

Code Number :.....

THERMODYNAMICS QUALIFYING EXAM

August 2006

OPEN BOOK (only one book allowed) & CLOSED NOTES

Answer all four questions

All questions have equal weight

TIME: 3.0 hrs

Prepared by Hyungson "David" Ki & A. Engeda

-
- Take any required property from your book, approximate values if necessary.
 - If you make any assumption to reach a solution state it clearly
-

Question # 1

A tank having a volume of 0.85 m^3 initially contains water as a two-phase liquid-vapor mixture at 260°C and a quality of 0.7 . Saturated water vapor at 260°C is slowly withdrawn through a pressure-regulating valve at the top of the tank as energy is transferred by heat to maintain the pressure constant in the tank. This continues until the tank is filled with saturated vapor at 260°C . Determine the amount of heat transfer. Neglect all kinetic and potential energy effects.

Question # 2

Air enters an insulated diffuser operating at steady state at 1 bar, -3°C , and 260 m/s and exits with a velocity of 130 m/s. Employing the ideal gas model and ignoring potential energy, determine (a) the temperature of the air at the exit and (b) the maximum attainable exit pressure.

Question # 3

A reversible cycle is performed by a piston–cylinder device using steam.

State Change 1-2: Steam initially at 400 kPa and 400°C with a volume of 0.3 m³ is expanded isothermally to 200 kPa,

State Change 2-3: next, the steam is compressed adiabatically to the initial pressure,

State Change 3-1: finally, the steam is compressed at constant pressure to the initial state.

- i) Sketch the process on a T-S diagram
- ii) Determine the change in entropy for each process, 1-2, 2-3 and 3-1
- iii) Determine work and heat transfer for each process, 1-2, 2-3 and 3-1.
- iv) Determine the entropy change, net work and net heat transfer for the cycle.

Question # 4

- a) Consider a simple ideal Brayton cycle operating between the temperature limits of 300 and 1500 K. Using constant specific heats at room temperature, determine the pressure ratio for which the compressor and the turbine exit temperatures of air are equal.

- b) Helium gas is throttled steadily from 500 kPa and 70°C with an entropy change of 0.25 kJ/kg .K . Determine
 - (i) the exit pressure and temperature when heat is lost from the helium in the amount of 2.5 kJ/kg
 - (ii) the exit pressure and temperature when the throttling valve is insulated