UNIVERSITY OF GHANA

FIRST SEMESTER EXAMINATIONS: 2016/2017

SCHOOL OF ENGINEERING

FAEN 205: THERMODYNAMICS (3 CREDITS)

INSTRUCTIONS: ANSWER ALL QUESTIONS

TIME ALLOWED: 1 HOUR 45 MINUTES

The Universal Gas Constants are Provided on page 2

1. Define the following and give two examples each
   a. Extensive property
   b. Intensive property
   c. State functions
   d. Process variable.
   e. Open system
   f. Closed system

20 Marks

2. One mole of a monoatomic ideal gas, in the initial state $T = 273\ K, P = 1\ atm$, is subjected to the following three processes, each of which is conducted reversibly:

   i. A doubling of its volume at constant pressure,
   ii. Then a doubling of its pressure at constant volume
   iii. Then a return to the initial state along the path $P(atm) = 6.643 \times 10^{-4}V^2 + 0.6667$. ***Note: V is in liters***

   Calculate the heat (Q) and work (W) effects which occur during each of the three processes.

   Note: $C_p = 2.5\ R$ *and* $C_V = 1.5\ R$ *where* $R = 8.314\ ^{J}/_{mol\ K}$

   Also $1\ atmL = 101.3J$ *and* $R = 0.08206\ ^{atmL}/_{mol\ K}$

30 Marks

3. Steam at 14 bar and 588.15 K enters a turbine through a 75 mm-diameter pipe with a velocity of 3 m/s. the exhaust from the turbine is carried through a 250 mm diameter pipe and is at 0.3 bar and 366.15 K.

   Calculate the power output of the turbine. Use steam tables

15 Marks

4. The van der Waal's equation of state is given as

$$P = \frac{RT}{V-b} - \frac{a}{V^2}$$

Prove that the compressibility factor at the critical temperature; $Z_C = \frac{3}{8}$

20 Marks

5. Calculate the compressibility factor (Z) and volume (V) for sulfurhexafluoride at 348.15 K and 15 bar by the truncated virial equation

$$Z = \frac{PV}{RT} = 1 + \frac{B}{V} + \frac{C}{V^2}$$

$$B = -194\ cm^3 mol^{-1}\ and\ C = 15300\ cm^6 mol^{-2}$$

15 Marks

Table A.2 Values of the Universal Gas Constant

$R = 8.314\ J\ mol^{-1}\ K^{-1} = 8.314\ m^3\ Pa\ mol^{-1}\ K^{-1}$
$= 83.14\ cm^3\ bar\ mol^{-1}\ K^{-1} = 8314\ cm^3\ kPa\ mol^{-1}\ K^{-1}$
$= 82.06\ cm^3\ atm\ mol^{-1}\ K^{-1} = 82\ 363.95\ cm^3\ torr\ mol^{-1}\ K^{-1} = 0.082\ 06\ m^3\ atm\ kmol^{-1}K^{-1}$
$= 1.9872\ (cal)\ mol^{-1}\ K^{-1} = 1.986\ (Btu)(lb\ mole)^{-1}(R)^{-1}$
$= 0.7302\ (ft)^3(atm)(lb\ mol)^{-1}(R)^{-1} = 10.73\ (ft)^3(psia)(lb\ mol)^{-1}(R)^{-1}$
$= 1545\ (ft)(lb_f)(lb\ mol)^{-1}(R)^{-1}$