

(Time 3 Hours)

[Total Marks : 80]

- N.B.: (1) Question No. 1 is compulsory.
(2) Attempt any THREE from question no. 2 to 6.
(3) Use illustrative diagrams wherever required.

1. Attempt ANY FOUR

20

- (a) What do you mean by 'effectiveness' of a heat exchanger?
(b) State and explain critical thickness of insulation. How it is calculated in case of cylinders.
(c) Define and explain degree of reaction as applied to reaction turbines.
(d) Draw pool boiling curve for water and state different regions.
(e) State Zeroth law of thermodynamics. What is its significance?
(f) Differentiate CI and SI engines.

2. (a) Two large parallel steel plates of emissivities 0.8 and 0.5 held at temperatures of 1000K and 500 K respectively. A thin copper plate of emissivity 0.1 is introduced as a radiation shield between these two plates. Determine the radiant heat exchanger in W/m^2 between the plates. Take $\sigma = 5.67 \times 10^{-8} W/m^2 K^4$. 10

- (b) In a straight tube of 60 mm diameter, water is flowing at a velocity of 12 m/s. The tube surface temperature is maintained at $70^\circ C$ and the flowing water is heated from the inlet temperature $15^\circ C$ to an outlet temperature of $45^\circ C$. Calculate the following: 10
(i) The heat transfer coefficient from the tube surface to the water,
(ii) The heat transferred, and
(iii) The length of the tube.

Take the physical properties of water at its mean bulk temperature of $30^\circ C$, $\rho = 995.7 kg/m^3$, $C_p = 4.174 kJ/kg K$, $k = 61.718 \times 10^{-2} W/m K$, $\nu = 0.805 \times 10^{-6} m^2/s$, $Pr = 5.42$, Use $Nu = 0.23 (Re)^{0.8} (Pr)^{0.4}$

3. (a) Derive the expression for maximum blade efficiency in Parson's reaction turbine. 10

- (b) The impulse turbine has a covering nozzle and one ring of moving blades. The nozzles are inclined at 22° to the blades whose tip angles are both 35° . The velocity of steam leaving the nozzle is 660 m/s. Find (i) Blade speed and diagram efficiency assuming no friction along the turbine blades, (ii) If the relative velocity of steam to blade is reduced by 15 % due to friction, find blade efficiency and end thrust. 10

Assume power developed = 170 kW.

TURN OVER

4. (a) Explain with neat sketches any **two** of the following: 10
(i) Stop valve, (ii) Feed check valve, (iii) Blow off cock, (iv) Fusible plug
(b) Derive general heat conduction equation in Cartesian Co-ordinate & reduce it to all three forms. 10
5. (a) A steady flow system receives 45 kg/min of gas at 2 bar, 90°C, with negligible velocity, and discharges it at a point 25m above the entrance section at a temperature of 300°C with a velocity of 2500 m/min. During this process 1.4 k W of heat is supplied from external source and the increase in enthalpy is 8.4 kJ/kg. Determine the power output. 08
(b) A gas engine working on otto cycle has a cylinder diameter 20cm and stroke of 25 cm. The clearance volume is 1570 cm³. Find air standard efficiency. Assume $C_p = 1.004$ kJ/kgK and $C_v = 0.717$ kJ/kgK 06
(c) Derive expression for LMTD for parallel flow type heat exchanger 06
6. (a) During a boiler trial following readings were noted, 10
Feed water = 1400 kg/hr,
Temperature of water $T = 140^\circ\text{C}$,
Boiler working pressure of dry and saturated steam = 20 bar,
Coal used = 200 kg/hr,
Calorific value of fuel = 28000 kJ/kg,
 C_p of products of combustion = 1.028 kJ/kg K
Find
(i) Thermal efficiency
(ii) Equivalent of evaporation
(iii) Heat carried away by flue gases
- (b) Write the steady flow energy equation and apply it to: 10
(i) Nozzle
(ii) Throttling device
(iii) Turbine
(iv) Compressor