POLITEKNIK
Jabatan Pengajian Politeknik

EXAMINATION AND EVALUATION DIVISION
DEPARTMENT OF POLYTECHNIC EDUCATION
(MINISTRY OF HIGHER EDUCATION)

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION

DECEMBER 2011 SESSION

J2006 : THERMODYNAMICS 1

DATE : 30 APRIL 2012 (MONDAY)
DURATION : 2 HOURS (8.30 AM - 10.30 AM)

This paper consists of **FOUR (4)** pages including the front page.
Structured/Essay (6 questions – answer any **4 question**)

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Instruction : This section consists of **SIX (6)** essay questions. Answer **FOUR (4)** questions only

QUESTION 1

(a) Define the first law of thermodynamics, an ideal gas, specific volume and specific heat.

(12 marks)

(b) A tank containing a fluid is stirred by a paddle wheel. The work input to the paddle wheel is 5090 kJ. The heat transfer from the tank is 1500 kJ. Considering the tank and the fluid as the system, determine the change in the internal energy of the system.

(6 marks)

(c) Calculate the mass of oxygen (O_2) molecules in 170 cm^3 container at 2 bar and 250^0 C.

(7 marks)

QUESTION 2

(a) Air at 1 bar and 20^0C occupies an initial volume of 1000 cm^3 in a piston cylinder arrangement. The air is confined by the piston, which has a constant restraining force, so the gas pressure always remains constant . Heat is added to the air until its temperature reaches 260 ^{0} C. Calculate the heat added, the work the gas does on the piston and the change in internal energy of the gas. Molecular weight of air 28.97.C_p= 1.005 X 10^3 J/kgK (15 marks)

(b) An ideal gas which obeys the equation pV = mRT is compressed in a piston cylinder arrangement such that the temperature remains constant (isothermal process). Derive an expression for the work done on the gas and calculate the quantity of work when 2 kg of helium is compressed from 1 bar, 20^0C to 1 MPa, holding the temperature constant. Also, calculate the heat added and the change in internal energy. M for helium = 4 kg/kg mol

(10 marks)

QUESTION 3

(a) Helium is expanded in a turbine from 400 kPa and 260^0 C to 100 kPa. The turbine is insulated and the inlet velocity is small. The exit velocity is 200 m/s. Calculate the work output of the turbine per unit mass of helium flow. $C_p = 5.234$ kJ/kg K. $\gamma = 1.66$.

(10 marks)

(b) Air at 3 bar and 120^0 C enters a diffuser nozzle section at 530 m/s. The air goes through a adiabatically process until its velocity is reduced 134 m/s. Calculate the final temperature and pressure. $C_p = 1.005$ kJ/kg K.

(15 marks)

QUESTION 4

(a) Determine the specific volume, specific enthalpy and specific internal energy of wet steam at 42 bar if the dryness fraction is 0.94.

(8 Marks)

(b) Find the dryness fraction, specific volume and specific internal energy of steam at 165 bar and specific enthalpy 2011 kJ/kg.

(8 Marks)

(c) With reference to the Steam Tables,

i. Determine the specific volume of superheated steam at 20 bar and 330°C.

ii. Determine the degree of superheated , specific volume and specific internal energy of steam at 90 bar and enthalpy 3633 kJ/kg.

(9 Marks)

QUESTION 5

(a) The work done by heat engine is 24 kW. If the rate of heat that enters into the hot reservoir is 60 kJ/s, determine the thermal efficiency and the rate of heat rejection to the cold reservoir.

(6 Marks)

(b) Steam at 40 bar and enthalpy 2700 kJ/kg expands isothermally and reversibly to a pressure of 8 bar. Calculate the entropy change, heat supplied and the work done per kg steam during the process. Show the process on a T-s diagram, indicating the area that represents the heat flow.

(19 Marks)

QUESTION 6

(a) Explain why the Rankine cycle and not the Carnot cycle is taken as the ideal cycle for steam plant. Sketch the T-s diagram for these cycles when using steam as the working fluid.

(8 Marks)

(b) A steam power plant operates between a boiler pressure of 50 bar and a condenser pressure of 0.030 bar. Calculate for these limits the cycle efficiency, the work ratio and the specific steam consumption for a Rankine cycle with dry saturated steam at entry to the turbine.

(17 Marks)