DISCIPLINE SPECIFIC ELECTIVE (DSE-EVS-7): WATER TREATMENT TECHNOLOGIES

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
DSE-EVS-7: WATER TREATMENT TECHNOLOGIES	4	2	0	2	Class XII pass	NA

Learning objectives

The Learning Objectives of this course are as follows:

- Gain insights into physico-chemical, and biological processes involved in water treatment
- Familiarize with different types of water treatment technologies and their applications
- Understand the importance of water quality standards and learn criteria to evaluate the effectiveness of water treatment processes
- Identify and appreciate the critical linkages among environmental, socio-economic impacts of water treatment and importance regulations

Learning outcomes

After the course, students will be able to:

- Explain the performance of water treatment plant based on the physico-chemical, and biological processes
- Apply theoretical concepts for operation, management, and improvement of water treatment systems
- Evaluate the effectiveness of water treatment plants and its link with socio-economic and environmental impacts
- Collaborate for learning the structure and function of local water treatment plants to solve related problems

SYLLABUS OF DSE-EVS-7

Theory (02 Credits: 30 lectures)

UNIT – I Fundamentals of Water Treatment Technologies (1½ Weeks) (3 lectures)
Water sources: types, quality parameters, different uses; Water treatment processes: overview, types, importance in public health; Water treatment plants: design, operations, maintenance, future trends; Regulations and standards

UNIT – II Pre-Treatment and primary treatment processes (3½ Weeks) (7 lectures)
Screening and sedimentation, Adsorption and absorption, Coagulation and flocculation, Chemical dosing, pH control methods, Aeration and degasification, Membrane filtration and reverse osmosis

Sedimentation and clarification, Dissolved air flotation and gravity separation, Hydrocyclone and centrifugation methods, Physical and chemical disinfection, UV irradiation and ozonation, Chlorination and chloramination, Taste and odor control methods, Color removal and demineralization techniques

UNIT – III Secondary Treatment Processes (2½ Weeks) (5 lectures)
Biological treatment methods, Activated sludge: aerobic and anaerobic digestion; Bioreactors, Nutrient: removal, denitrification, and recovery techniques; Sludge dewatering and drying methods, Biofilm and trickling filters, Constructed wetlands and bioswales

UNIT – IV Tertiary Treatment Processes (2½ Weeks) (5 lectures)
Advanced oxidation processes, Granular activated carbon and adsorption beds, Ion exchange and membrane technologies, Electrocoagulation and electrochemical treatment, Chemical precipitation and coagulation-flocculation, Disinfection byproduct removal and control, Emerging contaminants and micropollutants, Industrial wastewater treatment methods

UNIT – V Water Distribution Systems (2½ Weeks) (5 lectures)
Water distribution systems: overview, and components; Pipeline materials and design considerations, Pumping stations and pressure regulation, Storage tanks and reservoirs, Water quality monitoring and testing, Water loss and leak detection, Cross-connection control and backflow prevention

UNIT – VI Water Treatment Plant Management (2½ Weeks) (5 lectures)
Water treatment plant performance metrics, Safety and emergency response planning, Human resources and staffing, Asset management and maintenance, Energy management and optimization, Capital and budgeting planning, Public outreach and Regulatory compliance

Teaching and learning interface for theoretical concepts

To achieve the course objectives and match with the contents, a wide range of teaching and learning tools will be employed, including (a) Formal lectures; (b) Interactive sessions using visual aid; (c) Case study analyses; (d) Hypothetical scenario building; (e) Group discussion on key topics; and (f) documentary screening and critical analyses.

Practicals/Hands-on Exercises – based on theory (02 Credits: 60 hours)

1. Visit local water treatment plant and understand its structure and function and link it with the efficacy of water treatment
2. Analyze the water samples collected from local water treatment plant at different stages of treatment and analyze the role of ongoing physico-chemical and biological processes
3. Based on analyses of practicals 1 and 2, prepare a plan for improvement of water treatment plant with appropriate justification
4. Assess efficacy of filtration by different media, including sand, activated carbon, and gravel in removing contaminants from water
5. Prepare and test the potential of biofilters to remove nutrients and organic matter from water.
6. Ascertain the requirement and assess the effectiveness of chlorination for disinfection of microbial contaminated water samples
7. Test the effectiveness of coagulation-flocculation in removing suspended particles from water and determine effectiveness of different coagulants and flocculants
8. Determine the sedimentation rate of suspended particles in water using graduated cylinders packed with different soil particle size fractions
9. Determine effectiveness of UV radiation and ozone treatment in reducing the microbial load in water samples.
10. Assess the effectiveness of reverse osmosis in treating the water loaded with salts and other contaminants and improving the water quality
11. Determine the effectiveness of activated carbon and other self-prepared biological sorbent in reducing the chemical oxygen demand (COD)

Teaching and learning interface for practical skills

To impart training on technical and analytical skills related to the course objectives, a wide range of learning methods will be used, including (a) laboratory practicals; (b) field-work exercises; (c) customized exercises based on available data; (d) survey analyses; and (e) developing case studies; (f) demonstration and critical analyses; and (h) experiential learning individually and collectively.

Essential/recommended readings

- Crittenden, J. C., Trussell, R. R., Hand, D. W., Howe, K. J., & Tchobanoglous, G. (2012). MWH's Water Treatment: Principles and Design (3rd ed.). John Wiley & Sons.
- Farooq, R., & Fan, J. (2020). Water Treatment Technologies for the Removal of High-Toxicity Pollutants. Elsevier. https://doi.org/10.1016/C2019-0-03681-3
- Johnson, L. (2021). Emerging Water Treatment Technologies. Boca Raton, FL: CRC Press.

- Kim, S. (2021). Sustainable Water Treatment Technologies. Amsterdam, Netherlands: Elsevier.
- Zhang, Q. (2020). Innovative Water Treatment Technologies. Singapore: Springer.

Suggestive readings

- Brown, R. (2020). Membrane-Based Water Treatment Technologies. Hoboken, NJ: Wiley.
- Chen, X., Li, Y., & Li, P. (2021). Environmental Water Treatment Technologies: Advanced Treatment Processes, Modeling and Optimization. Elsevier. https://doi.org/10.1016/C2021-0-03457-3
- Chen, W. (2019). Advanced Oxidation Technologies for Water and Wastewater Treatment. Springer.
- Davis, M. L., & Masten, S. J. (2018). Principles of Environmental Engineering and Science (3rd ed.). McGraw-Hill Education.
- Smith, J. (2022). Advanced Water Treatment Technologies. New York, NY: Springer.
- Tchobanoglous, G., Burton, F. L., & Stensel, H. D. (2013). Wastewater Engineering: Treatment and Resource Recovery (5th ed.). McGraw-Hill Education.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.