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14MTP22

Second Semester M.Tech. Degree Examination, June/July 2015
Steam and Gas Turbine

Time: 3 hrs. Max. Marks:100

Note: *1. Answer any FIVE full questions.*
2. Use of thermodynamic data hand book, Mollier chart, steam table permitted.

1 a. Obtain an expression for the critical pressure ratio and the mass flow rate of steam through nozzle. **(06 Marks)**

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

c. Calculate the throat and exit dimeters of a convergent divergent nozzle, which will discharge 820 kg of steam per hour from a pressure of 8 bar superheated to 220°C into a chamber having a pressure of 1.05 bar. Friction loss in the divergent part of the nozzle may be taken as 0.15 of the total isentropic enthalpy drop. **(10 Marks)**

2 a. Obtain an expression for maximum blade efficiency in a single stage inpulse turbine. **(10 Marks)**

b. Draw the velocity diagram for a stage in impulse turbine with two rings of moving blades for the following particulars. Nozzle angle = 15°, moving blade tip discharge angle = 30°, Fixed blade discharge angle = 20°, Final discharge is axial. Friction loss per blade is 10% of relative velocity. It occurs both on the fixed and moving blades. Find the blade velocity for nozzle steam exit velocity of 500 m/s and the diagram efficiency of the stage. **(10 Marks)**

3 a. Show that for a parson turbine :

$$\eta_{bmac} = \frac{2\cos^2 \alpha_1}{1+\cos^2 \alpha_1}.$$ **(10 Marks)**

b. Steam flows into the nozzles of a impulse reaction turbine stage from the blades of the preceding stage with velocity of 100 m/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 = 180 m/s, expansion efficiency for nozzle and blade = 0.9 carry over coefficient for nozzles and blades = 0.9. degree of reaction = 0.26 blade outlet angle = 28°.
(10 Marks)

4 a. Explain the design procedure for impulse – reaction turbines. **(10 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 5, 1.2 and 0.25 bar respectively. Loss due to friction throughout the expansion is 24%. Determine :
i) The isentroic enthalpy drop in each stage
ii) The enthalpy drop for the turbine if friction is neglected
iii) The work done in kJ/per kg of flow neglecting all losses other than the one stated above
iv) The steam flow required to obtain one kwh of work from the turbine. **(10 Marks)**

5 a. Explain the phenomenon of surging in centrifugal compressor, Stalling in axial flow compressor. **(08 Marks)**

b. A centrifugal compressor running at 9000 rpm delivers 6000 m^3/min of free air. The air is compressed from 1 bar and 20°C to a pressure ratio of 4 with an isentropic efficiency of 0.82. Blades are radial at outlet of impeller and the flow velocity of 62 m/s may be assumed throughout constant. The outer radius of impeller is twice the inner and the slip factor may be assumed as 0.9. The blade area coefficient of 0.9 may be assumed at inlet. Calculate the following :

i) Final temperature of air
ii) Theoretical power
iii) Impeller diameters at inlet and outlet
iv) Breadth of impeller at inlet
v) Impeller blade angle at inlet
vi) Diffuser blade angle at inlet. **(12 Marks)**

6 a. Sketch and explain the following :

i) Simple Rankine cycle with reheating
ii) Turboprop engine. **(10 Marks)**

b. A gas turbine power plant works between 290 k and 1200 k with a compression ratio of 9. Find out :

i) the power developed by the plant if the air flow rate is 12.8 kg/s and the thermal efficiency
ii) it is decided to increase the maximum output by rehearing to its original temperature. Find out the % increase in power output and % change in thermal efficiency
iii) find out the amount of heat added in the reheater per minute. **(10 Marks)**

7 a. A jet propulsive system is flying with a speed of 800 km/hr. The mass of air used is 40 kg/s. The gases coming out of turbine at 800 k and 1.5 bar are passed through the nozzle where it expands to 0.75 bar with nozzle efficiency of 0.95. A : F = 80 : 1. Neglecting the fuel mass, determine the thrust power developed by the system and its propulsion efficiency. **(10 Marks)**

b. Explain with a neat sketch, solid core nuclear heated hydrogen rocket. **(10 Marks)**

8 Write short note on the following :

a. Ram jet engine
b. Plasma rocket propulsion
c. Compressor characteristics
d. Co gas cycles. **(20 Marks)**

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