DEPARTMENT OF MATHEMATICS,

UNIVERSITY OF KARACHI,

Course Outline

MATH 655: FLUID DYNAMICS – I (2 + 1)

Prerequisite: Physics in B.A. / B.Sc. / B.S.

Course contents:

General introduction. Fluid Properties: Density, Specific Volume, Specific gravity, Pressure, Viscosity, temperature, Thermal Conductivity, Vapour Pressure, Bulk modulus of Elasticity. Kinematics of the flow field: Description of fluid motion, Lagrangian and Eulerian methods, Steady and Unsteady Flow, Uniform and Non-uniform flows, Line of flows, Streamlines, Stream Surfaces and Stream tube, streak lines, Substantial or Material Derivative, The Reynolds Transport theorem. Differential form of conservation Equations (Continuity, Navier- Stokes Equation (NSE), and Energy Equation), Vorticity, rotational and irrotational motions, Existence of Streamfunction, Potential flows (uniform, sourse, sink, vortex, forced vertex, free vortex, combinational vortex, Doublet, source in a uniform stream (half body)) and spiral. Bernoulli Equation, Circulation. Exact Solutions of the Navier Stokes equations: Planes, Couette Flow, Generalized plane Couette flow, plane poiseulle flow, flow between co-axial and circular pipes/cylinder, Impulsive and oscillatory motion of an infinite flat plate, pulsatile flow between parallel surfaces. Dimensions, Dimensional Homogeneticity, Dimensionless Parameters, Dimensional analysis and Dynamic similitude.

Labs:

1. Plotting of implicit streamfunctions using available software(s) such as Mathematica/ MATLAB/ MAPLE, etc.
2. Computing and plotting of Exact solution of NSE.
3. To study problems in Dimensional Analysis and Dynamic similitude with the aid of software(s).

Books Recommended:

1. Munson, B. R., Young, D. F and Okiishi, T. H., Fundamentals of Fluid Mechanics, Fifth Edition, John Wiley Sons, N. Y., 2005.
2. Panton, R. L., Incompressible Flows, John Wiley and Sons, N.Y., 2005.
3. Batchelor, G.K., An Introduction to Fluid Dynamics, Cambridge University Press, 2008.

4. Cengel, Y. A. and Cimbala, J. M., Fluid Mechanics: Fundamentals and Applications, McGraw- Hill, Higher Education, 2008.
5. Thompson, P. A., Compressible Fluid Dynamics, McGraw - Hill, 1972
6. O' Neill, M. E. and Cholton, F., Ideals and Incompressible Fluid Dynamics, Ellis Horwood Ltd, West Sussex, England, 1986.
7. Bansal, J. H., Viscous Fluid Dynamics, Oxford and IBH Publishers Co, New Delhi, 2000.
8. Acheson, D. J., Elementary Fluid Dynamics, Clarendon Press, Oxford, 1990.
9. Kuethe, A. M. and Chow, C. Y., Foundation of Aerodynamics, John Wiley and Sons, N.Y., 1986.
10. Shivamaggi, K. B., Theoretical Fluid Dynamics, Princeton Hall, New Dehli, 1998.
11. Cengel, Y. A., Thermodynamics An Engineering Approach, Fifth Edition, McGraw Hill Higher Education, 2006.
12. Crowe, C. T., Elger, D. F. and Roberson J. R., Engineering Fluid Mechanics, Seventh Edition, John Wiley and Sons, Inc, 2001.
13. Finnemore, E. J., and Franzini, J. B., Fluid Mechanics with Engineering Applications, Tenth Edition, McGraw Hill, New York, 2002.
14. Cengel, Y. A., Heat and Mass Transfer. Third Edition, McGraw Hill, New York, 2007.