# Elements of Environmental Engineering - Sources and characterization

**EV 310** | **L:T:P = 3:1:0** | **CIE: 50 Mks**
**4 h/wk** | **SEE: 100 Mks**

## Course Objectives

The students gain engineering knowledge on elements of environment, sources of pollution/contamination; understands and analyzes environment related problems for application in the society following code of ethics.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:** Understand and remember basic elements/concepts of various attributes to ethically protect the environment. | Remember | 1 |
| **CO2:** Analyze various units for conversion, sampling protocols, attribute standards to address/communicate environmental problems to society (rural and urban). | Analyze | 2, 6 |
| **CO3:** Understand assimilative and supportive capacities of environment and initiate steps through team work to safeguard environment for sustainability. | Remember | 7, 9 |
| **CO4:** Comprehend proactive environmental solutions for futuristic needs of the society and to communicate effectively to people. | Remember | 6, 10 |
| **CO5:** Engage in applying critical thinking skills to continually address society related problems and find appropriate solutions. | Apply | 6 |

| COURSE CONTENT | Hours |
|---|---|
| **Environmental Pollution and Contamination,** Human ecology – relationships with Environment. Role of Environmental Engineers in Environmental Protection. Code of Environmental Ethics, economic growth and Environmental quality. Cradle to Grave and Grave to Cradle concepts; Indian Environmental Legislation. Organizations involved in Environmental Protection.<br>Natural and manmade, actions and consequences. Environmental foot prints. Effect of mixed land use on pollutant / contaminant levels. Online monitoring.<br>**Units of Expression and Conversions: Air, Noise, Water and Soil -** Mass to mass units, mass to volume units, volume to volume & its conversions (lab | 12 |

| COURSE CONTENT | Hours |
|---|---|
| component). Reactive approaches for mass balancing contaminants and pollutants (lab component). Dilution concepts. | |
| **Urban and Rural Ecosystems -** Land use pattern and Landscape, Zoning regulation for different land users and externalities caused by mixed land uses, Special Economic Zone (SEZ), Coastal Regulation Zone (CRZ), Urban green belt concept – Biological species for Carbon Sequestration, Importance of lung space. Neighborhood concepts. Rain Water Harvesting - necessity and types.<br>**Environmental Sampling** – Sampling plan; liquid, solid and gaseous components, Characterization to generate flow schemes for treatment – concepts.<br>**Classification of Environmental Contaminants and Pollutants** - Combustion products, Industrial emissions, and other sources; Transportation, construction and mining activities; Process and manufacturing industries. Pollutant-soil interactions. | 10 |
| **Environmental Attributes and Parameters -** Characteristics of Air, Water, and Soil -control at Source, Media and Receptor. Solid waste – Municipal, Bio medical, Hazardous, E-waste.<br>**Point Sources and Non-Point Sources of Pollution-** Air, water and land attributes – Pollutant / contaminant interactions between attributes and externalities. NPS prevention & control. Health-care facilities and Industries Nutrients and pesticides.<br>**Characteristics of Noise Pollution from Point and Non-Point Sources -** Noise – Urban, Rural, and Industrial sources. Transport network, construction and mining activities, Industrial Noise.; $L_{eq}$ concepts, background noise, standards. Power, pressure and Intensity of noise (field component). Noise characteristics – simple problems. | 12 |
| **Environmental Systems -** Assimilative, Supportive and Carrying Capacity. Environmental Indices. Environmental Sustainability – Resource depletion and Environmental degradation – Control strategies.<br>Biodiversity – Concept and Importance. Renewable and Non- Renewable Natural Resources. Mass Balance concepts and problems.<br>**Sub-surface Pollutant Sources -** Septic tanks soak pits, and dispersion trenches. Low cost sanitation systems. SLF leachate, Oil and chemical storage tanks. | 10 |
| **Recent Trends -** Emerging Environmental problems, Responsibility and Degrees of freedom. Prevention of Significant Deterioration. Pollution prevention hierarchy. Environmental cost, Proactive and Passive Environmental management. Priority contaminants and hazardous substances. Critical thinking on sustaining water resources. Remediation. Environmental Forensics. Sustainable development. Case studies. | 8 |
| **Total hours of Teaching** | **52** |

## Text books


1. Richard. O. Mines. Jr. 2014. Environmental Engineering – Principles and Practice. John Wiley and Sons., USA, New York.
2. Gilbert M. Masters. 2005. Introduction to Environmental Engineering Science, 5th Edition. Prentice Hall of India. New Delhi.


## Reference books


1. William W Nazaroff and Lisa Alvarez-Cohen. 2010. Environmental Engineering Science. John Wiley & Sons, New Delhi.
2. Verma P.S. and Agarwal V.K. 1998, Concept of Ecology. S. Chand & Company Ltd. Roorkee.
3. Rai, G.D. 1999. Non-conventional Energy Sources. 3rd Edition, Khanna Publications, New Delhi.
4. Quasim, S. R. 2003. Wastewater Treatment Plants – Planning, Design and Operation. Hoit Rinehart and Winston, CBS College publishing.
5. Metcalf and Eddy. Wastewater Engineering and Resue. 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
6. Tchobanoglous. G, Theisen. H, and Vigil. S. Integrated Solid Waste Management – Engineering Principles and Management Issues, McGraw Hill Inc., New York.
7. APHA. 2014. Standard Methods for Examination of Water and Wastewater, Washington DC. 21st Centennial edition.
8. Ruth F. Weiner and Robin Matthews. 2007. Environmental Engineering. 4th Edition. Elsevier Science publications – First reprint in India.
9. Vladimir Novotny and Gordon Chesters. 1981. Handbook of Non-point pollution – sources and management. Van Nostrand Reinhold Company, New York.
10. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# Environmental Chemistry and its applications

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|---|---|---|
| **EV 320**<br>**4 h/wk** | **L:T:P = 3:1:0** | **CIE: 50 Mks**<br>**SEE: 100 Mks** |

