Note: Answer Six Questions only and Q6 and Q7 must be included

Q1/ A liquid is to be transferred from one tank to a higher tank without using a pump but by pressurizing the space above the liquid in the lower tank. The frictional head loss in the pipe is equal to 1000 velocity heads [$h_f = 1000\,(u^2/2g)$] and the density of the liquid is 800 kg/m^3. What pressure difference will be required to cause the liquid to flow turbulently at a speed of 0.3 m/s when the liquid surface in the supply tank is 7m below that in the discharge tank?

(15 Marks)

Q2/ Calculate the frictional pressure gradient ($\Delta P_f /L$) for a liquid in steady state turbulent flow in a galvanized iron pipe? The density of the liquid equals to 1000 kg/m^3, the flow rate is 9 m^3/s, the inside diameter of pipe is 0.05 m and the viscosity of liquid is 0.01 Pa.s.

(15 Marks)

Q3/ Calculate the available net positive section head NPSH in a pumping system if the liquid density is 1200 kg/m^3, the liquid viscosity is 0.4 Pa.s, the mean velocity is 1 m/s, the static head on the suction side is 3 m, the inside pipe diameter is 0.0526 m and the equivalent length on the suction side is 5 m? The liquid is at its normal boiling point. Neglect entrance and exit losses.

(15 Marks)

Q4/ Two centrifugal pumps are connected in parallel in a given pumping system. Determine the operating point on the basis of the following data:

Operating data for pump 1:

Δh, m	40.0	35.0	30.0	25.0
Q, m^3/h	169	209	239	265

Operating data for pump 2:

Δh, m	40.0	35.0	30.0	25.0
Q, m^3/h	0	136	203	267

Data for system:

Δh, m	20.0	25.0	30.0	35.0
Q, m^3/h	0	244	372	470

(15 Marks)

Q5/ A flat-blade turbine with six blades is installed centrally in a tank conforming to the standard configuration. The turbine is 1.2 m in diameter. The tank is filled with a solution of 50% caustic soda at 65.5 □C, which has a viscosity of 1.0785 kg/m.s and a density of 1498 kg/m^3. The turbine is operated at 60 rpm. What power will be required to operate the agitator?

(15 Marks)

Q6/ Calculate the volumetric flow rate of water through a pipe with an inside diameter of 0.2 m fitted with an orifice plate containing a concentric hole of diameter of 0.1 m? The difference in mercury level on the manometer is 0.25 m. The specific gravity of mercury is 13.6. The viscosity of water is 0.01 Pa.s.

(20 Marks)

Q7/ What is the terminal velocity of a spherical steel particle, 0.4 mm in diameter, settling in an oil of density 820 kg/m^3 and viscosity 10 mNs/m^2? The density of steel is 7870 kg/m^3.

(20 Marks)