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12MTP22

Second Semester M.Tech. Degree Examination, Dec. 2013 / Jan 2014.
Steam and Gas Turbines

Time: 3 hrs. Max. Marks:100

Note: ***Answer any FIVE full questions.***

1 a. Define and obtain expression for Nozzle efficiency and diffuser efficiency. **(12 Marks)**

b. Steam is expanded in a set of nozzles from 10 bar 200°C to 5 bar. Is the nozzle convergent or convergent – divergent? Neglecting the initial velocity, find the minimum area of the nozzles to flow 3kg/s of steam under given conditions. Assume the expansion of steam is isentropic. **(08 Marks)**

2 a. Obtain expression for mass rate of flow through a nozzle and critical pressure ratio. **(10 Marks)**

b. Calculate the throat and exit area of a convergent divergent nozzle which will discharge 800kg of steam per hour from a pressure of 8 bar superheated to 220°C into chamber having a pressure of 1.05bar. Friction loss in diverging part of the nozzle may be taken as 15% of the total enthalpy drop. **(10 Marks)**

3 a. Obtain an expression for the blade efficiency and optimum blade speed ratio in the case of a single stage impulse turbine. **(10 Marks)**

b. The mean diameter of blades of an impulse turbine with a single row wheel is 1m and speed is 3000 rpm. The nozzle angle is 18°, the ratio of blade speed to steam speed 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 is 8kg/s. Draw the velocity diagram for the blades and determine the following :
i) Blading efficiency ii) Power developed by the blades iii) Resultant thrust on the blades. **(10 Marks)**

4 a. What is degree of reaction? Explain. Obtain an expression for maximum blade efficiency in the case of Parson's Turbine. **(10 Marks)**

b. Steam flows into the nozzles of a turbine stage from the blades of the preceding stage with a velocity of 100m/s and issues from the nozzles with a velocity of 325 m/s at an angle of 20° to the wheel plane. Calculate the gross stage efficiency for the following data ;
Mean blade velocity = 180m/s ; Expansion efficiency for nozzle and blades = 0.9 ;
Carry over factors for nozzle and blades = 0.75 ; Blade outlet angle = 28°. **(10 Marks)**

5 a. What is reheat factor and why is it greater than unity. On what factors does the reheat factors depend? Show that

$$\frac{RF_{z-1}}{RF_{\infty-1}} = \frac{z-1}{z}.$$ **(12 Marks)**

b. Steam issues from the nozzle at an angle of 18° to the direction of wheel and impinges on the blades with a velocity of 480m/s. The blade velocity is 200m/s. If the velocity coefficient for the blade is 0.84, find the blade friction loss. **(08 Marks)**

6 a. For an axial flow compressor derive an expression for stage pressure ratio as given by

$$\frac{P_{o3}}{P_{o1}} = \left[1 + \frac{\eta_s \Delta(T_{os})}{To_1}\right]^{(\gamma/\gamma-1)}.$$ **(12 Marks)**

b. Explain in detail the factors affecting stage pressure ratio. **(08 Marks)**

7 a. Sketch and explain the following : i) Simple gas turbine cycle ii) Turbo fan engine. **(08 Marks)**

b. Air enters a turbo jet engine at a rate of 12×10^4 kg/h at 15^0C and 1.03 bar and is compressed adiabatically to 182^0C and four times the pressure. Products of combustion enter the turbine at 815^0C and leave it at 650^0C to enter the nozzle. Calculate the isentropic efficiency of the compressor, the power required to drive the compressor , the exit speed of the gases and thrust developed when flying at 800km/h. Assume the isentropic efficiency of turbine is same as that of compressor and the nozzle efficiency 90%. **(12 Marks)**

8 Write short notes on :

a. Ramjet engine.
b. Principle of Rocket Propulsion.
c. Impulse and Reaction turbines.
d. Pressure compounding of steam turbines. **(20 Marks)**

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