be able to

- Apply principles and steps in precipitation, complexation and titrations
- Explain principle, instrumentation and application of instruments (MP-AES, IC, TOC, TGA, DTA)
- Distinguish steps and working principle of spectrometric and thermogravimetric methods
- Know to the methods/instruments to be used for various chemical analysis of soil and water samples.

Practical's/Demonstration

1. To determine the pH, EC, TDS of water, soil and sludge sample
2. Complexometric titration for determination of hardness (Total, Ca, permanent and Temporary).
3. Determination of Total Kjeldahl Nitrogen (TKN) and ammonical nitrogen etc. in water and soil samples
4. Turbidometry analysis (determination of sulfate)
5. Sample preparation and analysis using:
6. Microwave digestion system
7. TOC analyzer
8. AAS
9. MP-AES
10. IC chromatography
11. Thermogravimetric Analysis (TGA, DTA)

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

Evaluation criteria:

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

Total Marks: **50**

Course Title: Instrumental Methods of Analysis - II

L	T	P	C
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0	0	4	2
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Total teaching hours: 60 h

Learning Outcomes

Student will be able to:

- Describe the types, principle and applications of chromatographic techniques
- Explain principle, instrumentation and application of instruments (Viscometer, Bomb calorimeter)
- Demonstrate properties of fuel samples
- Apply remote sensing and GIS software for mapping and layout and image interpretation

Practical's/Demonstration

1. Determination of Gross Calorific Value of fuel/straw samples using Bomb Calorimeter.
2. To determine the kinematic viscosity of the sample by viscometer
3. Determination of flash point of the sample by flash point apparatus
4. To determine the cloud and pour point of the sample
5. To analyze the biogas composition by gas chromatography
6. Familiarization with GC, HPLC
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

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

Evaluation criteria:

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

Total Marks: **50**