## Course Objectives

The students gain knowledge on concepts in chemistry for analyses; to apply learnt concepts to water/wastewater treatment and other environmental attributes; understands usefulness and importance of equations, stoichiometrically solves numerical problems relating to environmental chemistry addressing environment aspects/attributes of the society for its protection from pollution/contamination.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:** Understand application of concepts of chemistry and equations for various processes. | Remember | 2, 4 |
| **CO2:** Stoichiometric analyses to solve real time problems and to addressimpacts of pollution. | Analyze | 6, 7 |
| **CO3:** Apply learnt concepts of environmental chemistry to remediate polluted and contaminated sites in the field and communicate to people. | Apply | 2, 6, 7 |
| **CO4:** Comprehend environmental significance of pollutional parameters and their interactions with biotic life. | Remember | 7, 10 |
| **CO5:** Demonstrate/apply green chemistry concepts/skills to continually address society-environment related problems and arrive at logical decisions. | Apply | 6, 7, 8 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Hours |
|---|---|
| **Introduction -**Scope and Significance of Environmental Chemistry. | 10 |
| **Properties of Chemical Compounds -** Molecular weight, Equivalent weight, Molecular volume, Critical volume, Boiling point, Melting point, Density - Numerical exercises. | |
| **Physical Chemistry-** Oxidation, Reduction, Osmosis, Dialysis, Solvent Extraction, Catalysis, Absorption, Adsorption and Isotherms, Ion exchange, | 10 |

| COURSE CONTENT | Hours |
|---|---|
| Electrodialysis, Colorimetry- Beer's Law and Lamberts Law, Electrochemistry. Applications and numerical problem solving in Environmental Engineering. | |
| **Equilibrium Chemistry-** Introduction, Acids, Bases, Buffers, Buffer index. Numerical problems on pH neutralization. | |
| **Colloidal Chemistry -** Colloidal dispersion in water and air attributes. | 10 |
| **Biochemistry -** Enzymes, Cofactors, Biochemistry of Carbohydrates and Proteins, Biochemical Pathways, Enzyme reactions. | |
| **Environmental Characteristics of Organic Compounds -** Saturation concentration, Solubility, Octanol Water partition coefficient. Hydrolysis, Photolysis, Volatilization and Decay, Half-life concept.<br>**Organic Chemistry -**Aliphatic, Aromatic, Carboxylic, Heterocyclic compounds, Fats, Oil and Detergents.<br>**Chemical Thermodynamics -** Free Energy Formation, Entropy Formation, Ionic Strength considerations, Theoretical Equations for Active Coefficient, Simultaneous Reactions, Factors affecting Equilibrium concentration and Temperature effects - Numerical exercises. | 12 |
| **Environmental Significance of Pollution Parameters -** Temperature, Color, pH, Hardness, Iron, Manganese, Fluoride, Nitrogen, Phosphorous, Carbon, Sulphate, DO, BOD, COD, TOC, TOD, THOD; Related equations and Numerical exercises.<br>**Green Chemistry -** Goals, Principles of Green Chemistry, Sustainable Chemistry, Hierarchy, Solid waste – Issues and aspects. | 10 |
| **Total hours of Teaching** | **52** |

## Text Books


1. Sawyer G.N., McCarty P.L. and Parkin G.F. 2003. Chemistry for Environmental Engineering and Science, 5th Edition, Tata McGraw Hill publications.
2. Manohar, S.E. 2009. Fundamentals of Environmental Chemistry. 3rd edition Taylor and Francis / CRC press.


## References


1. Treybul R.E. 1960. Mass Transfer Operation. McGraw Hill publications, Kogakusha.
2. Michael P.N. Ecology. 2016, CBS Publishers and distributors. New Delhi.
3. Stumn and Morgan. 1981. Aquatic Chemistry, Second Edition, John Wiley publications.
4. Morrison and Boyd. 2011. Organic Chemistry, 7th edition, Eastern Economy Edition, Pearson, India.
5. APHA. 2018. Standard Methods for Examination of Water and Wastewater, Washington DC. Recent edition.

6. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

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# ENVIRONMENTAL FLUID MECHANICS – I

**EV 330** **L:T:P = 3:1:0** **CIE: 50 Mks**
**4 h/wk** **SEE: 100 Mks**

## Course Objective

Students will be able to understand basic concepts underlying hydraulics as applied to fluid properties, pressure measurement, hydrostatics, kinematics, fluid dynamics, impact of fluid flow in pipe lines/open channels - for application to address Environmental Engineering problems of the society.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:**Define, Understand and Remember to interpret properties of fluids and their significance. | Remember | 1 |
| **CO2:** Understand and Apply measurements of pressure in open & closed conduits. | Analyze | 2 |
| **CO3:** Analyse hydrostatics, kinematics of fluids under different flow conditions and obtain the output from dimensional analysis. | Analyze | 3, 4 |
| **CO4:** Application of Euler's & Bernoulli's Equation to fluid related aspects in hydraulic systems. | Apply | 4, 6, 7 |
| **CO5:** Effectively communicate the importance of fluid related aspects to be addressed on public domain. | Remember | 6, 7, 10 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Number of hours |
|---|---|
| **Fluid Properties and Classification - Fluids** and Continuum, properties of Fluids, Newtonian and non-Newtonian fluids: applications, Capillarity. Newton's law of Viscosity, Surface Tension – Numerical exercises. | 10 |
| **Fluid Pressure and Measurement -** Pressure at a point, Pascal's law, Hydrostatic pressure law, Pressure-density-height relationship. Absolute and Gauge pressure, Manometers and types -Numerical exercises. | 10 |

| | |
|---|---|
| **Hydrostatics -** Pressure - Equation for hydrostatic force, depth of centre of pressure on plane surfaces (vertical and inclined), inclined surfaces, vertically submerged and curved surfaces- Numerical exercises. | 6 |
| **Kinematics of Fluids -**Types and classification of flow, Lagrangian and Eulerian approaches. Pathline, streamline, streakline, stream tube. 1-D flow, Continuity equation in differential form. Velocity potential, Stream functions and relationship, Equipotential line, Laplace equation –Numerical exercises.<br>**Dimensional analysis and model similitude -** Units, Scale effects, Dimensional Homogeneity, Methods of Analysis, Model Studies, Similitude, Dimensionless parameters. Froude's and Reynold's models - Numerical exercises. | 10 |
| **Dynamics of Fluid Flow -**Concept of Inertia, derivation of Euler's and Bernoullis equations – limitations, modification of Bernoulli's equation - problems and applications of Bernoulli's equation - Pitot tube and Venturimeter, Momentum equation - Numerical exercises. | 8 |
| **Impact of Jets -** Introduction, force exerted by the jet on plates - stationary vertical, inclined and curved. In the direction of jet - moving flat vertical plate, inclined plate and curved plate. Unsymmetrical moving curved plate when jet strikes tangentially at one end of the tip, a series of flat and curved vanes. Numerical exercises. | 8 |
| **Total hours of Teaching** | **52** |

