Central University of Punjab

Centre for Environmental Sciences and Technology

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

Academic Session 2018-19

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Sl. No	Paper Code	Course Title	L	T	P	Cr	Total marks
1	EVS 701	Research Methodology	4	1	0	4	100
2	EVS 702	Computer Applications	2	1	0	2	50
3	EVS 703	Biostatistics	2	1	0	2	50
4	EVS XXX	Elective I	4	1	0	4	100
5	EVS XXX	Elective II	4	1	0	4	100
6	EVS 704	EVS Lab I (Computer Applications)	0	0	2	2	50
7	EVS 705	EVS Lab II (Instrumental methods of Analysis)	0	0	2	2	50
8	EVS 799	Seminar	0	0	2	2	50
5 & 6	EVS 711	Water Treatment Technologies	4	1	0	4	100
	EVS 712	Biological Wastewater Treatment Technologies	4	1	0	4	100
	EVS 713	Bioenergy and Bioproducts	4	1	0	4	100
	EVS 714	Application of Remote Sensing and GIS in Environmental Management	4	1	0	4	100
		Total	16		6	22	550

***Students may opt any two relevant courses within or outside the Centre**

Synopsis Submission at the end of Semester II

L: Lectures T: Tutorial P: Practical Cr: Credits
Total Marks: Continuous Assessment and End-Term Exam

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: Research Methodology

Paper Code: EVS 701

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Introduction

Meaning and importance of research, Critical thinking, formulating hypothesis and development of research plan, Review of literature, Interpretation of results and discussion. Scientific writing, Writing research paper, Poster preparation and presentation and Dissertation. Library Classification systems, e-Library, Reference management, Web-based literature search engines.Plagiarism, copyright issues. (14 Lectures)

Unit 2: Research Procedure

Review of Literature, Identifying gap areas for literature review, formulation of research questions, development of working hypothesis, Sampling: Designing probability and non probability sampling techniques for research problems, reliability and validity of qualitative and quantitative tools. Quantitative and qualitative data analysis.

(14 Lectures)

Unit 3: Quantitative Analysis

Acid-Base, complexometric, argentometric, iodo- and iodimetric, redox and coulometric titrations. Gravimetric analysis – total solids, suspended solids and volatile solids. pH meter, Conductivity meter, TDS meter, DO meter, Salinity meter

(12 Lectures)

Unit 4: Instrumental Analysis and Chromatographic Technique

UV-Vis spectrophotometer, Flame photometry, Atomic absorption and atomic emission spectrophotometry, mass spectrometry.

Classical methods like paper chromatography, TLC, Column chromatography, GC, LC, IC, HPLC, GC-MS.

(16 Lectures)

Suggested Readings:

1. Eaton, A. D., Clesceri, L.S., Rice, E.W. and 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.
2. Ewing, G. W. (1985), *Instrumental methods of chemical analysis, 5th edition,* McGraw Hill Publications, USA.
3. Gupta, S. (2005). *Research methodology and statistical techniques,* Deep and Deep Publications (P) Ltd. New Delhi.
4. Katz, M.(1977). *Methods of air sampling and analysis, 2nd edition,* American Public Health Association, USA.
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. Shukla, S. K. and Srivastava, P. R. (1992). *Methodology for environmental monitoring and assessment,* Commonwealth Publishers, New Delhi.
8. Skoog D. A., Holler F.L. and Crouch, S. R. (2007). *Principles of instrumental analysis,* Thomson Brooks/Cole Publishers, Australia.
9. Svehla G. (1996). *Vogel's qualitative inorganic analysis, 7th Edition,* Prentice Hall, USA.
10. Wiersma G.(2004). *Environmental monitoring,* CRC Press, UK

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: Computer Applications

Paper Code: EVS 702

L	T	P	Cr	Marks
2	0	0	2	50

Unit 1

Fundamentals of computers: Parts of computers, Hardware, BIOS, Operating systems, Binary system, Logic gates and Boolean algebra.

