DEPARTMENT OF APPLIED MECHANICS
End Semester Examination (Odd Semester 2020-21)
B. Tech. (Chemical Engineering) - 3rd Semester
Fluid Flow Operations and Hydraulic Machine (AM 13107)

Time: 2 hrs. **Max. Marks: 40**

Note: Attempt all questions. Assume data if necessary with proper justifications.

1(a). A Francis turbine is to operate under a head of 24 m. If it generates 2000 kW power and the overall efficiency turbine is 92 percent, determine speed (N) and discharge of the turbine. **(4)**

1(b). A centrifugal pump discharges water at 0.12 m^3/s against a head of 15 m when working at 800 rpm. A second geometrically similar pump running at 600 rpm delivers water at 0.065 m^3/s at its best efficiency. Find the design head of the second pump and scale ratio between the first and the second pump? **(4)**

2(a). Why an observer at ground watching an aeroplane does not hear any sound when the plane in passing the observer and suddenly listen a cracking sound when the aeroplane passes away from the observer. Explain in detail. **(2)**

2(b). A pipe diameter reduces 100 mm to 50 mm diameter through a sudden contraction. When it carries air at 25°C under isothermal condition, the absolute pressures observed in the two pipes just before and after the contraction are 500 kN/m^2 and 400 kN/m^2 respectively. Determine densities and velocities at the two sections. Also find the mass rate of flow through the pipe if R= 287 J/kg K. **(5)**

3(a). A flat plate is placed at a wall and is parallel to an approaching boundary layer. Assume that the flow over the plate is fully turbulent and that the approaching flow is a one-sixth-power law. Obtain an expression for drag force in terms of Reynolds Number. **(5)**

3(b). The power input P to a centrifugal pump is assumed to be a function of the volume flow Q, impeller diameter D, rotational rate Ω, overall efficiency η_0, density ρ and viscosity μ of the fluid. Rewrite this as a dimensionless relationship using Buckingham's π theorem. **(5)**

4(a). Oil, with ρ = 800 kg/m^3 and ν = 0.00001 m^2/s, flows at ***0.R m^3/s*** through 600 m of 240 mm diameter Cast-iron pipe (ε = 0.23 mm, f = 0.0225). Determine the pressure drop if the pipe slopes down at *3°* in the flow direction. ***(Where, R is the last digit of your registration no.)*** **(4)**

4(b). The tank in *Figure 1* contains benzene (ρ = 880 kg/m^3), water and is pressurized to 180 kPa (gage) in the air gap. Determine the vertical hydrostatic force on circular-arc section AB and its line of action. **(4)**

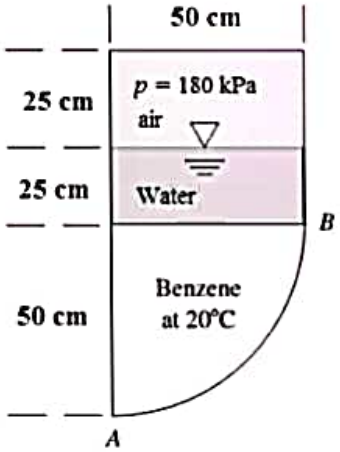

Figure 1

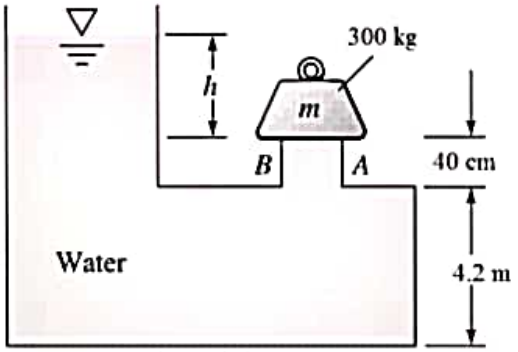

Figure 2

5(a). In *Figure 2*, the cover gate AB closes a circular opening 100 cm in diameter. The gate is held closed by a 300 kg mass as shown. Assume standard gravity at 20°C. At what water level h will the gate be dislodged? Neglect the weight of the gate. **(3)**

5(b). A shaft 7 cm in diameter and 50 cm long is pulled steadily at velocity of 0.5 m/s through a bearing sleeve 7.03 cm in diameter. The clearance, assumed uniform, is filled with oil whose properties are ν = 0.003 m^2/s and SG = 0.9. Estimate the force required to pull the shaft. **(4)**