## Text books


1. P.N.Modi and S. M.Seth. 2013. Hydraulics and Fluid Mechanics. Standard Book House, New Delhi.
2. K.Subramanya.2005. Fluid Mechanics and Hydraulic Machines- Problems and Solutions. Tata McGraw Hill Publishing Co. Ltd. New Delhi


## Reference books


1. S. K. Som and G. Biswas. 2007. Introduction to Fluid Mechanics and Fluid Machines. Tata McGraw Hill, New Delhi
2. K. R. Arora. 2010.Fluid Mechanics, Hydraulics and Hydraulic Machines. Standard Publishers Distributors, New Delhi.
3. R.K. Bansal. 2011. Fluid Mechanics and Hydraulic Machines. Lakshmi Publications, New Delhi.
4. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

# CONSTRUCTION ENGINEERING MATERIALS

**EV 340** **L: T:P = 3:0:0** **CIE: 50 Mks**
**3 h/wk** **SEE: 100 Mks**

## Course Objective

The course will expose the student to various facets of construction engineering, conventional, non-conventional and eco friendly engineering materials and their functional properties.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:**Understandvarious materials for construction and the differences between various aggregates based on properties. | Remember | 1 |
| **CO2:** Remember relevant building materials based on engineering properties. | Remember | 2 |
| **CO3:** Use their discretion on allied materials for application in construction. | Apply | 3, 6, 8 |
| **CO4:** Understand various construction procedures and identify mixing proportions for different situations in environmental engineering applications. | Apply | 4, 6, 9 |
| **CO5:** apply critical thinking onpotential non-traditional building materials andreuse in construction; waste resource recovery. | Analyze | 7, 9, 10 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Hours |
|---|---|
| **Building Stones -** Common building stones - Quarrying, Dressing, Deterioration, and Preservation techniques.<br>**Aggregates -** Coarse and Fine aggregates (M sand) – properties. | 8 |
| **Bricks -** Types and classification, Manufacturing and testing.<br>Hollow and solid fly ash concrete blocks<br>**Tiles -** Types, quality and testing.<br>**Timber -** Types, properties, Methods of Seasoning, Plywood and alternate materials – preservatives.<br>**Cement:** Types, composition and properties, and tests.<br>IS Codes for construction materials. | 8 |
| **Allied Construction materials -** Properties and use of Reinforcing steel, Structural steel, Glass, Electrical, Thermal and Sound Insulating Materials, Paints, Plumbing materials, Rubber, Bitumen and Asphalt, Water proofing compounds. Metals: | 8 |

| | |
|---|---|
| Frames, trusses, partitions, etc. | |
| **Construction Engineering -** Earthwork and foundation in different types of soils; Scaffolding-types and materials.<br>**Mixing proportions** - stone and brick masonry; Cement mortar. Cement concrete, ready mix concrete, Reinforced concrete, pre-stressed concrete, fiber reinforced concrete; Plastering, flooring-different types, Roof types; | 10 |
| **Recent trends** – Green Building materials, fabricated timber, Floating concrete and permeable pavements, Composite materials. Low cost construction materials. Waste reuse in construction.<br>Prefabricated Package units for environmental engineering applications. Aluminum shuttering, self-compacting cement concrete. | 8 |
| **Total hours of Teaching** | **42** |

## Text Books


1. Sushil kumar. 2010. Engineering Materials. Standard Publication and Distributors, New Delhi.
2. P. G. Varghese. 2011. Building Materials, Second edition, Prentice Hall of India Pvt. Ltd. New Delhi.


## Reference books


1. Neville A. M. and Brooks J. J. 2010. Concrete Technology - Second edition. Prentice Hall, New Delhi.
2. M. S. Shetty. 2002. Concrete Technology - Theory and practice, S. Chand and Co, New Delhi.
3. Manjunath K. S. 2010. Materials of construction, Sanguine Publishers, Bengaluru.
4. Duggal S. K. 2008. Building Materials. Third revised edition. New Age International publishers. New Delhi.
5. Indian Standard codes for construction materials.
6. Mohan Rai and M. P. Jain. 2010. Advances in Building Material and Construction by Singh Publication by CBRI, Roorkee.
7. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# SURVEY ENGINEERING

**EV 350** **L:T:P = 3:1:0** **CIE: 50 Mks**
**4 h/wk** **SEE: 100 Mks**

## Course Objective

The students will obtain extensive knowledge, understand and apply surveying practices to execute Environmental Engineering infrastructure.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:**Remember basic principles/concepts about various types of survey techniques for application in construction of Environmental Engineering structures. | Remember | 1 |
| **CO2:** Understands to record and analyze field measurements and to solve numerical/field problems in spite of uncertainties. | Remember | 1, 2 |
| **CO3:** Apply surveying concepts to water distribution networks, wastewater treatment facilities and other Environmental engineering applications. | Apply | 4, 5, 6 |
| **CO4:** Analyze for interpolations in contours for various applications using recent upgradations in survey instruments/equipment's for environmental infrastructure. | Analyze | 2, 9 |
| **CO5:** Use survey engineering for application to remote sensing of – pollutional hotspots, hazardous dumpsites, geographical locations of hazardous vulnerability. | Apply | 7, 8, 9 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Hours |
|---|---|
| **Introduction -** Surveying, Classification and uses of Surveys. Units of Measurements, Maps, Survey of India topographical Maps and their numbering. Basic principles of surveying, Errors, Precision and accuracy, Reconnaissance survey. Applications in Environmental Engineering | 6 |
| **Measurement techniques:**<br>**Horizontal distance -** Chains and tapes, Electromagnetic Distance Measurement devices, Ranging of lines, Direct and Indirect, Measurement of distances over sloping grounds, Chain and Tape corrections – Numerical exercises. | 6 |
| **Chain Surveying -** Accessories, Selection of stations and lines, Offsets and | 9 |

