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**UNIVERSITY OF TECHNOLOGY, JAMAICA**

**COLLEGE/ FACULTY: Engineering and Computing**

**SCHOOL/ DEPARTMENT: SOE/Chemical Engineering**

**Final/ Redo Examination, Semester 3**

**Module Name:** Chemical Engineering Thermodynamics 1

**Module Code:** CHE3003

**Date:**  August, 2012

**Theory/ Practical:** Theory

**Groups:** B.Eng.3C

**Duration:** 2 hours

**Instructions**

1. **ANSWER ALL QUESTIONS**
2. **EACH QUESTION MUST BEGIN ON A NEW PAGE**
3. **LEAVE TWO LINES BETWEEN PARTS OF A QUESTION**
4. **READ EACH QUESTION CAREFULLY BEFORE ANSWERING**
5. **SHOW CLEARLY ALL EQUATIONS USED FOR CALCULATIONS**
6. **THE INTENDED MARK IS INDICATED AT THE BEGINNING OF EACH QUESTION**
7. **ANSWER MUST BE NUMBERED IDENTICAL TO THE QUESTION BEING ANSWERED**
8. **A FORMULA SHEET AND UNIT CONVERSION CHART ARE ATTACHED.**

**DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO**

**QUESTION 1 (25 marks)**

1. A Carnot engine receives 1250 kW of heat from a heat-source reservoir at 525°C and rejects heat to a heat-sink reservoir at 50°C. Determine the power developed and heat rejected? **[8]**
2. An ideal gas with constant heat capacities undergoes a change of state from conditions 50°C and 1.5 bar to conditions 170°C and 8 bar. If the ratio of Cv/R = 3/2, determine ∆ and ∆ **[8]**
3. An inventor claims to have devised a cyclic engine which exchanges heat with reservoirs at 30°C and 300°C, and which produces 0.45 kJ of work for each kJ of heat extracted from the hot reservoir. Is the claim believable? Why? **[9]**

**QUESTION 2 (25 marks)**

One mole of an ideal gas, initially at 323.15 K and 150 kPa, undergoes the following cyclic processes in a closed system. It is first compressed adiabatically to 550 kPa, then cooled at constant pressure to 323.15 K, and finally expanded isothermally to its original state. If each step is mechanically irreversible with an efficiency of 55% compared with the corresponding mechanically reversible process, calculate Q, W, ∆U, and ∆H for each step of the process and for the cycle. Take Cp = (5/2)R and Cv = (3/2)R.

**QUESTION 3 (25 marks)**

Determine Z and for steam at 523.15 K and 2.0 MPa by the following:

1. The truncated virial equation, with a value of B from the generalized Pitzer correlation. **[18]**
2. The steam tables. **[7]**

**QUESTION 4 (25 marks)**

Chlorine is produced by the reaction:

4HCl (g) + O2 (g) = 2H2O (g) + 2Cl2 (g)

The feed stream to the reactor consists of 60 mol-% HC1, 36 mol-% O2, and 4 mol-% N2, and it enters the reactor at 823.15 K. If the conversion of HC1 is 75% and if the process is isothermal, how much heat must be transferred from the reactor per mole of the entering gas mixture?

**TOTAL MARKS =100**

**END OF PAPER**

Formula Sheet

*Adiabatic Process*

*Generalized Pitzer Correlation*



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