Course Code MENG-462	**Course Title** Fluid Dynamics	**ECTS Credits** 6
Department Engineering	**Semester** Fall/Spring	**Prerequisites** MENG-280
Type of Course Required	**Field** Mechanical Engineering	**Language of Instruction** English
Level of Course 1st Cycle	**Year of Study** 4th	**Lecturer(s)** Dr Constantinos Hadjistassou
Mode of Delivery Face-to-face	**Work Placement** N/A	**Co-requisites** None

Objectives of the Course:

Fluid dynamics builds on MENG-280 Fluid Mechanics and its main objectives are to:

- Review the characteristics of internal flows;
- Explain fluid flow at low, moderate and high Reynolds Numbers;
- Analyse fluid mechanics phenomena of cavitation, advection, diffusion and convective transport;
- Present lubrication theory;
- Understand the characteristics of surface tension;
- Acquaint attendees with flows in porous media;
- Present the mathematical foundations of multi-phase flows;
- Outline the mathematical aspects of partial differential equations (PDEs) as applied to fluid flows;
- Numerical solution of Navier-Stokes equation;
- Appreciate the utility of computational fluid dynamics (CFD) and flow visualisation.
- Introduce non-Newtonian flow and rheology;

Learning Outcomes:

Upon completion of the course students are expected to:

- Better understand the mechanics of fluid flows in conduits;
- Distinguish between low, moderate and high Reynolds Number flows;
- Appreciate the challenges associated with the fluid mechanics of turbulence as applied to engineering problems;
- Learn the physics of cavitation, convection, diffusion and advection;
- Become acquainted with the lubrication approximation;
- Solve practical problems associated with drag forces and lift generation;
- Know some of the aspects of compressible flow;
- Understand the concepts associated with fluid flow in porous media;

- Familiarise themselves with two-phase and three-phase flows;
- Tackle problems related non-Newtonian flows and rheology;
- Comprehend the mathematics of partial differential equations in fluid dynamics;
- Become familiar with approximate results of the Navier-Stokes equation;
- Be aware of the numerical techniques used to solve PDEs and the tools used to solve and visualize such problems;

Course Contents:

Course syllabus comprises:

- Fully developed flow, turbulent flows in pipelines, minor and major energy losses, fluid compression and pumping, flow rate measurements;
- Open channel flow, hydraulic jumps, quantify flow rates;
- Stoke's equations, entrance flows, flow around a cylinder, Bernoulli equations;
- Physics of cavitation, cavitation inception, types of cavitation, cavitation issues on propeller blades, pumps and control valves;
- Convection in gases and liquids, the convection-diffusion equation, advection equation;
- Bearing theory equations and viscous adhesion;
- Bubbles & drops and constant tension flows;
- Creeping flow, Cauchy momentum equation, incompressible Navier-Stokes equation, approximate solutions;
- Porosity, seepage velocity, continuity equation, Darcy's Law, inertial effects;
- Flow assurance, mass conservation, energy conservation, slug flow, 2D & 3D fluid flow;
- Compressible Couette flow, power law, steady compressible flow;
- Governing equations of fluid flow, classification and the solution of PDEs, CFD and flow visualisation;
- Problem formulation, discretization methods, boundary conditions and initial conditions;
- The finite difference method, the finite element method and the finite volume method;
- Non-Newtonian fluid behaviour, visco-elastic fluids, particulate systems.

Learning Activities and Teaching Methods:

Lectures, in-class exercises, examples

Assessment Methods:

Problem sheets, mid-term, simulation exercises, final exam

Required Textbooks/Reading:

Authors	**Title**	**Publisher**	**Year**	**ISBN**
Graebel W.P.	Advanced Fluid Mechanics	Academic Press	2007	978-0-12-370885-4

Recommended Textbooks/Reading:

Authors	**Title**	**Publisher**	**Year**	**ISBN**
Basniev S.K., Dmitriev M.N., Chilingar V.G., Gorfunkel M. & Nejad A.G.M.	Mechanics of fluid flow	Scrivener Publishing	2012	978-1-118-38506-7
Versteeg H.K. and Malalasekera W.	An Introduction to Computational Fluid Dynamics: The Finite Volume Method	Pearson Education	2007	978-0-13-127498-3