B. TECH.
(SEM-III) THEORY EXAMINATION 2019-20
THERMAL & HYDRAULIC MACHINES

Time: 3 Hours   *Total Marks: 100*

Note: Attempt all Sections. If require any missing data; then choose suitably.

SECTION A

1.   **Attempt *all* questions in brief.**   **2 x 10 = 20**

(a) What do you understand by a thermodynamic process?

(b) What is intercooling in gas turbine?

(c) What is the difference between throttling process and a free expansion process?

(d) Explain clearly what is meant by entropy of a gas.

(e) Define diagram efficiency and stage efficiency.

(f) List the different losses in a steam turbine.

(g) What do you understand by the term atomizer?

(h) Define the term impact of jet.

(i) Differentiate between Kaplan and Propeller turbines.

(j) Define the term specific speed of pump.

SECTION B

2.   **Attempt any *three* of the following:**   **10 x 3 = 30**

(a) A volume of 0.14 m^3 of air at 1 bar and 90°C is compressed to 0.014 m^3 according to $pv^{1.3}$ = contant. Heat is then added at a constant volume until the pressure is 66 bar. Determine : **1.** Heat exchange with cylinder walls during compression, and **2.** Change of entropy during each portion of the process. Assume γ= 1.4 and R = 286 J/kgK.

(b) Describes the difference between an ideal gas turbine plant and an actual gas turbine plant. Give relations for the isentropic efficiencies of compressor and turbine.

(c) Derive an expression for the efficiency of Otto cycle and comment on the effect of compression ratio on the efficiency with respect of ratio of specific heats by means of a suitable graph.

(d) Derive an expression for the work done per second per unit weight of water in a reaction turbine.

(e) What is an air vessel? Describe the function of the air vessel for reciprocating pumps.

SECTION C

3.   **Attempt any *one* part of the following:**   **10 x 1 = 10**

(a) Derive the expression for maximum work output,
Maximum work output(W_{net}) = $C_p[\sqrt{T_{max}} - \sqrt{T_{min}}]^2$.

(b) A gas initially at 603 K expands until its volume is 5.2 times the initial volume, according to pv^n = Constant. If the initial and final pressures are observed to be 8.5 bar and 1 bar, determine : **1.** The index of expansion, **2.** Work done per kg of gas, and **3.** Heat exchange per kg of gas. Assume γ= 1.4 and R = 286 J/kgK.

4.   **Attempt any *one* part of the following:**   **10 x 1 = 10**

(a) A gas turbine plant receives air at a pressure of 1 bar and 290 K. The air is then compressed in a rotary compressor to a pressure of 4 bar and then heated to a temperature of 840 K. The efficiencies of compressor and turbine are 83% and 85% respectively. Neglecting the pressure drop, find overall efficiency of the plant **(i)** without heat exchanger ; and **(ii)** with heat exchanger of 70% effectiveness. Take γ and C_p for air and hot gas gases as 1.4 and 1 kJ/kgK respectively.

(b) Describe briefly the Rankine cycle using superheated steam and show in what respect this cycle differs from Carnot cycle between the same temperatures.

5.   **Attempt any *one* part of the following:**   **10 x 1 = 10**

(a) Derive the expressions for the efficiency and mean effective pressure of a Dual cycle.

(b) A diesel cycle operates at a pressure of 1 bar at the beginning of compression and the volume is compressed to $\frac{1}{16}$ of the initial volume. Heat is supplied until the volume is twice that of the clearance volume. Calculate the mean effective pressure of the cycle. Take γ as 1.4.

6.   **Attempt any *one* part of the following:**   **10 x 1 = 10**

(a) Prove that the force exerted by a jet of water on a fixed semi-circular plate in the direction of the jet when the jet strikes at the centre of the semi-circular plate is two times the force exerted by the jet on a fixed vertical plate.

(b) Define the specific speed of a turbine? Derive an expression for the specific speed. What is the significance of the specific speed?

7.   **Attempt any *one* part of the following:**   **10 x 1 = 10**

(a) A centrifugal pump with 1.2 m diameter runs at 200 rpm and pumps 1080 litres/s, the average lift being 6 m. The angle which the vanes make at exit with the tangent to the impeller is 26° and the radial velocity of flow is 2.5 m/s. determine the manometric efficiency and the least speed to start pumping against a head of 6 m, the inner diameter of the impeller being 0.6 m.

(b) Draw an indicator diagram, considering the effect of acceleration and friction in suction and delivery pipes. Find an expression for the work done per second in case of single-acting reciprocating pump.