Teaching and Learning Objectives of Week 4 – 5

1. Define, Illustrate, and Compare and Contrast the following terms and concepts:

    - Viscous Flow in Ducts
        - Developing vs. fully-developed flow
        - Reynolds number and flow regimes
        - Mechanical energy balance
            - Energy vs. Pressure vs. Head form
            - Restrictions
            - Head loss
            - Pump/Turbine Efficiencies (Incompressible flow)
        - "Major" losses due to friction in straight pipes
            - Reynolds number — $Re = \rho V D_H / \mu$
                - Hydraulic diameter (D_H) for non-circular ducts.
            - Laminar vs. turbulent flow
            - Pipe roughness (ε) and relative roughness (ε/D_H)
            - Darcy-Weisbach (Moody) friction factor
            - Moody friction factor diagram
                - Laminar region
                    - Ducts with circular cross-section: $f = 64/Re_D$.
                    - Ducts with non-circular cross-section (Use D_H but geometry specific correlation $f = C/Re_{DH}$
                - Critical (transitional flow) region
                - Turbulent region: transitionally rough vs. fully rough region
                    - Colebrook equation (or Haaland equation)
        - "Minor" losses due to changes in velocity direction or magnitude (fittings)
            - Loss coefficient K_L
            - Inlet vs. exit losses
            - Expansion and contraction losses
            - Valves, fittings, and elbow losses

2. List the assumptions that reduce the conservation of energy equation to the *mechanical energy balance* for incompressible fluids.

3. Given steady flow in a pipe or fitting, calculate the head loss, i.e. gh_{Loss} for flow through the fitting or pipe.

4. Given the steady flow of an incompressible substance through a single-inlet/single-outlet piping system, apply the mechanical energy balance to the system to relate the pump work, turbine work, and loss of mechanical energy (head loss), to changes in pressure, elevation, and velocity in the piping system. If necessary, correctly use the efficiency values to find the actual work into the pump or out of the turbine.