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12MTP22

Second Semester M.Tech. Degree Examination, June/July 2013
Steam and Gas Turbines

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Thermodynamic data hand book if permitted.

1 a. Derive an expression for isentropic flow through a passage of varying cross sectional area. **(08 Marks)**

b. Explain the phenomenon of super saturation using h – s diagram. **(04 Marks)**

c. The nozzles of a certain turbine have a throat diameter of 0.6 cm each. The power developed by the turbine is 150 kW and steam consumption is about 9.5 kwh. The upstream pressure is 14 bar and temperature is 300°C. The back pressure is 0.05 bar. Assuming that the flow is isentropic between entrance and exit, find the number of nozzles and the steam consumption based on these conditions. Neglect the velocity of approach. If 12% of the isentropic heat drop is wasted between throat and exit find the exit diameter? **(08 Marks)**

2 a. What is compounding? What are the different types of compounding? Explain with a neat sketch pressure velocity compounding. **(10 Marks)**

b. In a Curtis stage with two rows of moving blades, the rotors are equiangular. The first rotor has angle of 29° each while second rotor has angle of 32° each. The velocity of steam at the exit of nozzle is 530 m/sec and the blade co-efficient are 0.9 in the first, 0.95 in the stator and in the second rotor. If the absolute velocity at the stage exit should be axial, find :
i) mean blade speed ii) the rotor efficiency iii) the power out put for a flow rate of 32 kg/sec.(Assume U = 3 cm) **(10 Marks)**

3 a. Derive an expression for gross stage efficiency of a parson's reaction turbine. **(10 Marks)**

b. A person's turbine develops 1140 KW at 400 rpm and consumes 7.89 kg of steam per kwh. Steam is supplied at 11 bar and 260°C and the isentropic efficiency of expansion is 85%. The blade angles are 35° and 20° at inlet and outlet tips respectively. Find the drum diameter and the blade height at a stage where the pressure is 1.4 bar. A height of drum diameter ratio of 1/12 is recommended. Find the power developed at that sage. (Assume U = 3 cm). **(10 Marks)**

4 a. Define stage efficiency? Explain the design procedure for single stage impulse turbine. **(08 Marks)**

b. A turbine is supplied with steam at 35 bar and a temperature of 435° C. It is expanded in four stage to the condenser pressure of 0.04 bar. The pressure at the end of stages are F_2, 1.2 and 0.25 bar respectively. Loss due to friction on through out the expansion is 24%. Determine : i) The isentropic enthalphy drop in each stage ii) The enthalphy drop for the turbine if friction is neglected iii) The work done in kJ/kg of flow neglecting all losses iv) The steam flow required to obtain one kwh of work from the turbine. **(12 Marks)**

5 a. What is work done factor in an axial flow compressor? Explain this briefly with suitable sketches. **(08 Marks)**

b. Explain the phenomenon of surging in centrifugal compressors. **(04 Marks)**

c. A centrifugal compressor rotor has inlet radius of 30 cm and exit radius of 60 cm. Entry is radial with a component of 60 m/sec which is constant through out. The compressor requires 700 KW of power to handle 20 kg of air per second. Find the blade angles at inlet and outlet if the compressor runs at 5100 rpm. Calculate the width an inlet and outlet if specific volumes at inlet and outlet are respectively 0.85 m^3/kg and 0.71 m^3/kg. **(08 Marks)**

6 a. Obtain an expression for the specific work output of a gas turbine unit, in terms of pressure ratio (r_p). Isentropic efficiency of the turbine (η_c). Isentropic efficiency of the compressor (η_c) and maximum and minimum temperatures of the cycle. Hence show that pressure ratio for the maximum power is given by

$$r_p = \left(\eta_c \eta_T \frac{T_3}{T_1}\right)^{\frac{\gamma}{2(\gamma-1)}}.$$ **(10 Marks)**

b. A gas turbine cycle takes air at 1 bar and 15°C. There are two stages of compression with perfect inter cooling in between total pressure ratio is 8 and the maximum temperature of the cycle is 800°C. A regenerator is used which recovers 70% of heat efficiency of the compressors. The turbine are 0.83 each and 0.86 respectively. Determine the thermal efficiency and the air rate? **(10 Marks)**

7 a. Explain the following :

i) Effect of chord on aspect ratio (h/c)

ii) Effect of pitch on the blade root fixing. **(10 Marks)**

b. Explain the limiting factors in turbine design. **(10 Marks)**

8 a. With a neat sketch , explain the working of Ramjet engine. **(10 Marks)**

b. Write a short notes on :

i) Nuclear propulsion

ii) Plasma rocket propulsion. **(10 Marks)**

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