University of Technology
Mechanical Engineering Department
Final Exam.Semester II2015/2016

Subject: Thermodynamic II
Division: Power Plants Eng.
Examiner: Dr. Falah Al-Jaberee

Year: First year
Exam Time: 3 hrs.
Date: 7 /6 / 2016

Note: Answer **four** questions only

Take: R_o=8.134kJ/kg K, For air c_p=1.005kJ/kg K & γ=1.4
M_C =12kg/kmol, M_{O2} =32kg/kmol, M_{N2} =28kg/kmol

Q.1) (17.5 marks)
The gas in an engine cylinder has a volumetric analysis of 12% CO_2, 11.5% O_2, and 76.5% N_2. The temperature at the beginning of expansion is 1000°C and the gas mixture expands reversibly through a volume ratio of 1:7, according to the law $PV^{1.25}$ = constant. Calculate:

a-The mixture molecular mass and gas constant.
b- The work done and the heat flow per kg of the gas.

Take: C_p for CO_2=1.235 kJ/kg K, C_p for O_2=1.088 kJ/kg K, C_p for N_2=1.172 kJ/kg K.

Q.2) (17.5 marks)
A- A heat pump working on reversed Carnot cycle having 1kg of carbon dioxide(CO_2) (C_p=1.235kJ/kg K & γ=1.35) in a piston/cylinder arrangement. This heat pump operates between reservoirs at 300Kand 400K. At the beginning of the low-temperature heat addition, the pressure is 1MPa. During this process the volume triples. Draw the cycle on P-V & T-S diag. and analyze each of the four processes in the cycle and determine:-

I. The pressure, volume, and temperature at each point.
II. The work and heat transfer for each process.

B- Drive an expression of entropy change during isothermal process.

Q.3) (17.5 marks)
A- Air enters a gas turbine at 1600K and exits at 100kPa, 830K.The turbine efficiency is estimated to be 85%. What is the turbine inlet pressure?
B- 0.01Kg of air at 1bar and 25°C receives heat at constant volume until its pressure doubled, its then receives heat at constant pressure until its volume doubled. Determine the change of entropy during each process and the final air temperature.

Q.4) (17.5 marks)
A- What are the sources of irreversibility? Give one example of reversible process.
B- Air enters a compressor at 1bar and 15°C,it's compressed to 150kPa. The compressor isentropic efficiency is 70%. What is the required work input per kilogram of air? What is the exit temperature?

Q.5) (17.5 marks)
A-Define the nozzle isentropic efficiency and deriver an expression in term of fluid velocities.
B- A mixture of 1kmol of CO_2 and 4kmol of air (21% O_2 ,79% N_2 by volume), the mixture at 1atm and 27°C. Calculate:

a- The mass of each constitute.
b- The relative mixture molecular mass.
c- The density of the mixture.
d- The percentage carbon content by mass.

(GOOD LUCK)