| COURSE CONTENT | Hours |
|---|---|
| types, setting out of right angles, Working principle and use of optical square, prism square, cross staff. Field book, conventional symbols, Obstacles in chain survey, Errors in chain survey and precautions, Numerical exercises. | |
| **Compass Surveying -** Meridians and bearings, Principle and use of Prismatic compass and Surveyor's compass, Dip and Declination, Accessories required for compass surveying.<br>Traverse - closed and open traverse, Computation of bearings and included angles, Local attraction, determination and corrections, Dependent and independent co-ordinates, Checks for closed traverse.- Numerical exercises. | 8 |
| **Levelling -** Principles and basic definitions, dumpy level-types, adjustments and its types, Sensitiveness of bubble tube, Curvature and refraction correction, Types of levelling.<br>**Reduced Level -** Booking of levels, Rise and fall method and Height of instrument method, Comparison and arithmetic checks, Fly levelling, Errors and precautions. Introduction to Theodolites. | 8 |
| **Contouring -** Contours-Types, characteristics, methods and uses, Interpolation techniques, Numerical exercises. | 5 |
| **Recent Trends -** Total station, LIDAR, Laser measurement instrument, GIS, GPS/ DGPS, aiding design of water supply and sewerage projects, solid waste management facilities. Condition Assessment survey basic concept including inventories of existing systems. | 10 |
| **Total hours of Teaching** | **52** |

## Text Books


1. Punmia B.C. Surveying Vol–1, Laxmi Publications, New Delhi.
2. Duggal S.K. Surveying Vol. I, Tata McGraw Hill - Publishing Co. Ltd., New Delhi.


## Reference Books


1. Fundamentals of Surveying - Milton O. Schimidt – Wong, Thomson- Learning.
2. Fundamentals of Surveying - S.K. Roy – Prentice Hall of India.
3. Alak De, Plane Surveying, S. Chand & Co. Ltd., New Delhi, 2000.
4. Chandra, A.M., Plane Surveying, New Age International (P) Ltd., New Delhi, 2002.
5. Anderson, J. and Mikhail, E. Introduction to Surveying, Mc-Graw Hill Book Company, 1985.
6. Benister,A., Surveying, Pearson Education, 2006.
7. Kanetkar T.P. and Kulkarni S.V. Surveying and Levelling Part I, Pune VidyarthiGrihaPrakashan, 1988. Edition.
8. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# WATER QUALITY ANALYSIS LABORATORY

**EV 36L** **L: T:P = 0:0:3** **CIE: 50 Mks**
**3 h/wk**

## Course Objective

The laboratory provides practical experience to students on various qualitative and quantitative analytical techniques for analyses of various parameters under water attributes.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:** Acquaint with lab layout, apparatus and instruments, chemicals and reagents measurement techniques for various water quality parameters and standards. | Remember | 1, 8 |
| **CO2:** Apply relevant analytical procedure for measuring various physico - chemical water quality parameters and trace contaminants. | Apply | 2, 4, 5 |
| **CO3:** Develop ability to analyze, interpret and infer the laboratory analytical data comparing with the prescribed standards. | Analyze | 3, 5, 9 |
| **CO4:** Follow standard methods for analyses and report the results in a logical manner. | Evaluate | 8, 10 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| EXPERIMENTS | Hours |
|---|---|
| **Analysis of water (Surface and Ground)** | |
| **Sampling techniques and preservation** | 3 |
| **Physical:**<br>a. Temperature and DO.<br>b. Color (Apparent and true) and Turbidity<br>c. Total Solids, Suspended solids, Dissolved and Volatile solids.<br>**d.** Dissolved organic matter (DOM) & Natural organic matter (NOM). | 9 |
| **Chemical:**<br>a. pH, Alkalinity and Hardness .<br>b. Chloride, Conductivity and TDS.<br>c. Sodium and Potassium.<br>d. Iron and Manganese. | 24 |

| | |
|---|---|
| e. Ammonia, Nitrite and Nitrate.<br>f. Sulphate, Phosphate and Nitrate.<br>g. Chloride Sulphate ratio.<br>h. Fluoride and Arsenic.<br>i. Trace contaminants (Heavy metals and pesticides). | |
| **Total hours of Teaching** | **36** |

## References


1. Sawyer G.N., McCarty P.L. and Parkin G.F. 2003. Chemistry for Environmental Engineering and Science, 5th Edition, Tata McGraw Hill publications.
2. APHA - AWWA - WEF. 2014. Standard Methods for Examination of Water and Wastewater, Washington DC. 21st Centennial edition.
3. Manual on water and wastewater analysis, NEERI, Nagpur.
4. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# SURVEYING PRACTICES FOR ENVIRONMENTAL ENGINEERING APPLICATIONS

**EV 37L** **L: T:P = 0:0:3** **CIE: 50 Mks**
**3 h/wk**

## Course Objective

Surveying practice provides opportunity to students to practically apply the theoretical aspects of engineering survey using various survey instruments and accessories.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:** Practice linear and angular measurement by setting different geometrical sections using chain, tape and compass | Apply | 2, 4 |
| **CO2:** Know appropriate instruments for determining difference in elevation as well as distance between two inaccessible points | Analyze | 1, 4, 5 |
| **CO3:** Plot profile and block levels using levelling instrument and demo of Theodolite, Total Station, GPS. | Analyze | 3, 4, 5 |
| **CO4:** Follow standard methods for surveying and report the results in a logical manner. | Evaluate | 8, 10 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| | CONTENT | Hours |
|---|---|---|
| 1 | Distance between two points using direct ranging. Setting perpendiculars using cross staff, Optical Square and tape | 3 |
| | Setting out of rectangle, hexagon using tape/chain | 3 |
| | To set out rectangles, pentagons, hexagon, using tape/chain and Compass. | 3 |
| | To measure distance between two inaccessible points using Chain/tape and compass. | 3 |
| 2 | To determine the difference in elevation between two points using fly Leveling technique, booking of levels using HI and Rise & Fall methods. | 6 |
| | To determine difference in elevation between two points using reciprocal Leveling and to determine the collimation error. | 3 |
| 3 | To conduct profile leveling for water supply/sewage/storm water drainage line and to draw the Longitudinal section for obtaining balancingdepthof earthwork. | 6 |
| | Household survey for water supply and sanitation.<br>Conditional survey for water supply and wastewater systems.<br>**Demonstration Instruments:**<br>1. Theodolite; (2) Total Station; and (3) GPS/DGPS | 9 |
| **Total hours of Teaching** | | **36** |

