Minoufiya University
Faculty of Engineering
Mechanical Power Eng. Dept
Academic Year: *2014-2015*
Date: 14-6-2015

Minufiya University

Subject: *Gas Turbines*
Code: *MPE 519*
Academic level: Diploma.
Time allowed: *3 hours*
Total degree : *100 marks*

Answer all the following questions: ***Resources: Steam Tables and Chart***

Question-1

[50 marks]

a- Explain using a diagrammatic sketch the components of intercooled reheat gas turbine. Discuss with the aid of a heat balance graph what takes place when a gas turbine is intercooled and then regenerated. [10 marks]

b) In a gas turbine plant, the ratio of maximum to minimum cycle temperatures is fixed. Two arrangement of components are to be investigated: i) single-stage compression followed by expansion in two turbines of equal pressure ratios, with reheat at inlet to the second stage of the expansion to the maximum cycle temperature, ii) compression in two compressors of equal pressure ratios, with intercooling to the minimum cycle temperature at inlet to the second compression stage, followed by single stage expansion.

If the isentropic efficiencies of compressors and turbines are respectively η_c and η_t , show that the optimum specific output is obtained at the same overall pressure ratio for each arrangement. Neglect the weight of fuel burned and assume that the working fluid is the same throughout. If η_c is 0.85 and η_t 0.9 and the ratio of maximum and minimum cycle temperatures is 3.5, determine the above pressure ratio for the optimum specific output and show that with the arrangement (i) the optimum output exceeds that of arrangement (ii) by about 11.3%. [40 marks]

Question-2

[50 marks]

a- Prove that of the axial compressor, the stage load coefficient (ψ) can be determined from the following equation:

$\Psi = 1 - \Phi\,[tan(\alpha_1) - tan(\beta_2)]$ where Φ is the flow coefficient. [6 marks]

b- Explain with sketching the effect of increasing the axial velocity on stator deflection and stator eflection. Also, their effects on the compresser performance. [6 marks]

c- Compressor surge is a complex phenomenon and problem of the compressor blades due to high positive incidence. Discuss with detials this phenomenon. Also, show the the effect of mass flow on the pressure ratio during surge unstable and stable operation of the compressor. [8 marks]

d- Air at 1 bar pressure and 25 °C temperature is compressed inside the stage of axial compressor. If the air inlet to the stage with the stagnation temperature equals 390 K and the inlet flow angle is 16°. The compressed air leaves the stage at the following conditions: the flow exit angle is 30° and the air temperature at exit is 70 °C (exit temperature). The compressor shaft velocity is 3000 rpm and the compressor efficiency is 0.9. The mean diameter of the stage is 1.4 m. The exit rotor blade angle (β_2) is 25°.

Draw the velocity triangles of the stage and find out the following:

i- The inlet flow velocity,

ii- The degree of reaction of this stage.

iii- The compressor work done.

iiii- The pressure ratio of the stage.

v- The work done factor. [30 marks]

With best wishes
Prof. Nabil Hanfy and Dr. Ashraf Amin