(7 Lectures)

Unit 2

World wide web: Origin and concepts, Latency and bandwidth, Searching the internet, Advanced web-search using Boolean logic, Cloud computing. (7 Lectures)

Unit 3

Computer language: Basic DOS commands, AutoHotKey scripting language, HTML and basic structure of a webpage, Designing websites. (7 Lectures)

Unit 4

Sharing Data over Network, Computer Configuration, Memory Hierarchy, Software Structure. Introduction to MS Paint, Notepad and Word. Introduction to Word Processing and Microsoft Office, Creating and Saving Documents, Text Formatting, Tables, Document Review Option, Mail Merge, Inserting Table of Contents, Reference Management.

Application software: Spreadsheet applications, Word-processing applications, Presentation applications, Internet browsers, Reference management, and Image processing applications. Introduction to MATLAB.

(10 Lectures)

Suggested readings:

1. Gookin, D. (2007). MS Word for Dummies.Wiley.
2. Harvey, G. (2007). MS Excel for Dummies. Wiley
3. Sinha, P.K., Computer Fundamentals, BPB Publications
4. Bhatt, Pramod Chandra P. (2008). An introduction to Operating systems: Concept and practice. 2nd Edition. PHI learning Pvt. Ltd, New Delhi.

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: Basic Statistics

Paper Code: EVS.703

L	T	P	Credit	Marks
2	0	0	2	50

Unit 1

Overview of biostatistics: Meaning, need and importance of statistics. Attributes and variables. Measurement and measurement scales. Collection and tabulation of data. Diagrammatic representation of frequency distribution: histogram, frequency polygon, frequency curve, ogives, stem and leaf plot, pie chart. Difference between parametric and non-parametric statistics, Univariant and multivariant analysis, Confidence interval, Errors, Levels of significance, Hypothesis testing.

Descriptive statistics: Measures of central tendency and dispersal, Histograms, Probability distributions (Binomial, Poisson and Normal), Sampling distribution, Kurtosis and Skewness. Linear regression and correlation (Karl Pearson's and Spearman's) and residual plots, curve fitting. Error analysis- types of errors, instrumental, statistical, propagation of errors.

(14 Lectures)

Unit 2

Random experiments, sample spaces (finite and infinite), events, algebra of events, three basic approaches to probability, combinatorial problems. Axiomatic approach to probability. Product sample spaces, conditional probability, Bayes' formula. **Probability distributions**- Binomial, Poission, Gaussian, Lorentzian distributions.

Sampling and Testing-Experimental design and analysis: Sampling techniques, Sampling theory, Steps in sampling, Collection of data-types and methods.

Comparing means of two or more groups: Student's t-test, Paired t-test, Mann-Whitney U-test, Wilcoxon signed-rank, One-way and two-way analysis of variance (ANOVA), Critical difference (CD), Least significant difference (LSD), Kruskal–Wallis one-way ANOVA by ranks, Friedman two-way ANOVA by ranks, $\chi 2$ test.

Least square fitting: Least square fit to a straight line, polynomial, matrix, arbitrary function. Testing the Fit- Chi square test, Linear correlation coefficient, multi variable correlations, Confidence intervals. (14 Lectures)

Suggested Readings:

1. Guest, P.K. (2012). Numerical methods of curve fitting, Cambridge University Press, Cambridge, U.K.
2. Meyer, P.L. (1975). Introductory Probability and Statistical Applications Oxford & IBH Pub, 1975.
3. Hogg, R.V. and Raise, A.T. (1978): Introduction to mathematical statistics, Macmillan Pub. Co. Inc.
4. Croxton, F.E. and Cowden, D.J. (1975): Applied General Statistics.
5. Hoel, P.G. (1997). Introduction to Mathematical Statistics.
6. Johnson, S. (2009). *Windows 7 on demand*. Perspiration Inc., USA.

7. Norman, G. and Streiner, D. (2008). *Biostatistics: The Bare Essentials*. 3rd Edition, Decker Inc., Canada.
8. Sokal, R.R. and Rohlf, F.J. (1994). *Biometry: The Principles and Practices of Statistics in Biological Research.* W.H. Freeman and Company,USA.
9. Thurrott, P. and Rivera, R. (2009). *Windows 7 Secrets*. Wiley Publishing, USA.