## References


1. Punmia B.C.., “Surveying Vol.-1”, ,Laxmi Publications, New Delhi.
2. Kanetkar, T.P. and Kulkarni, S.V. “Surveying and Leveling Part I”, Pune VidyarthiGrihaPrakashan, 1988.
3. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# ENVIRONMENTAL MICROBIOLOGY AND ECOLOGY

**EV 410** **(L: T:P = 3:0:0)** **CIE: 50 Mks**
**3 h/wk** **SEE: 100 Mks**

## Course Objective

This course provides the student the basics as well as application aspects of both microbiology and environmental ecological systems for Environmental Pollution Control.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:**Classify micro-organisms, understand nutritional requirements and growth kinetics. | Remember | 1, 2 |
| **CO2:** Understand the importance of heavy metal uptake metabolism, Biocatalysis and Enzyme regulation | Remember | 2, 4 |
| **CO3:** Apply the theoretical concepts of microbial indicators, identification techniques and their importance as Biomarkers. | Apply | 5, 6 |
| **CO4:** Analyze inter relationships of abiotic and biotic components of ecosystems, understand the ecological pyramids and related models. | Analyze | 4, 7 |
| **CO5:** apply the knowledge of various diversity and dominance indices for water quality assessments and to assess pollution inputs to lakes. | Analyze | 6, 7 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Hours |
|---|---|
| **Microbiology and its Environmental Significance, Microbial Diversity in the Environment-** Bacteria, Fungi, Algae, Protozoa and Virus; Microbial Infectious Diseases, Metal munching microbes for pollution abatement,. | 8 |
| Bacterial growth curve, Monod's equation and Michali's - Menton equation with numerical problems, Microbial interactions, industrial applications. | |
| **Bio-indicators of Surface and Ground Water contamination -** Indicator microorganisms,TC, FC, FS, EC, algae and fungi.<br>Plate count, MTFT and MFT - Determination of MPN using Thomas formula and Standard methods, comparison with MPN table (Lab component). | 8 |

| COURSE CONTENT | Hours |
|---|---|
| **Metabolism, Catabolism and Anabolism -** Microbial metabolism of Heavy metals and Pesticides. Bio-catalysis - Enzymes and Enzymatic reactions for Environmental applications. | |
| Microbial diversity in Natural Ecosystems**,** Ecological Relationships among Microorganisms, indoor microbial environment - air changes per hour (Lab component). Status of lakes- oligotrophy to eutrophy and beyond - prevention and control. Restoration of lakes. External effects of GEMS. | 10 |
| Symbiotic Interactions of microbes - Interactions with Environment and Nutrient Cycling. Algae and weed control, Bio-accumulation, Bio-concentration, Bio-magnification and Bio-concentration factor (BCF) – numerical problems. Bioassay. | |
| **Scope of Ecology, sub-divisions, Ecological Terminology, Ecosystems –** Classification, biotic and abiotic components, elementary cybernetics of ecosystems, energy flow, Eltonian pyramids. Lotic and Lentic Ecosystems, Lake Stratification, Lindeman's model, productivity and measurement. | 8 |
| Limiting factors, Liebig's law, Shelford's law of tolerance, Systems Ecology and Ecosystems' modelling. Biodiversity and ecological perspective – human benefits, threats, conservation, preservation and protection.<br>Diversity index, dominance, unevenness and similarity indices – numerical problems. | 8 |
| **Total hours of Teaching** | **42** |

**Text Books**


1. Odum E.P. and Barrett G. W. 2004. Fundamentals of Ecology. Cengage publisher.
2. Kormondy. E. J.1996. Concepts of Ecology. Pearson Publisher..4th edition.


**Reference Books**


1. Pradipta K Mohapatra. 2008. Text book of Environmental Microbiology. I.K International publishing house Pvt. Ltd.
2. McKinney R.E., Microbiology for Sanitary Engineers. McGraw Hill.
3. Raina.M.Maier. Ian L Pepper. andChales P Gerba. 2008. Environmental Microbiology – Second edition, Elsevier.
4. Verma P.S and Agarwal V.K. 1998. Concept of Ecology, S. Chand & Company Ltd.
5. Mitchell R., 1978. Water Pollution Microbiology, Vol 2. Wiley Interscience
6. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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## ENVIRONMENTAL FLUID MECHANICS – II

**EV 420** **L:T:P = 3:1:0** **CIE: 50 Mks**
**4 h/wk** **SEE: 100 Mks**

### Course Objective

Students will be able to understand basic concepts of hydraulics as applied to fluid open channel, flow measurements, pipe hydraulics, pump and turbines for application to address Environmental Engineering problems of the society.

### Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:** Understand and design the closed conduit and open channel hydraulics, derivative conditions for various economical geometric sections. | Remember | 1 |
| **CO2:** Apply discharge equations and determine hydraulic co-efficient for flow devices. | Apply | 3, 5 |
| **CO3:** Design and Analyzehydraulic losses in pipes. | Analyze | 3, 4, 6 |
| **CO4:** Analyze water hammer in pipes with possible solutions. | Analyze | 3,4, 6 |
| **CO5:** characterize curves of pumps and their applications in society. | Analyze | 2, 4, 6 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Number of hours |
|---|---|
| **Flow through Channels -** Closed and open channel flow, Geometric properties. Chezy's and Manning's equations. Hydraulic flow Characteristics for different cross sections, Derivations and Numerical exercises. | 12 |
| Specific energy curve and its applications, Minimum specific energy and Maximum discharge, Critical flow, Hydraulic jump in rectangular channels, Derivation with Froude number concept, Conjugate depth relationships - Numerical exercises. | |

