

**UNIVERSITY OF TECHNOLOGY, JAMAICA**

**COLLEGE/ FACULTY:** Faculty ofEngineering and Computing

**SCHOOL/ DEPARTMENT:** SOE**/**ChemicalEngineering

**Mid-semester Examination 2, Semester 1**

**Module Name:** Chemical Engineering Thermodynamics 1

**Module Code:** CHE3003

**Date:** November 19, 2013

**Theory/ Practical:** Theory

**Groups:** B.ENG.3C

**Duration:** 1 hour & 45 minutes

**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] = 33.3%**

1. An inventor claims to have devised a cyclic engine which exchanges heat with reservoirs at 50 oC and 320 oC and which produces 0.45 kJ of work for each kJ of heat extracted from the hot reservoir. Is the claim believable?
2. A nuclear power plant generates 750 MW. The reactor temperature is 415oC and a river with water temperature of 20oC is available.
3. What is the maximum possible thermal efficiency of the plant and what is the minimum rate at which heat must be discarded to the river?
4. If the actual thermal efficiency of the plant is 60% of the maximum, at what rate must heat be discarded to the river, and what is the temperature rise of the river if it has a flowrate of 165 m3/s. Take *Cp* = 4183 J/kg.K & *ρ* = 998.2 m3/kg.

**Question #2 [25 marks] = 33.3%**

An equimolar mixture of n-butane(1) and n-hexane(2) at pressure, P, is brought to a temperature of 368.15K where it exists as a vapour/liquid mixture in equilibrium. If the mole fraction of n-hexane in the liquid phase is 0.75 and assuming Raoult's law applies, what is:

1. the total pressure?
2. the composition of the vapour phase?
3. the mole fraction of the system that is liquid?

Constants for the Antoine Equation are as follows:

n-butane:- A = 13.6608 B = 2154.70 C = -34.361

n-hexane:- A = 13.8193 B = 2696.04 C = -48.833

**Question #3 [25 marks] = 33.4%**

One hundred kmol per hour of sub-cooled liquid benzene at 300 K and 3 bar is heated at constant pressure to saturated vapour in a steady-flow heat exchanger. If Tsat for benzene at 3 bar is 392.3K, estimate the exchanger duty (in kW).

**Total Marks = 75**

**\*\*\*\*\* END OF PAPER \*\*\*\*\***Formula Sheet

*Riedel’s equation*

Where, *P****c*** is the critical pressure in bars and *Trn* is the reduced temperature at *Tn.*

*Watson’s equation*







