2023

Paper / Subject Code: 53353 / Power Engineering

B.E. Sem VIII (C Scheme, R-2019) Mechanical May 2023

Time: 3-hour **Max. Marks: 80**

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. Question No.1 is compulsory.

. Attempt any three questions from the remaining.

. Assume suitable data if required.

Q1. **Solve any four out of five.** **5 Marks each**

a Define adiabatic flame temperature, enthalpy of combustion & enthalpy of reaction.

b Derive an expression for the force exerted by a jet of water on a fixed curved plate in the direction of the jet.

c Write the differences between the mounting and Accessories of the boiler.

d Describe the working of reheating gas turbine plant with the help of a T-S diagram.

e Write a short note on the air vessel with a neat sketch.

Q2. **20 Marks**

a In a Parson reaction turbine, the angles of receiving tips are 35° and of discharging tips, 20°. The blade speed is 100 m/s. Calculate the tangential force, power developed, diagram efficiency, and axial thrust of the turbine if its steam consumption is 1 kg/min. **10 Mark**

b Write a short note on the Francis turbine. **5 Mark**

c Write a short note on the Turbojet engine. **5 Mark**

Q3. **20 Marks**

a The following data refers to a gas turbine plant:
Power developed = 5 MW
Inlet pressure and temperature of air to compressor = 1 bar and 30°C
Pressure ratio of the cycle = 5
Isentropic efficiency of the compressor = 80%
Isentropic efficiency of turbines = 85%
Maximum temperature in the turbines = 550°C
Take for air, Cp = 1.0 kJ/kgK, γ = 1.4 and
for gases, Cp = 1.15 kJ/kgK, γ = 1.33.
If a reheater is used between two turbines at a pressure of 2.24 bar, calculate the following:
(a) Mass flow rate of air,
(b) The overall efficiency,
Neglect the mass of fuel. **10 Mark**

b What is specific speed for turbine and centrifugal pump? **5 Mark**

c Write a short note on the Rocket engine. **5 Mark**

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Q4. **20 Marks**

a A boiler generates 8 kg of steam per kg of fuel burnt at a pressure of 12 bar from feed water entering at 80°C. The boiler is 75% efficient and its factor of evaporation is 1.15. Calculate
(a) Degree of superheat and temperature of the steam generated,
(b) Calorific value of fuel in kJ/kg.
(c) Equivalent evaporation in kg of steam per kg of fuel.
Take specific heat of superheated steam as 2.3 kJ/kg·K **10 Mark**

b Derive the condition for maximum blade efficiency of the impulse turbine. **5 Mark**

c What is the Classification of pumps? **5 Mark**

20 Marks

Q5.

a Determine the air–fuel ratio and the theoretical amount of air required by mass for the complete combustion of a fuel containing 85% of carbon, 8% of hydrogen, 3% of oxygen, 1% of sulfur, and the remaining ash. If 40% of excess air is used, what is the volume of air at 27°C and 1.05 bar pressure? Does this represent per kg of fuel? **10 Mark**

b A centrifugal pump has an impeller 0.5 m outer diameter and when running at 600 rpm discharges water at the rate of 8000 liters/minute against a head of 8.5 m. The water enters the impeller without whirl and shock. The inner diameter is 0.25 m, the vanes are set back at the outlet at an angle of 45° and the area of flow which is constant from inlet to outlet of the impeller is 0.06 m^2. Determine (a) the manometric efficiency of the pump, and (b) the vane angle at the inlet. **10 Mark**

Q6. **20 Marks**

a Design a Francis turbine runner with the following data: Net head H = 68 m; speed N = 750 rpm; output power P = 330 kW; η_h = 94%; η_o = 85 %; flow ratio ψ = 0.15; breadth ratio n = 0.1; inner diameter of the runner is half of the outer diameter. Also, assume 6% of the circumferential area of the runner to be occupied by the thickness of the vanes. The velocity of flow remains constant throughout and flow is radial at the exit **10 Mark**

b Draw a general layout of a hydroelectric power plant using an impulse turbine and define the following:
(a) Gross head, (b) Mechanical Efficiency, (c) Hydraulic efficiency, and
(d) Overall efficiency of the impulse turbine. **5 Mark**

c What do you mean by cavitation and its effect on the turbine and pump? **5 Mark**

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