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: EVS Lab I (Statistics and Computer Applications)
Paper Code: EVS.704

L	T	P	Cr	Marks
0	0	2	2	50

1. Familiarization with Advances in MS Office (MS WORD, MS Excel)
2. Familiarization with SPSS
3. Analysis of variance
4. Chi square test
5. t-test
6. F-test
7. Z-test

Course Title: EVS Lab II (Instrumental Methods of Analysis)
Paper Code: EVS.705

L	T	P	Cr	Marks
0	0	2	2	50

1. Familiarization with GC, HPLC
2. To determine the pH of water, soil and sludge sample
3. Conductivity measurement and conductometric titrations.
4. Adsorption study – Iodine value determination of charcoal.
5. TCLP extract preparation
6. Determination of Gross Calorific Value of fuel/straw samples using Bomb Calorimeter.
7. To determine the kinematic viscosity of the sample by viscometer
8. Determination of flash point of the sample by flash point apparatus
9. To determine the cloud and pour point of the sample
10. To analyze the biogas composition by gas chromatography
11. Precipitation titrations : Solubility product based chloride determination.
12. Flocculation studies of wastewater samples.
13. Complexometric titration for determination of hardness (Total, Ca, permanent and Temporary).
14. Gravimetric determination of Sulphate, Silica content
15. Determination of Sulphide by iodometric titration.
16. Determination of DO, COD and BOD of waste water.

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: Water Treatment Technologies

Paper Code: EVS 711

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Introduction

Water as elixir of life, Water Pollution: Causes and Management, Drinking water, Standards for water Quality, Water analysis, water purification, Waste water & treatment technologies. (14 Lectures)

Unit-2: Sedimentation and Ion exchange

Sedimentation: Principle and process of sedimentation, Coagulation, methods for determining Optimum coagulation dose, Flocculation process etc. Water softening, demineralization, deionization, ion specific resins, packing of resins, resin regeneration. (14 Lectures)

Unit-3: Adsorption

Characteristics of adsorbents like Silica gel, Zeolites, Activated carbon. Waste materials as adsorbents, research for new adsorbents, chemistry of adsorption, particle size analysis, zeta potential, adsorption kinetics, adsorption equilibrium etc. Adsorption Isotherms (Freundlich, Langmuir, BET, Kisliuk etc.), Adsorption chillers,Adsorption spillover,Polymer adsorption.Sand filter, Charcoal filter, Dual media filter, Pressure filter, filter media, Filter operation. Inclusion based removal of organic pollutants like dyes, pesticides and PCBs, polymer immobilization of host for water treatment. (14 Lectures)

Unit-4: Reverse Osmosis

Membrane Processes, types of membrane, characterization of membranes, nano-membranes and their formation, efficiency of different membranes in removal of different elements. Chemical oxidation and precipitation.Deflurodation, iron, manganese & arsenic removal. (14 Lectures)

Suggested Readings:

1. American Water Works Association and James Edzwald (2011). *Water Quality & Treatment: A Handbook on Drinking Water*. McGraw-Hill Professional, New York.
2. Eckenfelder, W.W. Jr., Ford, D.L. and Englande, A.J. Jr. (2009). *Industrial water quality*. McGraw-Hill, New York.
3. Eaton, A.D., American Public Health Association, American Water Works Association and Water Environment Federation (2005). *Standard Methods for the Examination of Water and Wastewater*. Washington, D. C: American Public Health Association.
4. Patnaik P. (2011). *Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes.* CRC Press.
5. Rouquerol, F., Rouquerol, J., and Sing, K.S.W. (1999). *Adsorption by Powders and Porous Solids: Principles, Methodology, and Applications*. Academic Press, San Diego.
6. American Water Works Association and James Edzwald (2011). Water Quality & Treatment: A Handbook on Drinking Water. McGraw-Hill Professional, New York.Eckenfelder, W.W. Jr., Ford, D.L. and Englande, A.J. Jr. (2009). Industrial water quality. McGraw-Hill, New York.
7. Eaton, A.D., American Public Health Association, American Water Works Association and Water Environment Federation (2005). Standard Methods for the Examination of Water and Wastewater. Washington, D. C: American Public Health Association.
8. Patnaik P. (2011). Handbook of Environmental Analysis: Chemical Pollutants in Air, Water, Soil, and Solid Wastes. CRC Press.