| | |
|---|---|
| **Flow Measurements -** Orifices and Mouth pieces - Classification, Discharge Equations, Hydraulic Coefficients, Equations for coefficient of velocity - Numerical exercises. | 10 |
| **Notches –** Types and Classification, Discharge equations, Types of Nappe, Numerical exercises,<br>Weirs – Types, Discharge equations, Optical flow meters - Numerical exercises. | |
| **Flow through pipes -** Flow through pipes, Hydraulic and Energy gradients, Major and Minor losses in pipe flow, Head loss due to friction -Friction factor for commercial pipes, Head loss due to sudden expansion and contraction. Pipes in Series and Parallel, Equivalent pipe – Numerical exercises, Moody diagram for Pressure drop/ Flow rate computation. Electronic sensors for water and Wastewater flow measurements. | 12 |
| **Water Hammer in Pipes -** Pressure rise due to gradual and Sudden closure of valves in rigid and Elastic pipes, Control techniques – Types and functions, related Numerical exercises. | 8 |
| **Pumps -** Types of pumps, Working principle, Characteristic curves, Priming, work done and efficiency, Cavitation in Centrifugal pumps, Submersible pumps, Multistage pumps, Sludge pumps, Booster pumps. Numerical exercises. | 8 |
| **Recent Trends -** Electronic Pressure Sensors, Solar pumps, Hydro pneumatic systems. | 2 |
| **Total hours of Teaching** | **52** |

## Text books


1. P. N. Modi and S. M. Seth. 2013. Hydraulics and Fluid Mechanics. Standard Book House, New Delhi.
2. K. Subramanya. 2005. Fluid Mechanics and Hydraulic Machines - Problems and Solutions. Tata McGraw Hill Publishing Co. Ltd. New Delhi.


## References


1. R. K. Bansal. 2011. Fluid Mechanics and Hydraulic Machines. Lakshmi Publications, New Delhi.
2. K. R. Arora. 2010. Fluid Mechanics, Hydraulics and Hydraulic Machines. Standard Publishers Distributors, New Delhi.
3. S. K. Som and G. Biswas. 2007. Introduction to Fluid Mechanics and Fluid Machines. Tata McGraw Hill, New Delhi.
4. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

# WATER RESOURCES ENGINEERING

**EV 430** | **L: T:P = 3:1:0** | **CIE: 50 Mks**
**4 h/wk** | **SEE:100 Mks**

## Course objectives

The course deals with the significance of hydrologic cycle, global and Indian water resources, influencing natural processes, urban and groundwater hydrology and modern tools for water resources management.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:**Elucidate hydrologic cycle and its importance in water resource management and significance of precipitation with data analysis. | Remember | 1 |
| **CO2:** Illustrate the influencing factors and methods of estimating evaporation, infiltration and surface runoff. | Analyze | 2, 4 |
| **CO3:** Apply hydrograph theory in estimating overland runoff andanalyze low flow conditions. | Apply | 3, 4, 6 |
| **CO4:** Understandmethods for measuring flow in streams and basic equations to estimate discharge from confined and unconfined aquifers | Analyze | 5, 6, 7 |
| **CO5:** Analyze erosion impacts in reservoir, hydrologic aspects of irrigation system, GIS applications in water resource management. | Apply | 4, 6, 10 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Hours |
|---|---|
| **Introduction -** Water resources and issues - Global, National, and Regional. Hydrologic cycle and significance. National water policy. | 8 |
| **Precipitation -** Forms and Types, Measurement. Estimation of average and Missing rainfall data, Mass curve, Hyetograph, Moving average curve, Intensity-duration-frequency curves; Precipitation indices-related Numerical exercises. | |
| **Evaporation -** Influencing factors, Measurement and Estimation- Numerical exercises, evaporation control measures. | 10 |
| **Infiltration -** Influencing factors and Measurement, Infiltration indices - related numerical exercises. | |
| **Runoff:** Catchment, Influencing factors, Water budget equations, Rainfall-runoff relationship. | |

| COURSE CONTENT | Hours |
|---|---|
| **Hydrographs:** Components – Types and Derivation; Base flow separation from total runoff - Numerical exercises. | 12 |
| **Hydrologic Routing:** Channel and Flood routing–concepts, Low flow analysis. | |
| **Stream Gauging -** A- V method, Advanced techniques (Electromagnetic, ultrasonic etc) | 10 |
| **Groundwater Hydrology** - Basic flow equations; Aquifers - Unconfined confined, Perched; Artificial recharge techniques. Causes of pollution/contamination of ground water and Pollution prevention measures. | |
| **Reservoir -** Types and Storage zones; Evaporation control; measure for siltation, Sediment yield.<br>Water allocations for multiple uses. Drinking water policies.<br>**Recent trends -** Application of GIS and Remote sensing in water resource management. Attenuation of surface runoff. | 12 |
| **Total hours of Teaching** | **52** |

## Text Books


1. Subramanya K. 2008. Engineering Hydrology. 3rd Edition. Tata McGraw Hill Publishing Company Ltd., New Delhi.
2. Todd D.K. 2004. Groundwater Hydrology, Wiley Eastern Publication, New Delhi.


## Reference books


1. Jayaram Reddy P 2005. A Text Book of Hydrology. Lakshmi Publications, New Delhi.
2. Raghunath H.M. 2006. Hydrology: Principles, Analysis, and Design. Revised 2nd Edition, New Age International (P) Ltd.
3. VenTe Chow.1964. Handbook of Applied Hydrology. A compendium of water Resources Technology. Vol 1, McGraw Hill.
4. Modi, P.N. and Seth,S.M., 2013. Hydraulics and fluid mechanics. Standard Book House, New Delhi.
5. CPHEEO Manual.
6. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# GEOLOGY AND GEOTECHNICAL ENGINEERING

