

(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) State and explain Newton's law of viscosity.
 - b) Define i) Buoyancy ii) Metacentric height.
 - c) Define i) Laminar and Turbulent flow
ii) Uniform and Non uniform flow.
 - d) Define Major and Minor energy losses
 - e) State how are the compressors classified?
 - f) Define critical pressure ratio and state its significance
 - g) Explain different modes of heat transfer in brief.
- Q.2 a) Define dynamic viscosity and kinematic viscosity. 04
- b) Two large surfaces are 2.5 cm apart. This space is filled with glycerin of absolute viscosity 0.82 N-s/m^2 . Find what force is required to drag a plate of area 0.5 m^2 between the two surfaces at a speed of 0.6 m/s . (i) When the plate is equidistant from the surfaces, (ii) when the plate is at 1 cm from one of the surfaces. 08
- c) A rectangular plate $1.5 \text{ m} \times 3.0 \text{ m}$ is submerged in water and makes an angle of 60° with the horizontal, the 1.5 m sides being horizontal. Calculate the magnitude of the force on the plate and the location of the point of application of the force, with reference to the top edge of the plate, when the top edge of the plate is 1.2 m below the water surface. 08
- Q.3 a) Define Stream function and Velocity function 04
- b) What are the energy losses occurs in pipe? Derive Darcy-Weisbach equation for loss of head due to friction in pipes. 08
- c) A venturimeter has its axis vertical, the inlet & throat diameter being 150 mm & 75 mm respectively. The throat is 225 mm above inlet and $C_d = 0.96$. Petrol of specific gravity 0.78 flows up through the meter at a rate of $0.029 \text{ m}^3/\text{sec}$. Find the pressure difference between the inlet and throat. 08
- Q.4 a) Explain non-dimensional numbers used in Forced convection heat transfer. 06
- b) A pipe of diameter 20 cm and length 2000 m connects two reservoirs, having difference of water levels as 20 m . Determine the discharge 08

- through the pipe. If an additional pipe of diameter 20 cm and length 1200 m is attached to the last 1200 m length of the existing pipe, find the increase in the discharge. Take $f = 0.015$ and Neglect the minor losses
- c) 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, 06
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) What do mean by multi-stage compression? State its advantages. 04
- b) A single-acting, single-cylinder reciprocating air compressor is compressing 20 kg/min of air from 110 kPa, 27°C to 600 kPa and delivers it to a receiver. Law of compression is $PV^{1.25} = \text{constant}$. Mechanical efficiency is 80%. Find the power input to compressor, neglecting losses due to clearance, leakage and cooling! 08
- c) A gas turbine unit receives air a 1 bar and 300 K and compresses it adiabatically to 6.2 bar. The compressor efficiency is 88 %. The fuel has a heating value of 44186 kJ/kg and the fuel-air ratio is 0.017. The turbine efficiency is 90 %. Calculate the work done of turbine and compressor per kg of air compressed and thermal efficiency. For products of combustion, $C_p = 1.147 \text{ kJ/kgK}$ and $\gamma = 1.333$. 08
- Q.6 a) i) Define overall heat transfer coefficient and Fouling factor. 08
- ii) Define critical radius of insulation and state its physical significance.
- b) An experimental facility is constructed to measure the thermal conductivity of building material. The apparatus is designed such that there is one-dimensional, steady-state heat conduction between two isothermal parallel surfaces of the material being tested. A concrete slab measuring 15 cm x 15 cm x 5 cm is placed in the test rig. The two surfaces 5 cm apart are maintained at uniform temperature of 36°C and 22°C respectively. The heat transfer rate between the two surfaces is 27 KJ/hr. Determine the thermal conductivity of the concrete material being tested. 06
- c) The flow rates of hot and cold water streams running through parallel flow heat exchanger are 0.2 kg/s and 0.5 kg/s respectively. The inlet temperatures on the hot and cold sides are 75°C and 20°C respectively. The exit temperature of hot water is 45°C . If the individual heat transfer coefficients on both sides are $650 \text{ W/m}^2\text{K}$. Calculate area of heat exchanger. 06
