Sem VI / MECH

Paper / Subject Code: 89422 / Turbo Machinery

Time: 3 Hours **Max. Marks: 80**

Instructions:

- **Question No.1 is compulsory.**
- Solve **ANY THREE** questions from the **remaining five** questions.
- Figure to the right indicates full marks.
- Assume suitable data wherever required, but justify the same.
- Use of steam table is permitted.

Marks

Q. 1 Solve **ANY FOUR** questions from following. (Each question carries 5 marks) **(20)**

a) What will be the effect on multi stage compressor if the intercooler is not used in it?

b) How regeneration improves the efficiency of gas turbine? Does it affect the turbine work?

c) Why water tube boiler is preferred over fire tube boiler in power plant or large-scale applications?

d) Write short note on centrifugal pump.

e) Write short note on air vessel.

Q. 2 **a)** In a single stage impulse turbine the mean diameter of the blade ring is 1m and the rotational speed is 3000 r.p.m. The steam is issued from the nozzle at 300 m/s and nozzle angle is 20°. The blades are equiangular. If the friction loss in the blade channel is 19% of the kinetic energy corresponding to the relative velocity at the inlet to the blades, what is the power developed in the blading when the axial thrust on the blades is 98 N ?. **(10)**

b) Explain any five mountings of boiler. **(05)**

c) What is Euler's theory? What is the use of it in turbomachinery? **(05)**

Q. 3 **a)** Air is drawn in a gas turbine unit at 15°C and 1.01 bar and pressure ratio is 7:1. The compressor is driven by the H.P. turbine and L.P. turbine drives a separate power shaft. The isentropic efficiencies of compressor, and the H.P. and L.P. turbines are 0.82, 0.85 and 0.85 respectively. If the maximum cycle temperature is 610°C, calculate : **(10)**

(i) The pressure and temperature of the gases entering the power turbine.
(ii) The net power developed by the unit per kg/s mass flow.
(iii) The work ratio.
(iv) The thermal efficiency of the unit.
Neglect the mass of fuel and assume the following:
For compression process C_{pa} = 1.005 kJ/kg K and γ = 1.4
For combustion and expansion processes; C_{pg} = 1.15 kJ/kg K and γ = 1.333.

b) Derive the condition for maximum efficiency of reaction turbine. **(05)**

c) Illustrate working of Turbojet Engine. **(05)**

Q. 4 **a)** A boiler generates 7.5 kg of steam per kg of coal burnt at a pressure of 11 bar, from feed water having a temperature of 70°C. The efficiency of boiler is 75% and factor of evaporation 1.15, specific heat of steam at constant pressure is 2.3. Calculate: **(08)**

(i) Degree of superheat and temperature of steam generated;
(ii) Calorific value of coal in kJ/kg;
(iii) Equivalent evaporation in kg of steam per kg of coal

b) What is degree of reaction? Prove that the degree of reaction for parson's Reaction turbine is 50%. **(08)**

c) What is cavitation in pump? **(04)**

Q. 5 **a)** A centrifugal pump has the following characteristics: outer diameter of impeller = 800 mm; width of impeller vanes at outlet = 100 mm; angle of impeller vanes at outlet = 40°. The impeller runs at 550 r.p.m and delivers 0.98 m^3 of water per second under an effective head of 35 m. A 500 kW motor is used to drive the pump. Determine the manometric, mechanical and overall efficiencies of the pump. Assume water enters the impeller vanes radially at inlet. **(10)**

b) Write short note on surging and choking of compressor. Explain it with the help of Pressure ratio versus Mass flow rate graph. **(6)**

c) Define equivalent evaporation of boilers and what the significance of it is. **(4)**

Q. 6 **a)** Design a Francis turbine runner with the following data: **(10)**

Net head H = 68 m;
speed N = 750 r.p.m;
output power P = 330 kW;
η_h = 94%;
η_o = 85 %;
flow ratio ψ = 0.15;
breadth ratio n = 0.1;
inner diameter of runner is half of outer diameter.
Also assume 6% of circumferential area of the runner to be occupied by the thickness of the vanes. Velocity of flow remains constant throughout and flow is radial at exit.

b) Write short note on compounding of Impulse turbine. **(5)**

c) What is priming? and why it is not required in reciprocating pump? **(5)**
