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B. E. (Fifth Semester) Examination, Nov.-Dec. 2021

(New Scheme)

(Mech. Engg. Branch)

TURBO MACHINERY

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) is mandatory solve answer any two from (b), (c) and (d). Use of Steam table and Mollier chart is permitted.*

Unit-I

1. (a) Compare steam engine and steam turbine. 2

(b) Derive the equation for maximum blade efficiency.

And prove that

$$(\eta_b)_{max} = \cos^2 \alpha_1 \text{ and } K = B = 1$$ 7

(c) The mean diameter of the blades of an impulse turbine with a single row wheel is 105 cm and the speed is 3000 r.p.m. the nozzle angle is 18° the ratio of blade velocity to steam velocity is 0·42 and the ratio of relative velocity at outlet from the blades to that at inlet is 0·84. The outlet angle of the blade is to be made 3° less than the inlet angle. The steam flow rate is 8 kg/s. Draw the velocity dig for the blade and calculate :

(i) Tangential thrust on the blades

(ii) Axial thrust on the blades 7

(d) With a neat sketch show that variation of pressure and velocity of steam inside a velocity compounded impulse turbine. 7

Unit-II

2. (a) Write any two difference between impulse and reaction turbine. 2

(b) The following particulars refers to one stage of impulse reaction turbine : Mean diameter = 96 cm, rpm = 3000, Nozzle angle = 20°, Nozzle height = 12 cm, Blade height = 12 cm specific volume of steam at (a) nozzle outlet = 4·4 m^3/kg (b) at blade outlet = 4·8 m^3/kg, steam velocity at nozzle outlet = 275 m/s, Power developed by the blade = 265 kW. Calculate the heat drop in stage, the degree of reaction, the outlet angle of moving bade and gross stage efficiency. Assume expansion efficiency is 0·94 and carry over coefficient is 0·81. 7

(c) What is Parson's turbine, prove that $R = 0 \cdot 5$ for Parson's turbine? 7

(d) Explain the following :

(i) moving blade losses

(ii) disc friction losses

(iii) clearance losses 7

Unit-III

3. (a) What is reheat factor and state point locus? 2

(b) Superheated steam is expanded from a pressure of 20 bar to 0·1 bar in a turbine. The initial temperature of the steam is 350°C. At a pressure of 1·6 bar the steam is found to be just dry and saturated and at 0·1 bar it is 10% wet. Sketch the T-S the h-s diagram and calculate :

(i) The total enthalpy drop with isentropic expansion between the initial state and final pressure.

(ii) The actual enthalpy drop.

(iii) The % increase in volume of steam at the exhaust due to losses. 7

(c) An impulse turbine installation consisting of H. P., I. P., and L. P. turbine, is required to work with intitial steam condition of 17 bar with 120°C of superheat and a condenser pressure of 0.07 bar. Allowing a reheat factor of 1.05 and a loss of available heat of 6 kJ/kg steam. Determine the heat units to be allocated to each turbine in order that the H. P. and I. P. may each developed ¼ of the total power. Assume stage efficiency of 0·77, 0·75 and 0·72 in the H. P., I. P. and L. P. respectively. 7

(d) Explain Bypass governing with the help of neat sketch. 7

Unit-IV

4. (a) What is Regenerator and its effectiveness? 2

(b) Obtain the thermal efficiency in terms of pressure ratio for ideal Brayton cycle. 7

(c) A gas turbine draws air at 1 bar and 15°C there are two pressure stages with perfect intercooling and the total pressure is 25 : 1. The maximum temperature of the cycle is 1300°C as there is one turbine for expansion. A regenerator is used and recovers 70% of the avilable heat. Determine the efficiency of plant and the rato of the useful work to turbine work. The efficiency of turbine and compressor may be taken as 0·87 and 0·86 respectively. Assume mechanical efficiency of whole assembly equal to 0·96 and generator efficiency as 0·98. 7

(d) A gas turbine draws air at 15°C and pressure ratio is 14. The maximum temperature of the cycle is

1300 °C as there are two turbine stage for expansion such that expansion work is maximum. The air is first heated in heat exchanger which is 75% efficient and then in the combustion chamber. The air is reheated to 1300°C after the high-pressure stage. Determine the efficiency of plant. The efficiency of turbine and compressor may be taken as 0·86 and 0·85 respectively. Assume mechanical efficiency for turbine and compressor each and generator efficiency equal to 0·99 each. 7

Unit-V

5. (a) Show pressure rise in a centrifugal compressor in T-S diagram. 2

(b) The following data relate to a radial bladed centrifugal compressor-outer diameter of impleller = 50 cm, tip diameter of eye = 28 cm, Hub diameter of eye = 14 cm, speed = 16000 rpm Mass flow rate = 10 kg/s, Ambient condition = 1·15 bar and 10°C, Isentropic efficiency of compressor = 0·75. For zero prewhirl at entry. Determine the total

pressure ratio development and the power required to drive the compressor. 7

(c) Explain with diagram surging, choking and stalling. 7

(d) In 18 stage axial flow compressor, the overall compressor pressure ratio achieved is 15 : 1 with an overall isentropic efficiency of 90%. The temprature and pressure at inlet are 20° C and 1 bar. The work is equally divided between the stages. the mean blade velocity is 175 m/s and 50% reaction design is used. The axial velocity through the compressor is constant and equal to 100 m/s Calculate the power required and blade angles for mass flow rate of 300 kg/s. 7