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B. E. (Sixth Semester) Examination, 2020

(Old Scheme)

(Mech. Engg.)

TURBO MACHINERY

Time Allowed : Three hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : *Attempt all questions. Part (a) of each question is compulsory and attempt any* ***two*** *parts from (b), (c) and (d). All questions carry equal marks. Use of Steam table is to be permitted.*

Unit-I

1. (a) Differentiate Impulse and Impulse reaction turbine? 2

   (b) What is the need of compounding in impulse turbine? Explain velocity compounded impulse turbine with neat sketch. 7

(c) The isentropic heat drop in given stage of a multi stage impulse turbine is 33.5 kJ/kg of steam. The nozzle outlet angle is 20°. The efficiency of the nozzle is 92%. The mean diameter of the blade is 95.5 cm and the revolution per minute is 3000. The carry over factor is 0.88. Blades are equiangular with a velocity coefficient of 0.87. Calculate steam velocity at the outlet of the nozzles, blade and gross stage efficiency. 7

(d) Steam issues from the nozzles of a de Laval turbine with a velocity of 1200 m/s. The nozzle angle is 20°, the mean blade velocity is 400 m/s, and the inlet and outlet angle of blade are equal. The mass of steam flowing through turbine per hour is 900 kg. Calculate : 7

(i) the blade angles,

(ii) the relative velocity of steam entering the blades,

(iii) the tangential thrust on the blades,

(iv) the power developed,

(v) the blade efficiency.

Assume that K = 0·8.

Unit-II

2. (a) Define degree of reaction. 2

(b) List various losses in steam turbine? Explain any three of them. 7

(c) For a 50% reaction turbine, derive an expression for maximum blade efficiency. 7

(d) The following particulars refer to a stage of an impulse reaction turbine :

outlet angle of fixed blades = 20°, Outlet angle of moving blades = 30°, Radial height of fixed blades = 10 cm, Radial height of moving blades = 10 cm, mean blade velocity = 138 m/s, Ratio of blade speed to steam speed = 0·625, specific volume of steam at fixed blade outlet = 1·235 m^3/kg, specific volume of steam of moving blade outlet = 1·305 m^3/kg. Calculate the degree of reaction, the adiabatic heat drop in pair of blade rings and the gross stage efficiency, given the following coefficients which may be assumed to be the same in both fixed and moving blades : 7

$\eta_n = 0{\cdot}90,\ \phi = 0{\cdot}86.$

Unit-III

3. (a) Define Reheat factor. 2

(b) Explain Nozzle control Governing with neat sketch. 7

(c) Define internal efficiency, Stage efficiency and Reheat factor, Derive the relationship between them. 7

(d) An impulse turbine installation, consisting of H.P., I.P. and L.P. turbines, is required to work with initial steam conditions 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 develop 1/4 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

Unit-IV

4. (a) Draw P-V and T-S diagram of Brayton Cycle. 2

(b) Derive an expression for optimum pressure ratio for maximum cycle thermal efficiency. 7

(c) How Actual Brayton cycle differs from Ideal cycle. Explain with T-S diagram. 7

(d) In a gas turbine plant, the air at 10°C and 1 bar is compressed to 12 bar with compressor efficiency of 80%. The air is heated in the regenerator and the combustion chamber till its temperature is raised to

1400°C, and during the process the pressure falls by 0·2 bar. The air then expanded in the turbine and passes to regenerator which has 75% effectiveness, and causes a pressure drop of 0.2 bar. If the isentropic efficiency of the turbine is 85%. Determine the thermal efficiency of the plant. 7

Unit-V

5. (a) Define Euler's work? 2

(b) Differentiate Centrifugal and Axial flow compressor. 7

(c) Explain surging, choking and stalling phenomenon in compressor. 7

(d) An axial flow compressor is required to deliver air at the rate of 50 kg/s and provide a total pressure ratio of 5:1, the inlet stagnation conditon being 288 K and 1 bar. The isentropic efficiency is 86%. The compressor shall have 10 stages with equal rise in total temperature in each stage. The axial velocity of flow is 150 m/s and the blade speed is kept at 200 m/s to minimize noise generation. The stage degree of reaction at mean blade height is 50%. Assuming work done factor as 0·86, Calculate all

the fluid angles of the first stage. Also calculate the tip and hub diameter if hub-diameter ratio is 0·8. Determine the speed in rpm. 7