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: Biological Wastewater Treatment Technologies
Paper Code: EVS 712

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Introduction

An introduction to wastewater, its types, sampling methods and characterization of wastewater constituents - physical, chemical and biological; an overview of the biological wastewater treatment process and technologies

Microbiology of wastewater treatment: Role of microorganisms in wastewater, their composition and classification; microbial metabolism and their growth kinetics; Substrate removal and aerobic biological oxidation

(10 Lectures)

Unit 2: Aerobic and Anaerobic biological treatment process

Suspended (Activated sludge process), attached (trickling filter) and combined (Membrane bioreactor) growth biological treatment processes - process description, design, process control, operational problems and its applications

Anaerobic biological treatment process: Suspended (UASB, AnSBR, ABR) and attached (Attached growth anaerobic fluidized bed reactor, upflow packed bed attached growth reactor) growth biological treatment processes - process description, general design, process control, operational problems and its applications

(26 Lectures)

Unit 3: Biological Nutrient removal

Nitrogen removal - Biological nitrification and denitrification - process description, microbiology & technologies; Biological phosphorus removal - process description, microbiology & technologies

(8 Lectures)

Unit 4: Biological sludge stabilization

Anaerobic digestion, aerobic digestion, composting - process description and microbiology; Sludge pre-treatment.

(12 Lectures)

Suggested readings:

1. Tchobanoglous, G., Burton, F. L. and Stensel H. D. (2003) *Wastewater engineering: treatment and reuse*, McGraw-Hill Science, USA.
2. Crittenden, J. C., Trussell, R. R. and HandD. W. (2005). *Water treatment: principles and design*,2nd edition, Wiley Publishers, USA.
3. Grady, C.P. Leslie, G.T. Daigger, and H.C. Lim, (1999) Biological Wastewater Treatment, Second Edition, Marcel Dekker, Inc., New York
4. Viessman. W, Jr. and Mark J. (1998) Hammer Water supply and pollution control, 6th edition, Addison Wesley Longman, Inc.

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: Bioenergy and Bioproducts

L	T	P	Cr	Marks
4	1	0	4	100

Paper Code: EVS 713

Unit 1: Introduction

Bioenergy- Prospects and challenges; Types- first, second, third and fourth generation biofuels, conversion routes of biomass to bioenergy; Biodiesel production; Bioproducts-Microbial metabolites, conversion processes - Fermentation, Factors influencing metabolite production, Pathways. (12 Lectures)

Unit 2: Fermentation for bioenergy production

Bioethanol-Ethanol production from starch, sugar; lignocellulosic ethanol- pretreatments, saccharification, enzymatic hydrolysis, fermentation; metabolic pathways; factors; ABE fermentation.Biogas - feedstocks; processes in anaerobic fermentation; properties and composition of biogas, biogas plant- components, types; factors effecting biomethane formation; Biosolids- properties and application. Biohydrogen fermentation-Hydrogen production routes from biomass- dark, photo fermentation; metabolic process; factors; advances in hydrogen production- Genetic engineering, waste water utilization; Microbial fuel cell- principle and technology; ; algal biofuel- production, benefits and challenges. (16 Lectures)

Unit 3: Biopolymers

Natural biopolymers- Cellulose, Protein, Nucleic acids; Biocomposites, Biofibres; Bioplastics:Types- Poly hydroxyalkanoates, Polylactic acid, Properties, Feedstocks; Production process, Biodegradation; Applications, Environmental impacts. (14 Lectures)

Unit 4: Biorefinery

Concept of biorefinery;Applications-Energy, Fuel, Chemicals; Biorefinery of lignocellulose-Products from cellulose, hemicellulose, lignin; Paper and pulp industry; Enzyme production by solid state fermentation - cellulolytic,pectinolytic,ligninolytic,amylolytic and lipolytic enzymes; Environmental importance. (12 Lectures)

Suggested readings:

1. Michele Aresta, Angela Dibenedetto and Frank Dumeignil. (2012). Biorefinery: From Biomass to chemicals and fuels. Walter De Gruyter Publishers, Germany.
2. Levy, S.L. (2011). Biofuels, Biorefinery and renewable energy: Issues and Developments. Nova Science Publishers, USA.
3. Johnson, R.M., Mwaikambo,L.Y. and Tucker.N. (2003). Biopolymers. Smithers Rapra Technology Publishers, United Kingdom.
4. Brain McNeil and Linda Harvey. (2008). Practical Fermentation Technology. Wiley Publishers, United Kingdom.
5. EIRI Board. (2010). Modern Technology of Bioprocessing (Fermentation, Food, Enzyme, Pharmaceutical Industrial, Agricultural and Energy). Engineers India Research Institute Publishers,New Delhi.
6. Stansbury, P.F. (1999). Principles of Fermentation Technology, 2nd Edition. Butterworth-heinemann. Burlington, MA.
7. Pandey, A., Larroche, C. and Carlos Ricardo Soccol. and Claude –Gilles Dussap. (2009). Advances in Fermentation Technology. Asiatech Publishers Inc, New Delhi

CENTRE FOR ENVIRONMENTAL SCIENCES AND TECHNOLOGY
Scheme of Courses Ph.D.
Ph.D. Environmental Science and Technology (Batch 2018-19)

Course Title: Applications of Remote Sensing and GIS in Environmental Management
Paper Code: EVS 714

L	T	P	Cr	Marks
4	1	0	4	100

Unit 1: Methods in Geosciences-An overview of GIS, GPS, Remote Sensing, Google Earth
Georeferencing; Digitization; Active and passive remote sensing; Types of platform; Types of orbits (Geostationary, Polar, Sun-synchronous); Scanning Systems (Pushbroom and Whiskbroom); Types of Sensors; GPS; Google Earth.

(10 Lectures)

Unit 2: GIS - Basic Concepts and Spatial Analysis
Concept of space and time; Elements of GIS; Map Projection; Data structures in GIS: Raster and Vector data, Hierarchical, Network and relational data, Geo-relational and object oriented vector data structure; Vector and Raster based analysis; Overlays operations; Map algebra; Grid based operations; Buffering; Network Analysis; Terrain Analysis; Spatial analysis (Supplemented with laboratory Practicals).

(14 Lectures)

Unit 3: Remote Sensing – Energy response mechanism and Digital Image Processing
Definition; Electromagnetic Radiation (EMR) spectrum; Types of Resolutions: Spatial, Spectral, Radiometric and Temporal; Spectral signatures; Energy response mechanism; Atmospheric windows; Basic geometric characteristics of aerial photographs; Scale; Resolution; overlaps; flight planning; factors governing interpretability; Elements of photo interpretation; False Colour Composite (FCC); Image Fusion; Image contrast; stretching and image filtering, Multispectral remote sensing, Remote Sensing of water and land surface features, Unsupervised and supervised classification, accuracy assessment (Supplemented with laboratory Practicals).

(18 Lectures)

Unit 4: Environmental Applications of Remote Sensing and GIS
Role in environmental modelling and management; natural hazard management (floods, landslides, earthquakes); monitoring water quality and soil quality; wasteland mapping; mineral/oil exploration; resource management; Environmental Impact Assessment (EIA) studies; site-suitability analysis; land use mapping; lithological and structural mapping; hydrogeological studies and groundwater zonation mapping, role of GIS in studying air pollutants dispersal and its modelling. (14 Lectures)

Suggested Readings

1. Lillesand, T.M., Keifer, R.W. and Chipman J.W. (2007). Remote Sensing and Image interpretation, Wiley India Pvt Ltd., India.
2. John R. Jensen (2008). Remote Sensing of the Environment (2nd Ed.) Dorling Kindersley India.
3. Basudeb Bhatta (2008). Remote Sensing and GIS, Oxford University Press, USA.

4. Hamlyn G. Jones and Robin A. Vaughan (2010). Remote Sensing Of Vegetation: Principles, Techniques, and Applications, Oxford University Press, USA.
5. Andrew Skidmore, Hendrik Prins (2010). Environmental Modelling with GIS and Remote Sensing, CRC press.
6. Chang, Kang-taung (2002). Introduction to Geographic Information Systems, Tata McGraw-Hill Publishers, USA.
7. Critchfield H. J. (2009). *General climatology*, PHI Learning, New Delhi.
8. Singh, S.(2011), *Physical geography*, PrayagPustakBhavan, Allahabad.
9. Strahler, A.N. and Strahler, (1996). *An introduction to physical geography*. John Wiley & Sons, UK.