

**UNIVERSITY OF TECHNOLOGY, JAMAICA**

**COLLEGE/ FACULTY:** Engineering and Computing

**SCHOOL/ DEPARTMENT:** ChemicalEngineering

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

**Module Name:** Chemical Engineering Thermodynamics 1

**Module Code:** CHE3003

**Date:** November 14, 2011

**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. SHOW CLEARLY ALL EQUATIONS USED FOR CALCULATIONS.
5. ANSWERS MUST BE NUMBERED IDENTICAL TO THE QUESTION BEING ANSWERED.
6. READ THE QUESTION COMPLETELY BEFORE ANSWERING.
7. THE INTENDED MARK IS INDICATED AT THE BEGINING OF THE QUESTION.

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

**For ALL Calculations:** Take the work done **BY** the system to be negative (**-ve**) and the work done ON the system to be positive (+ve). NO marks will be awarded for answers with incorrect sign convention.

**Question #1 [25 marks]**

A piston–cylinder device contains 0.15 kg of air initially at 2 MPa and 350°C. The air is first expanded isothermally to 500 kPa, then compressed polytropically with a polytropic exponent of 1.2 to the initial pressure, and finally compressed at the constant pressure to the initial state. Determine the boundary work for each process and the net work of the cycle.

**Question #2 [25 marks]**

1. A geothermal power plant uses geothermal water extracted at 160°C at a rate of 440 kg/s as the heat source and produces 22 MW of net power. If the environment temperature is 25°C, determine (*i*) the actual thermal efficiency, (*ii*) the maximum possible thermal efficiency, and (*iii*) the actual rate of heat rejection from this power plant. **[15]**
2. A Carnot heat engine receives 650 kJ of heat from a source of unknown temperature and rejects 250 kJ of it to a sink at 24°C. Determine (*i*) the temperature of the source and (*ii*) the thermal efficiency of the heat engine. **[10]**

**Question #3 [50 marks]**

A two-phase liquid–vapor mixture of H2O with an initial quality of 25% is contained in a piston–cylinder assembly as shown in the Figure. The mass of the piston is 40 kg, and its diameter is 10 cm. The atmospheric pressure of the surroundings is 1 bar. The initial and final positions of the piston are shown on the diagram. As the water is heated, the pressure inside the cylinder remains constant until the piston hits the stops. Heat transfer to the water continues until its pressure is 3 bar. Friction between the piston and the cylinder wall is negligible. Determine the total amount of heat transfer, in J. Let *g =* 9.81 m/s2.

**Total Marks = 100**

**\*\*\*\*\* END OF PAPER \*\*\*\*\***

Formula Sheet









