

Semester:	8				
Course Code:	ME5180				
Course Name:	Environmental Fluid Mechanics: Mixing and Transport Processes				
Credits Value:	2 (Notional hours: 100)				
Pre-requisites:	ME5070				
Core/ Optional:	Optional				
Hourly Breakdown	Lectures (hours)	Tutorials (hours)	Practical classes (hours)	Assignments (hours)	Independent Learning & Assessment (hours)
	23	04	-	06	67

Course Aim: This course is aimed at introducing principles and mathematical descriptions pertaining to fluid flow that is associated with heat and mass transport processes which take place in environmental flows covering local and regional scales in the earth's hydrosphere and atmosphere. Students will also gain the skills of analyzing the interaction of flow, mass and heat with man-made facilities and the local environment.

Intended Learning Outcomes:

At the end of this course, students should be able to:

- **estimate** how diffusion, advection, dispersion, and chemical reactions affect on concentrations of chemicals in the environment,
- **identify** key physical processes contributing to mixing in surface waters, groundwater, and the atmosphere,
- **apply** advective, reactive diffusion equations to solve transport problems in rivers, lakes, estuaries, the oceans, groundwater, the atmosphere as well as at sediment-water-air interfaces,
- **synthesize** the analysis tools developed in the course to solve real-world fluid-transport problems.

Course Content:

- **Introduction:** Course outline, introduction and examples of transport problems
- **Advective Diffusion Equation:** Fick's Law, and derivation of the advective-reactive diffusion equation
- **Instantaneous Point-source Solution:** Self-similarity and the solution for advective diffusion of an instantaneous point source in one-dimension
- **Introduction to Turbulence:** Qualitative and quantitative description of turbulence, turbulent length and time scales, statistical methods, and the energy cascade

- **Turbulent Mixing:** Derivation of the turbulent diffusion equation and discussion of near- and far-field turbulent diffusion processes
- **Jets and Plumes I:** Self-similarity theory, entrainment and spreading hypotheses, integral models, axial jet and plume equations in stagnant ambient conditions
- **Near-Field River Mixing:** Solutions to the advective diffusion equation and applications to near-field turbulent mixing in rivers
- **Longitudinal Dispersion:** Taylor's analysis for the derivation of the longitudinal dispersion coefficient in a one-dimensional turbulent shear flow
- **Far-Field River Mixing:** Calculating and measuring the longitudinal dispersion coefficient in rivers and predicting the fate of contaminant sources
- **Mixing in Lakes and Reservoirs:** Buoyancy effects, simple physical limnology, and criteria effecting mixing (Richardson number)
- **Jets and Plumes II:** Effects of stratification, non-trivial geometries, cross-flows
- **Numerical Modeling:** Introduction to the methodology of water quality modeling

Teaching/ Learning Methods:

Classroom lectures, tutorials and in-class exercises and assignments

Assessment Strategy:

Continuous Assessment 50%		Final Assessment 50%		
Details:		Theory (%)	Practical (%)	Other (%)
Tutorials/assignments/quizzes	20%	50%		
Mini project	30%			

Recommended Reading:

- Fischer, H. B., List, E. G., Koh, R. C. Y., Imberger, J. & Brooks, N. H. (1979). *Mixing in Inland and Coastal Waters*, Academic Press, New York, NY
- Rutherford, J. C. (1994). *River Mixing*, John Wiley & Sons, Chichester, England.
- Csanady, G. T. (1973). *Turbulent Diffusion in the Environment*, D. Reidel Publishing Company, Dordrecht, Holland.

Note: Mini project will be done utilizing self-learning hours.