POLITEKNIK
Jabatan Pengajian Politeknik

EXAMINATION AND EVALUATION DIVISION
DEPARTMENT OF POLYTECHNIC EDUCATION

(MINISTRY OF HIGHER EDUCATION)

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION

JUNE 2012 SESSION

J 5106: THERMODYNAMICS 2

DATE: 22 NOVEMBER 2012(THURSDAY)

DURATION: 2 HOURS (2.30 PM - 4.30 PM)

This paper consists of **SEVEN (7)** pages including the front page.

Essay (6 questions – **answer 4** questions)

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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 steam power plant uses two stage turbine operating at boiler pressure of 50 bar and condenser pressure of 0.07 bar. Steam at temperature of 450°C is exapanded in the first stage turbine before being exhausted at pressure of 6 bar. The exhaust steam is then reheated at constant pressure until its temperature reaches the original temperature. The steam is then expanded in the second stage turbine until it reaches the condenser pressure. The work supplied to the feed pump of the boiler feed water is neglected.

a) Determine:

i. The state of exhaust steam from high pressure turbine. (5 mark)

ii. Skecth the T-s diagram process on a Rankine cycle. (3 mark)

b) Calculate the following values for each kilogram of steam supplied:

i. Total work output of the turbine ($W_{TURBINE}$). (10 mark)

ii. Total heat supplied to the system ($Q_{SUPPLIED}$). (3 mark)

iii. Thermal efficiency (η_{TH}). (2 mark)

iv. Specific steam consumption (s.s.c). (2 mark)

QUESTION 2

An engine working on the Otto cycle has a compression ratio of 12/1. At the beginning of the compression stroke the temperature of the air 27°C. After the addition of heat at constant volume the temperature of the air rises to 1100 °C.

a. Skecth the temperature-entropy (T-s) and pressure-enthalpy (P-v) diagram for Otto cycle. (6 mark)

b. Calculate the following values for each kilogram of air:

i. Heat supplied (6 mark)
ii. Heat rejected (6 mark)
iii. Net work (3 mark)
iv. Thermal efficiency of cycle (4 mark)

For air assume $\gamma = 1.4$ and $c_v = 0.718$ kJ/kgK.

QUESTION 3

A four stroke, single-cylinder engine has a bore of 160 mm and a stroke of 310 mm. When tested at 720 rev/min the net load on the rope brake is 610 N and the radius of arm 0.49 mm. The indicator diagram has a net area of 634 mm^2 and a length of 77 mm with a spring rating of 0.9 bar per mm. Determine for the engine:

i. Indicated mean effective pressure, (P_i). (4 mark)
ii. Indicated power, (I.P). (5 mark)
iii. Brake power, (B.P) . (5 mark)
iv. Friction power, (F.P). (3 mark)
v. Mechanical efficiency, (η_m). (4 mark)
vi. Mean piston speed. (4 mark)

QUESTION 4

An open system simple gas turbine power plant operates at a pressure ratio of 12:1 and maximum cycle temerature is 750°C. Isentropic efficiency for compressor and turbine is 0.82 and 0.85 respectively. Atmospheric air at temperature of 15°C enters the compressor at a rate of 15 kg/s. Fuel mass and any chance to the pressure energy and kinetic energy that takes place during the process is neglected.

a. Draw a schematic block diagram depicting flow process and Brayton cycle on a T-s diagram. (4 mark)

b. Determine the following values for each kilowatt:-

i. Pump work input, (W_{pump}). (6 mark)

ii. Gross work, ($W_{turbine}$). (6 mark)

iii. Net work, (W_{net}). (3 mark)

iv. Heat supplied, ($Q_{supplied}$). (3 mark)

v. Thermal efficiency (η_{TH}). (3 mark)

Given :

	C_p (kJ/kgK)	γ
Compression process	1.005	1.4
Expansion process	1.11	1.333

QUESTION 5

The pressure in the evaporator of a Ammonia refrigerator is 1.902 bar and the pressure in the condenser is 12.37 bar. Saturated dried vapour is delivered to the compressor where it is compressed isentropically. The liquip after condensation in undercooled by 10 °C.

a. Skecth the temperature-entropy (T-s) and pressure-enthalpy (P-h) diagram for vapour compression refrigeration cycle. (6 mark)

b. Calculate the:

i. Work done per kg of refrigerant. (10 mark)

ii. Refrigerating effect. (6 mark)

iii. Coefficient of performance, $C.O.P_{REF}$. (3 mark)

QUESTION 6

The inside air temperature is 23°C and the outside atmospheric air temperature is 35 °C for the glass window. The convection heat transfer coefficient on the inside and outside of the window is 7 W/m^{2}K and 50 W/m^{2}K respectively. The window size is 4 m x 3 m and the thickness of glass is 10 mm. Given thermal conductivities of glass is 0.78 W/mK.

a. Sketch the profile diagram. (4 mark)

b. Calculate the:

i. The total resistance of the glass window. (12 mark)

ii. The heat transfer rate. (3 mark)

iii. The surface temperature of the glass on the both sides. (6 mark)