POLITEKNIK
Jabatan Pengajian Politeknik

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

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION
JUNE 2012 SESSION

JJ207: THERMODYNAMICS 1

DATE: 24 NOVEMBER 2012 (SATURDAY)
DURATION: 2 HOURS (8.30 AM – 10.30 AM)

This paper consists of **SEVEN (7)** pages including the front page.
Structured (6 questions – answer 4)

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(The CLO stated is for reference only)

ESSAY (100 marks)

INSTRUCTION:
This section consists of **SIX (6)** questions. Answer **FOUR (4)** questions.

QUESTION 1

(a) Define the following: [CLO 1 : C1]

i. Intensive properties

(3 marks)

ii. Extensive Properties

(3 marks)

(b) i. Explain briefly the zeroth law of thermodynamics. [CLO 1 : C2]

(2 marks)

ii. Sketch the zeroth law of thermodynamics. [CLO 1 : C3]

(2 marks)

(c) Convert the following units : [CLO 1 :C2]

i. 250 km/h to cm/minutes

(3 marks)

ii. 45000 Pascal to MN/m^2

(3 marks)

iii. 10 N/cm^2 to MN/m^2

(3 marks)

iv. 76 mg/litre to kg/m^3

(3 marks)

v. 9.78 mg / cm^3 to kg/m^3

(3 marks)

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QUESTION 2

a) Give **FOUR (4)** usage of steam in industry. [CLO1: C2]
(4 marks)

b) Explain the following phase processes of pure substance. [CLO1: C2]

i. Solid phase
(3 marks)

ii. Liquid phase
(3 marks)

iii. Steam phase
(3 marks)

c) Determine specific enthalpy and internal energy for wet steam at 17.5 bar with dryness fraction 0.81. [CLO1: C3]
(12 marks)

QUESTION 3

a) List **THREE (3)** conditions that fulfill the steady flow process. [CLO1 : C1]
(6 marks)

b) A fluid flowing along a pipeline undergoes a throttling process from 10 bar to 1 bar in passing through a partially open valve. Before throttling, the specific volume of the fluid is 0.3 m^3/kg and after throttling is 1.8 m^3/kg. Determine the change in specific internal energy during the throttling process.
[CLO2 : C3]
(9 marks)

c) In a steady flow system, a substance flows at the rate of 4 kg/s. It enters at a pressure of 620 kN/m^2, a velocity of 300 m/s, internal energy of 2100 kJ/kg and specific volume of 0.37 m^3/kg. It leaves the system at a pressure of 130 kN/m^2, a velocity of 150 m/s, internal energy 1500 kJ/kg and specific volume 1.2 m^3/kg. During its passage through the system, 30 kJ/kg of heat is lost to the surroundings. Neglect any change in potential energy.

i. Determine the power produced by the system in kilowatts.

ii. State whether it is from or to the system.

[CLO2 : C3]
(10 marks)

QUESTION 4

a) List **FIVE (5)** types of Non-Flow Process. [CLO1: C1]
(5 marks)

b) A rotary air pump is required to deliver 950 kg of air per hour. The enthalpy at the inlet and exit of the pump are 350 kJ/kg and 700 kJ/kg respectively. The air velocity at the entrance and exit are 13 m/s and 24 m/s respectively. The rate of heat loss from the pump is 6500 W. Determine the power required to drive the pump. [CLO2: C3]
(8 marks)

c) A steam turbine received steam at the pressure of 9 bar, specific volume of 0.26 m^3/kg, internal energy of 3590 kJ/kg and velocity of 4.7 m/s. Steam leaves from the turbine at pressure of 1.5 bar, specific volume of 0.85 m^3/kg, internal energy of 3360 kJ/kg and velocity of 6 m/s. The rate of heat loss to surrounding is 95000W. If the flow rate is 1540 kg/h, calculate the power produced by the turbine. [CLO2: C3]
(12 marks)

QUESTION 5

a) Define heat engine and give an example. [CLO 1 : C1]
(3 marks)

b) Carbon dioxide (M = 44) contained in a cylinder is initially at pressure of 5.5 bar, volume of 0.012 m^3 and temperature of 160°C. The gas expands isothermally and reversibly until the pressure is 1 bar. Assume that carbon dioxide acts as a perfect gas. Calculate : [CLO 1 : C3]

i. The mass of gas
(7 marks)

ii. The change of entropy
(4 marks)

iii. The heat flow
(4 marks)

iv. The work done
(3 marks)

v. Sketch the process on $T-s$ diagram.
(4 marks)

QUESTION 6

a) List **FOUR (4)** characteristics of heat engines. [CLO2: C1]

(4 marks)

b) An air-conditioning system operating on the reversed Carnot cycle is required to transfer heat from a house at a rate of 750 kJ/min to maintain its temperature at 24°C. If the outdoor air temperature is 35°C, determine: [CLO2: C3]

i. The coefficient of performance of the refrigerator.

(5 marks)

ii. The power required to operate this air-conditioning system.

(5 marks)

c) A Carnot heat engine receives 850 kJ of heat per cycle from a high-temperature heat reservoir at 760°C and rejects heat to a low-temperature heat reservoir at 30°C. Determine: [CLO2: C3]

i. The thermal efficiency of this Carnot engine.

(5 marks)

ii. The amount of heat rejected to the low-temperature heat reservoir.

(6 marks)