(3 Hours) **Max. Marks: 80**

N.B:

1. Question No. 1 is compulsory
2. Attempt any **Three** questions from remaining **Five** questions
3. In all four questions to be attempted.
4. Figures on the right hand side indicate full marks.
5. Assume suitable data if necessary and state the same.

Q.1 a) Write a short note on (Any Five) **20**

a) Define i) Dynamic viscosity and ii) Kinematic viscosity
b) Define Stream line, Stream tube, Streak line and Path line.
c) Define Major and Minor energy losses
d) Explain multistage compression and state its advantages
e) Define critical pressure ratio and state its significance
f) State and explain Fourier's 'law of conduction.
g) Explain Hydrodynamic and Thermal boundary layer.

Q.2 a) Derive an expression for continuity equation for three dimensional flow in Cartesian co-ordinate system. **08**

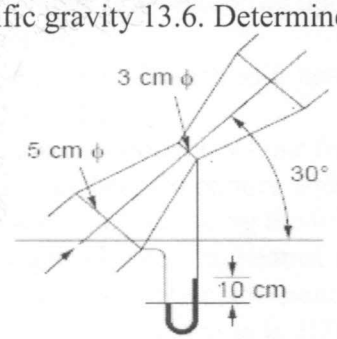
b) Determine the power required to run a 300 mm dia shaft at 400 rpm in journals with uniform oil thickness of 1 mm. Two bearings of 300 mm width are used to support the shaft. The dynamic viscosity of oil is 0.03 N-s/m^2. **06**

c) An oil tank is filled to a height of 7.5 m with an oil of specific gravity 0.9. It has a rectangular gate 1 m wide and 1.5 m high provided at the bottom of a side face. Determine the resultant force on the gate and also its point of action. **06**

Q.3 a) State and shortly explain the condition for stability of Floating bodies. **04**

b) i) Define Buoyancy and Metacentric height. **08**
ii) Define Stream function and Velocity Potential function.

c) A venturimeter as shown in Fig. below is used to measure the flow of petrol with a specific gravity of 0.8. The manometer reads 10 cm of mercury of specific gravity 13.6. Determine the flow rate. **08**



Q.4 a) State and prove Bernoulli's equation of fluid flow. Mention assumption made in derivation. **06**

b) Define Reynold's, Prandtl, Nusselt and Grashoff number and give their expressions. **08**

c) Three pipes of 400 mm, 350 mm and 300 mm diameter are connected in series between two reservoirs with a difference in level of 12 m. The friction factors are 0.024, 0.021 and 0.019 respectively. The lengths are 200 m, 300 m and 250 m respectively. Determine the flow rate neglecting minor losses. **06**

Or

Oil of viscosity 8 Poise and specific gravity 1.2 flows through a horizontal pipe 80 mm in diameter. If the pressure drop in 100 m length of the pipe is 1500 kN/m^2, determine,

1. Rate of flow of oil.
2. The maximum velocity
3. The velocity and shear stress at 10 mm from the wall

Q.5 a) Give comparison of parallel flow and counter flow heat exchanger, why are counter flow heat exchanger mostly used? **04**

b) A two stage air compressor air from 1 bar and 20°C to 42 bar. If the law of compression is $PV^{1.35}$ = constant and the intercooling is complete to 20°C, find per kg of air: 1. The work done in compressing the air; and 2. The mass of water necessary for abstracting the heat in the intercooler, if the temperature rise of the cooling water is 250°C **08**

c) A simple constant pressure gas turbine operates at a pressure ratio 5:1 and the turbine inlet temperature is 580 °C. The air inlet temperature is 15°C and the pressure is 1.01325 bar. The compressor has adiabatic efficiency of 80 %. What must be the adiabatic efficiency of the turbine in order that the overall cycle efficiency will be 18 %?. Assume Cp for air to be 1.005 kJ/kgK and Cp for combustion gases is 1.093 kJ/kgK. Take R to be 0.287 kJ/kgK for both air and combustion gases. **08**

Q.6 a) i) Discuss the significance of intercooling upon the performance of multi-stage compression **08**

ii) Write the equation for resistance in a heat transfer problem in case of: a) Series b) Parallel.

b) 500 kg of sulphuric acid is cooled per hour from 70°C to 30°C in a counter flow double pipe heat exchanger with the use of 400 kg of water per hour available at 20°C. Using the following data find area of heat exchanger required. Specific heat of sulphuric acid is 3.36 kJ/kgK. Convective heat transfer coefficient of water side is 500 W/m^2K and that of sulphuric acid side is 400 W/m^2K. Neglect the resistance of the tube and assume there is no loss of heat in the system. **06**

c) A steel pipe (K = 45.0 W/m.K) having a 0.05 m O.D is covered with a 0.042 m thick layer of magnesia (K = 0.07W/m.K) which in turn covered with a 0.024 m layer of fiberglass insulation (K = 0.048 W/m.K). The pipe wall outside temperature is 370 K and the outer surface temperature of the fiberglass is 305 K. What is the interfacial temperature between the magnesia and fiberglass? Also calculate the steady state heat transfer. **06**

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