Minoufiya University
Faculty of Engineering
Mechanical Power Eng. Dept
Academic Year: *2013-2014*
Date: 12/6/2014

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 [40 marks]

a- What are the specification must be considered during residual oils burning in gas turbine in order to achieve successful combustion. [6 marks]

b) An open cycle gas turbine is supplied with 9.07 kg of air par second at a temperature and pressure of 15.6 °C and 1 bar respectively. The air is compressed with an isentropic efficiency of 0.82 to a pressure of 4 bar. Gases temperature after combustion is 648.9 °C. Expansion to a pressure of 1 bar takes place through two stages of equal pressure ratios with interstage reheat to 648.9 °C. The isentropic efficiency of both turbines is 0.85. The exhaust gases from the low pressure turbine stage now pass to a heat exchanger which transfers heat from gases to air leaves the compressor. 75% of the heat available between turbine exit and compressor exit is transferred to the compressed air. Assuming the working fluid throughout to be air of constant specific heat and neglecting pressure losses, *estimate* the plant output in kW units together with its thermal efficiency. [34 marks]

Question-2 [40 marks]

a- Mention with sketch the difference between turbine stage and compressor stage based on velocity triangles. [6 marks]

b- Prove that of an axial flow compressor stage the energy transferred by the compressor blades is given by the following relation:

$$E = U\, C_a\, (\tan\alpha_1 - \tan\alpha_2)/g$$ [8 marks]

b- Air at 100 kPa pressure and 27 °C temperature is compressed inside the stage of axial compressor. If the air inlet to the stage with the stagnation temperature equals 380 K and the inlet flow angle is 18°. The compressed air leaves the stage at the following conditions: the flow exit angle is 30° and the air temperature at

exit is 67 °C (exit temperature). The compressor shaft velocity is 50 rps and the compressor efficiency is 0.92. The mean diameter of the stage is 1.6 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.

[26 marks]

Question-3

[20 marks]

a) Explain using a diagrammatic sketch the components of gas turbine combustor. Discuss with the aid of a diagrammatic sketch the air flow paths of such a gas turbine combustor.

b- Show with the aid of sketch the change of enthalpy and the stagnation pressures along the axial compressor stage.

c – Discuss the effect of humid air on the gas turbine performance and draw the variation of air humidity with the heat rate and the output power.

d - Mention the factors affecting gas turbine performance and some modification to decrease the effect of these factors.

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