Q. P. Code: 37173

(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) Attempt the following (Any Five) 20

a) Define Surface tension and Capillarity
b) State the condition of equilibrium of submerged bodies.
c) Define Total Pressure and Centre of Pressure
d) Define i) Stream line ii) Stream tube iii) Streak line iv) Path line
e) Explain multistage compression and state its advantages.
f) Define critical pressure ratio and state its significance
g) Define the term convective heat transfer coefficient and overall heat transfer coefficient.

Q.2 a) Derive an expression for total pressure and centre of pressure for vertically immersed surface. 08

b) A plate having an area of 1 m^2 is dragged down an inclined plane at 45^0 to horizontal with a velocity of 0.5 m/s due to its own weight. There is a cushion of liquid 1mm thick between the inclined plane and the plate. If viscosity of oil is 0.1 N-s/m^2. Find the weight of the plate. 06

c) Calculate the total hydrostatic force and location of centre of pressure for a circular plate of 2.5 m diameter immersed vertically in water with its top edge 1.5 m below the oil surface (Sp. Gr.=0.9) 06

Q.3 a) Define Stream function and Velocity function 04

b) Derive Hagen-Poiseuille equation for laminar flow through circular pipe. 08

c) A vertical venturimeter has an area ratio 5. It has a throat diameter of 10 cm. when oil of specific gravity 0.8 flows through it, the mercury in the differential gauge indicates a difference in height of 12 cm. Find the discharge through the venturimeter. Take Cd=0.98. 08

Q.4 a) Explain non-dimensional numbers used in Natural convection heat transfer. 06

b) What are the energy losses occurs in pipe? Derive Darcy-Weisbach equation for loss of head due to friction in pipes. 07

c) A main pipe divided into two parallel pipes which again forms one pipe. The length and diameter for the first parallel pipe are 2000 m and 1.0 m respectively, while the length and diameter of 2^{nd} parallel pipe are 2000 07

m and 0.8 m. Find the rate of flow in each parallel pipe, if total flow in the main is 3.0 m^3/s. The coefficient of friction for each parallel pipe is same and equal to 0.005.

Q.5 a) State different methods to employed for improvement of thermal efficiency of gas turbine plant and explain one of them. 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 $PV^{1.25}$ = 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, Cp = 1.147 kJ/kgK and γ = 1.333. 08

Q.6 a) State and explain Fourier's law of heat conduction. 04

ii) Give comparison of parallel flow and counter flow heat exchanger, why are counter flow heat exchanger mostly used? 04

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) 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

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