**EV 440** | **L: T:P = 3:0:0** | **CIE: 50 Mks**
**3 h/wk** | **SEE:100 Mks**

## Course Objective

The student gains knowledge on fundamentals of geology, geological formations, engineering properties, its importance and application in Environmental engineering. The course also substantiates the need for geotechnical engineering emphasizing on types of soil its properties, environmental geotechniques and its application to Environmental engineering.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:**understand origin and types of rocks, classification, Weathering of rocks, cause – effects of earthquake, soil erosion, landslides and remedies. | Remember | 1 |
| **CO2:** Analyze concepts underlying structural geology, geotechnical engineering aspects and soil properties. | Analyze | 6 |
| **CO3:** understand soil classification, compaction, mineral mass balances; remineralization and demineralization for water quality control. | Remember | 6, 7, 8 |
| **CO4:** explain and analyze permeability concepts through soils, application of geosynthetics in Environmental Engineering. | Apply | 4, 6 |
| **CO5:** understand the recent trends, soil aeration and state of soil health. | Analyze | 6, 7 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Hours |
|---|---|
| **Introduction to Geology -** Origin of rocks, Classification - Igneous, Sedimentary and Metamorphic rocks. Weathering of rocks – Types. | 6 |
| **Geomorphology and Geodynamics -** Soil erosion and Conservation. Landslides – Causes, remedies with gabions. | |
| **Structural Geology -** Concepts of Outcrops, Dip and strike, Compass clinometers, Folds, Faults – Applications in Environmental Engineering. | 12 |
| **Physical Properties of Soil-** Void ratio, porosity and Percent voids. Degree of saturation, Moisture content, Specific gravity, Density (bulk, dry, saturated & submerged) and Inter relationships. Alterations in SBC of soil.<br>**Index properties of soils** -Water content, Specific gravity, Relative density, Consistency limits and Indices, In-situ density (**Lab component**), and problem solving. Particle size distribution (sieve analysis). Liquid-limit- Casagrande and Cone | |

| COURSE CONTENT | Hours |
|---|---|
| penetration methods, Plastic limit and shrinkage limit determination. | |
| **Classification of Soil -** Particle size classification. Field identification of soils **(Field / Lab component).** Clay mineralogy - Kaolinite, Illite and Montmorillonite - Usefulness in Environmental Engineering applications. | 8 |
| **Dynamics of Soil -** Methods of compaction. Geological minerals and water quality interlinkages. Remineralization and demineralization through geo-filtration for water quality control. | |
| **Flow of Water through Soil:** Darcy's law - Assumptions and Validity, Co-efficient of permeability and factors - Its determination (lab & field component), Permeability of stratified soils, Seepage velocity, Superficial velocity and Co-efficient of percolation, Quicksand and Capillary phenomena. | 8 |
| Geosynthetics – Geotextiles, Geogrids, Geomembranes and Geocomposites, their applications in Environmental Engineering. (Lab component – Demo only). | |
| **Recent Trends -** Soil characteristics for waste discharge, Soil acidity, Alkalinity, Salinity and Sodicity, Soil remediation. Ecology of soil, Soil organic matter, Nitrogen and Sulphur economy of soils, Soil phosphorus and Potassium, Calcium, Magnesium and Trace elements. Soil pollution – Sources, effects and remedial measures. | 8 |
| **Total hours of Teaching** | **42** |

## Text Books


1. Coduto D P, Yeung M R, and Kitch W A. 2001. Geotechnical Engineering: Principles and Practices. Second edition. PHI learning Private Limited New Delhi.
2. Maruthesha Reddy M T. 2008. A text book of applied Engineering Geology. Second edition. New age International publishers. New Delhi.


## Reference Books


1. Robert L McConnell and Daniel C Abel. 2015. Environmental Geology Today. Jones & Bartlett Learning LLC, USA.
2. Shashi K Gulhati and ManojDatta. 2012. Geotechnical Engineering (Civil Engineering series). Tata McGraw-Hill education private limited. New Delhi.
3. Ramamurthy T N and Sitharam T G. 2013. Geotechnical Engineering (Soil mechanics). S Chand and Company Pvt. Ltd., New Delhi.
4. Miller R W and Donahue R L. 1995. Soils in our environment. Seventh edition. PHI learning Private Limited New Delhi.
5. Gopal Ranjan and A S R Rao. 2000. Basic and applied soil mechanics. Second edition. New age International publishers. New Delhi.
6. Varma C V J, Rao G V, Ramana G V and Rao A R G., "Waste containment with geosynthetics".. CPHEEO, International Geosynthetics society.
7. Venkatappa Rao G and Suryanarayanaraju. 1996. Engineering with Geosynthetics. Tata McGraw-Hill education private limited. New Delhi.
8. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# DISASTER MANAGEMENT

**Sub code: EV 450** **L: T:P = 3:0:0** **CIE: 50 Mks**
**3 h /wk.** **SEE: 100 Mks**

### Course Objective

The course imparts a thorough understanding of natural and man-made disasters, impact and vulnerability assessment, emergency response, preparedness, mitigative measures stressing the role of modern engineering and information technology. The course also supplements details on the legal framework with few case studies.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:**Able to state and Classify disasters and identify cause-effect relationships. | Remember | 1, 6 |
| **CO2:** Apply knowledge on 'vulnerability assessment' for pre-planning, early warning, forecasting systems and response plan. | Analyze | 2, 3 |
| **CO3:** Comprehend knowledge for mitigation of various disasters and vulnerability scenarios to prepare EMP and DMP. | Analyze | 3, 4, 6 |
| **CO4:** Understand information on National policy, IT and GIS in disaster management for effective mitigation. | Remember | 6, 7, 10 |
| **CO5:** Analyze various case studies on natural and man-made disasters with initiatives for forecasting and mitigation. | Analyze | 4, 10 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| COURSE CONTENT | Hours |
|---|---|
| **Introduction:** Natural and man-made disasters, causes and impacts.<br>**Types of Disasters:**Natural disasters - Drought, Floods, Earthquake, Volcanoes, Land Slides, Cyclones, Tsunami.<br>Manmade - Air accidents, Rail and Road accidents, Industrial, Chemical, Biological. Accidental oil spills on land and water. Nuclear and Space Debris. | 8 |
| **Disaster Assessment & Preparedness:** Vulnerability assessment. Pre disaster planning for earthquakes, cyclones, epidemics outbreak, drought and famine. Disaster resistant constructions, rehabilitation and reconstruction. Disaster forecasting, warning and management. | 8 |

| COURSE CONTENT | Hours |
|---|---|
| **Disaster Prevention and Mitigation**: Earthquake mitigation, Cyclone mitigation, Landslide hazard mitigation, Flood preparedness and response, building bye-laws and adaptation. Environmental Management Plans (on site and off site) and Disaster Management Plans (DMP). GIS for Disaster Management. | 12 |
| **Legal Framework:** National Policy on Disaster Management, Disaster Management Act and Code, Role of Information Technology in Disaster Management – Simulation studies. | 6 |
| **Case studies:** Bhopal gas tragedy, Meuse valley, Chernobyl, Fukushima, Tsunami, Forest fires, Gulf of Mexico Oil Spill and recent episodes. | 8 |
| **Total hours of Teaching** | **42** |

**TEXT BOOKS**


1. Peter R.J. Trim, (2004), "An Integrative Approach to Disaster Management and Planning", Emerald Group Publishing Ltd.,
2. Ramesh R. Rao, Jon Eisenberg, and Ted Schmitt, Editors, Committee on Using Information Technology to Enhance Disaster Management, National Research Council "Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery", The National Academies Press, Washington, D. C.


