

B. Tech.
(SEMESTER-III) THEORY EXAMINATION, 2012-13
THERMAL AND HYDRAULIC MACHINES

Time : 3 Hours]

[Total Marks : 100

SECTION – A

1. Attempt all parts : **2 × 10 = 20**
- (a) What is Thermodynamic equilibrium ?
 - (b) Define reheat factor.
 - (c) What is isothermal efficiency of a Compressor ?
 - (d) Draw PV & TS diagram of Diesel & dual cycle.
 - (e) Write the classification of Hydraulic turbine.
 - (f) Define compression ratio of an engine.
 - (g) Write difference between impulse and reaction turbine.
 - (h) What is cavitation ?
 - (i) Define Priming.
 - (j) What is Slip in Reciprocating pump ?

SECTION – B

- Attempt all the questions : **3 × 10 = 30**
2. Do any two parts : **(5 + 5)**
- (a) Air enter into an evacuated cylinder from the atmosphere when the valve is opened. Calculate the work done if atmospheric pressure is 1 bar and 2 m³ of air at atmospheric pressure enters the cylinder.
 - (b) Derive the expression for steady flow energy equation ?
 - (c) 5 kg of steam at 200 kPa occupies a volume of (i) 2.50m³ and (ii) 5.00 m³. Determine the temperature in each case and quality of steam.

3. Do any two parts :

(a) Prove that for steam Turbine :

$$\text{Blade efficiency } \eta_b = \frac{2P (\cos \alpha_1 - P)}{1 + 2P \cos \alpha_1 - P^2}$$

(b) Derive the express for maximum work output

$$\text{Maximum work output } (W_{\text{net}}) = C_p [\sqrt{T_{\text{max}}} - \sqrt{T_{\text{min}}}]^2$$

(c) Define the terms :

(i) Mean effective pressure of an I.C engine

(ii) compare between 2 stroke S.I. engine & 4 stroke C.I. engine.

4. Do any two parts :

(a) Prove that for moving flat plate,

$$\text{workdone } W = PA (V - U)^2 U$$

(b) A jet of water having a velocity of 50 m/sec impinges shock on a series of vanes moving at 15 m/s. The direction of motion of the vane is inclined at 20° to that of the jet. The relative velocity at outlet is 0.9 of that at inlet. The absolute velocity of water at exit is to be normal to the motion of vanes. Determine

(i) Vane angles at inlet & outlet

(ii) Hydraulic efficiency

(c) A single acting reciprocating pump running at 50rpm delivers $0.00736 \text{ m}^3/\text{s}$ of water. The diameter of the piston is 200 mm and stroke length 300 mm. If suction & delivery head are 3.5 m and 11.5 m respectively. Calculate

(i) Theoretical discharge

(ii) % of slip of the pump

Do all the questions :

5 × 10 = 50

5. (a) A system containing 0.25 m^3 of air at a pressure of 4 bar and 150°C expands isentropically to a pressure of 1 bar and after this the gas is heated at constant pressure till the enthalpy increases by 60 kJ. Calculate the workdone if these processes are replaced by a single reversible polytropic process producing the same work between initial and final states, find the index of expansion. Take $C_p = 1.005 \text{ kJ/kg } ^\circ\text{K}$ of air.

OR

A refrigerator absorbs heat at 5°C and rejects to the surrounding at 40°C . It's compressor is driven by a 3.5 kW motor and 45 MJ/h are absorbed at the low temperature. Calculate the heat rejected per hour and the irreversibility in kJ/h.

- (b) 1 kg of steam 0.85 dry at a pressure of 1 bar is compressed in a cylinder to a pressure of 2 bar according to $PV^{1.25} = \text{constant}$. Determine the final condition of steam and the heat transfer through the cylinder wall.

OR

A regenerative cycle with three blade heating works between 30 bar, 45°C and 0.04 bar. The bleed temperature are chosen at equal temperature range. Determine the efficiency of the cycle. Neglect the pump work.

- (c) Explain the working of Pearson's reaction turbine by giving velocity diagram.

OR

Prove that the efficiency corresponding to the maximum work done in a Brayton cycle is given by $\eta_{\max} = 1 - \frac{1}{\sqrt{\alpha}}$ where $\alpha = T_3/T_1$

- (d) A double acting compressor with a piston displacement of 0.05 m^3 per stroke operates at 50 rpm. The clearance is 5 percent and it releases air at 100 kPa, discharge it at 600 kPa. The compression is polytropic $PV^{1.25} = C$. Determine the power required and the air discharged in m^3/s .

OR

In an engine working on diesel cycle, inlet pressure and temperature are 1 bar and 20°C . Pressure at the end of adiabatic compression is 40 bar. The ratio of expansion after constant pressure heat addition is 5. Calculate the heat supplied, heat rejected and the efficiency of the cycle. Assume $C_p = 1.004 \text{ kJ/kg K}$ and $C_v = 0.717 \text{ kJ/kg K}$.

- (e) Discuss the main components of Francis Turbine with reference to working of Turbine.

OR

A double acting reciprocating pump, running at 40 rpm, is discharge $1.0 \text{ m}^3 / \text{min}$ of water. The pump has a stroke of 400 mm and piston rod diameter is 200 mm. The delivery and suction heads are 20 m and 5 m respectively. Find the slip of the pump and power required to drive the pump.