Menoufiya University
Faculty of Engineering
Shebin El-Kom
First Semester Examination
Academic Year: 2014-2015

Year: 4th year
Department: Mechanical Power Eng
Subject: Steam and gas turbine (MPE413)
Time Allowed: 3 hours
Date 5 / 1 /2015 Total Mark (90)

Final Term Exam

ANSWER **4** ONLY FROM THE FOLLOWING QUESTIONS

1-a) Gas turbines have special applications in a variety of industries. What are the advantages of the gas turbines in these applications?

b) Describe with the aid of illustrative sketches the working of the following:
Nuclear gas turbine plant - Nuclear aircraft engine.

c) Draw an illustrative sketch of a turbofan gas turbine engine, indicating its principal parts. Define the bypass ratio.

d) A small gas turbine plant has an output of 1 MW at a maximum - to- minimum temperature ratio of (5) and a pressure ratio of (25). The overall compressor and turbine efficiencies are 82% and 85% respectively. The compressor draws air at 300 K, the properties of the gas may be assumed to be the same at that of air. Determine the following: The mass flow through the turbine, 2- The thermal efficiency of the plant. Repeat the problem for an ideal reheat cycle with optimum reheat pressure.
(22.5 mark)

2- a) Draw the static pressure distribution around a turbine blade and variation of losses along the blade height.

b) Explain why the partial admission configuration employed for an impulse stage. Describe briefly the various losses which occur due to partial admission in axial turbine stages.

c) Discuss the importance of multi- stage pressure – compound impulse. Draw the variation of pressure and velocity through a two -stage pressure – compound impulse.

d) The nozzles of a single stage impulse turbine are inclined at an angle of 20^0 with absolute velocity of 700 m/s. The axial force is 250 N for a mass flow rate 5 kg/s. If the absolute velocity at exit from stage is 250 m/s and the power developed is 740 Kw. Find: 1- The angular velocity, 2- The blade velocity coefficient, 3- The blade efficiency, 4- The blade inlet and exit angle, 5- Maximum blade efficiency, and 6- Speed ratio.
(22.5 mark)

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

b) Explain briefly how a gas turbine power plant is combined with a conventional steam plant. What are the advantages of such a scheme?

c) With sketch explain the energy flow diagram for the reaction stage of an axial turbine.

d) In a two row velocity compound impulse turbine have a mean blade speed of 110 m/s. The steam velocity leaving the nozzle 600 m/s. Nozzle angle 18^0. The discharge

angles of the three rows of blades are 22^0, 28^0 and 45^0. Assuming the friction loss of velocity 15% in each row of blades. Find:

i) The work done/ kg. ii) Diagram efficiency.

iii) Maximum diagram efficiency. iv) Total axial thrust. (22.5 Mark)

4- a) What are the differences between open and closed circuit gas turbine plants?

b) Compare graphically the propulsive efficiencies of turbo-prop, turbojet and turbofan at various flight speeds. Show why the turbofan efficiency higher than turbojet.

c) With the aid of sketch draw gas turbine plant with intercooling, reheating, and exhaust heat exchanger. Explain the effect of them on the specific work output and the plant efficiency.

d) A reaction turbine has 50% degree of reaction delivers dry saturated steam at 3 bar. The velocity of steam is 200 m/s at exit. The mean blade height is 4 cm and the exit angle of the moving blade is 70^0 measured from axial direction. At the mean radius the axial velocity equals 3/4 blade speed for a steam flow rate of 1000 kg/hr. Calculate:
1- The rotor speed in rpm, 2- The power output of stage, 3- The diagram efficiency, 4- The percentage increase in relative velocity in the moving blades due to expansion in these blades, and 5- The enthalpy drop of the steam in this stage. (22.5 Mark)

5-a) Define the following for an axial compressor: Work-done factor - stall – surge.

b) Define the degree of reaction of a compressor stage.
Prove that: $R = 1/2(c_x/u)(\tan\beta_1 + \tan\beta_2)$

c) Discuss the main advantages and disadvantages of supersonic stages in axial compressor.

d) An axial compressor stage has the following data: Temperature and pressure at entry 314 K and 1 bar. The air angles are $\beta_1 = 51^0$, $\beta_2 = 9^0$, $\alpha_1 = \alpha_3 = 7^0$. The mean diameter 50 cm and the peripheral speed 100 m/s. Mass flow rate through the stage is 25 k[illegible], the work-done factor 0.95, stage efficiency 88% and mechanical efficiency 92%. Determine: 1- Air angle at the stator entry, 2- Blade height at entry and the hub-tip diameter ratio, 3- The power required to drive the compressor, 4- The loading coefficien and 5- The pressure ratio developed by the stage. (22.5 Mark)

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