**REFERENCES**


1. Committee on Disaster Research in the Social Sciences: Future Challenges and Opportunities, "Facing Hazards and Disasters- Understanding Human Dimensions" Division on Earth and Life Studies, (2006), The National Academies Press, Washington, D. C.
2. Committee on the Effective Use of Data, Methodologies, and Technologies to Estimate Sub national Populations at Risk, National Research Council, (2007), "Tools and Methods for Estimating Populations at Risk from Natural Disasters and Complex Humanitarian Crises", The National Academies Press, Washington, D. C.
3. Committee on Planning for Catastrophe, (2007)," A Blueprint for Improving Geospatial Data, Tools, and Infrastructure, National Research Council, "Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management", The National Academies Press, Washington, D. C.
4. Patricia Jones Kershaw and Byron Mason, (2005), "The Indian Ocean Tsunami Disaster: Implications for U.S. and Global Disaster Reduction and Preparedness - Summary", the National Academies Press, Washington, D. C.

5. UNEP Report,(2005),“Environmental Management And Disaster Preparedness” Lessons Learnt from the Tokyo Typhoon (Typhoon 23 of 2004) in Japan
6. UNEP Report, “Environmental Management and Disaster Preparedness” Building a multi-stakeholder partnership
7. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.

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# ENVIRONMENTAL MICROBIOLOGY LABORATORY

**EV 46L** **L: T:P = 0:0:3** **CIE: 50 Mks**

**3 h/wk**

## Course Objective

The lab course provides practical exposure to students on various qualitative and quantitative analytical methods for screening, identification, quantification of microrogranisms in different contaminated water samples.

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:** acquaint with apparatus/instruments/equipments, chemicals and reagents, measurement techniques for various microbiological parameters and applicable standards. | Remember | 1, 2, 9 |
| **CO2:** use various analytical methods for measuring different types of microorganisms and to compare the sensitivity of each method of analyses. | Analyze | 3, 5, 10 |
| **CO3:** develop ability to analyze, interpret and infer analytical data at bench scale and pilot scale. | Apply | 4, 10 |
| **CO4:** Follow standard methods and report results in a logical manner. | Remember | 1, 2, 8 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| EXPERIMENTS | Hours |
|---|---|
| Apparatus/equipment, washing and cleaning techniques, sterilization.<br>Lab safety aspects. Water sampling protocols. | 3 |
| Microscopic Identification of different microbial organisms present in air, soil and water. | 3 |
| Identification and characteristics of aquatic weeds. | 3 |
| Culture media – types and preparation. | 9 |
| Bacteriological tests on water samples (TC,FC & FS) Multiple Tube Fermentation Test, Membrane Filter Technique. | |
| Tests – Agar Plate Count, MPN and Staining technique. | 6 |
| Bacteriological examination of Recreational Water – Swimming pool, bathing ghats, water parks – Rapid detection method. | 3 |
| Microbial culture, isolation and plate count.<br>Microbial Cells Immobilization Technique – methods of immobilization and Applications, Bio assay test (Theory and method of analysis). | 6 |
| Detection of fungi in Water & Air. | 3 |
| **Total hours of Teaching** | **36** |

## References


1. APHA, Standard Methods for Examination of Water and Wastewater, 2018. New Edition.
2. Pelczar M.J. Chan E.C.S. and Krieg, N.R. 2008. Microbiology. Tata McGraw – Hill Publishing Company ltd.5th edition. New Delhi.
3. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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# ENVIRONMENTAL FLUID MECHANICS LAB

**EV 47L** **CIE: 50 Mks**

**3 h/wk(L: T:P = 3-0-0)**

## Course Objective

The lab course provides practical exposure to students on various flow measurement techniques, hydraulic coefficient determination, calibration aspects, tests on Centrifugal pumps and demo of selected instruments

## Course Outcomes (COs) and Learning Outcomes (LOs)

At the end of the course the students are able to:

| COs - LOs | *Cognitive Domains | Program Outcomes |
|---|---|---|
| **CO1:** Understand and calibrate flow measurement devices by conducting experiments under standard conditions using standard procedure. | Apply | 2, 3, 5 |
| **CO2:** Analyze minor losses in pipes under various conditions and to carryout tests on centrifugal pumps | Analyze | 2, 5 |
| **CO3: I**nterpret and infer the laboratory analytical data | Analyze | 2, 10 |
| **CO4:** Apply learnt concepts to address real time societal problems. | Apply | 3, 4, 6 |

*** Cognitive Domains based on Revised Bloom's Taxonomy**

| EXPERIMENTS | Hours |
|---|---|
| **Orifices and Mouthpieces:** Determination of hydraulic coefficient of circular orifice, external cylindrical and convergent divergent mouth pieces. | 6 |
| **Calibration of Notches:** Rectangular and Triangular notches. | 3 |
| **Calibration of Venturimeter and Orifice meter** | 3 |
| Determination of minor losses in pipes due to sudden expansion, sudden contraction, bends and elbows. | 3 |
| Impact of jet on vanes (flat, inclined and hemispherical). | 3 |
| **Test on Centrifugal pumps:** Single-stage and multi-stage centrifugal pump. | 3 |
| Demonstration of turbines. | 3 |
| Flow through different media | 3 |
| **Field visit.** | 9 |
| **Total hours of Teaching** | 36 |

## References


1. P. N. Modi and S. M. Seth. 2013. Hydraulics and Fluid Mechanics. Standard Book House, New Delhi.
2. Sarbjit Singh., “Experiments in Fluid Mechanics” - PHI Pvt. Ltd. - New Delhi.
3. Kumar K.L., “Engineering Fluid mechanics” Eurasia publishing House Pvt. Ltd New Delhi.
4. Technical articles from peer reviewed journals of Science Direct, acs.org, Springer, Taylor and Francis and patented materials.


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