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توربين 2 غازي

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Final Term Examination
Academic Year: 2013-2014

Minufiya University

Year: 4th
Department: Mechanical Power Eng.
Subject: Steam and Gas Turbines (MPE 413)
Time Allowed: 3 Hours
Date: 6 /1/2014
Total Mark: (90 mark)

Answer 4 Only From The Following Questions

1-a) Explain why is partial admission of working gas/steam employed in some applications. Describe briefly the various losses which occur due to partial admission in axial turbine stages.

b) Define the degree of reaction of a turbine stage and Prove: $R = \frac{c_a}{2u}(\tan\beta_3 - \tan\beta_2)$.

c) In a reaction stage of a steam turbine, the blade angles for the stators and rotors of each stage are: $\alpha_2 = 25^0$, $\beta_2 = 60^0$ and $\alpha_3 = 70^0$, $\beta_3 = 32^0$. If the blade velocity is 300 m/s, and the steam flow rate is 5 kg/s, find:

i – The power developed, ii – Degree of reaction, and iii – The axial thrust.

(22.5 Mark)

2- a) Explain the reasons for causing secondary and profile losses in turbine blade rows. What are the suggested methods to eliminate the secondary loss? How can the secondary loss be estimated in laboratory. Show the effect of blade height on the secondary loss.

b) For single stage impulse turbine prove that for maximum blade efficiency: $W_{max} = 2U^2$ and $\eta_{b\,max} = \sin^2\alpha_2$. Draw velocity triangles for a single impulse stage with maximum blade efficiency.

c) The steam velocity leaving the nozzle is 590 m/s and the nozzle angle is 20^0. The blade is running at 2800 rpm and blade diameter is 1050 mm. The axial velocity at rotor outlet 155 m/s, and the blades are symmetrical. Calculate:

1- The work done, 2-The blade efficiency, 3- The blade velocity coefficient, 4- Maximum work, and 5- The maximum blade efficiency. (22.5 Mark)

3- a) Explain why the impulse turbine need to be compounded .With the aid of sketch draw the variation of pressure and velocity through a two-stage pressure-compounded impulse turbine.

b) Discuss the variation of blade and stage efficiency with speed ratio for turbine stages.

c) The following data for a two- row velocity compounded impulse turbine stage:

Isentropic heat drop in the nozzles	260 kJ/kg
Ratio of blade speed to steam speed	0.24
Nozzle angle	16^0
Exit blade angle of first row	β_1 - 2
Exit angle of guide blade	α_2 - 6
Exit angle of second row of moving blades	β_3 - 16

Coefficient of velocities $k_n = 0.95$, $k_{b1} = 0.855$, $k_g = 0.877$, $k_{b2} = 0.923$

Mass flow rate of steam	50 kg/s.

Determine: 1- The stage efficiency, 2- Power developed, 3- Maximum blade efficiency, 4- Total axial thrust and 5- Optimum speed ratio. (22.5 Mark)

4-a) With sketch draw the gas turbine plant with reheat, exhaust heat exchanger and intercooler. Show the effect of them on the plant work and thermal efficiency.

b) In a simple constant pressure gas turbine with maximum to minimum temperature ratio β and turbine and compressor efficiencies of η_t and η_c respectively, prove that:

- Maximum specific work output $= \frac{C_p T_1}{\eta_c}\left(\sqrt{\beta\eta_c\eta_t}-1\right)^2$

- The thermal efficiency fort maximum power output is:

$$\frac{(\sqrt{\beta\eta_c\eta_t}-1)^2}{(\beta-1)\eta_c-(\sqrt{\beta\eta_c\eta_t}-1)}$$

c) In a constant pressure cycle gas turbine plants the maximum and minimum temperatures are 950°c and 50°c respectively. If the compressor and turbine efficiencies are 0.82 and 0.87, determine for maximum power output:
1-Pressure ratio of the turbine and compressor, 2-The maximum power output per unit flow rate, 3-The thermal efficiency of the plant. Assume for both compressor and turbine $\gamma = 1.4$ and C_p=1.005 kJ/kg.k. (22.5 Mark)

5- a)Describe with the aid of illustrative sketch the working of Nuclear aircraft engine.

b) Explain the importance of turbine and propelling nozzle in turbofan, turbo-propeller and turbojet engine.

c) Draw the actual performance characteristics of an axial compressor. What is surging and rotating stall, what are its effects in axial-flow compressor.

d) An axial flow compressor has a tip diameter of 0.95 m and a hub diameter of 0.85 m. The absolute velocity of air makes an angle of 28° measured from the axial direction and relative velocity angle is 56°. The absolute velocity outlet angle is 56° and the relative velocity outlet angle is 28°. The rotor rotates at 5000 rpm and the density of air is 1.2 kg/m³. Determine: 1. The axial velocity, 2. The mass flow rate, 3. The power required, 4. The flow angles at the hub, and 5. The degree of reaction at the hub. (22.5 Mark)

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