POLITEKNIK
Jabatan Pengajian Politeknik

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

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION

JUNE 2012 SESSION

JJ507: THERMODYNAMICS 2

DATE: 23 November 2012 (Friday)
DURATION: 2 HOURS (2.30 PM - 4.30 PM)

This paper consists of **FIVE (5)** 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) State **TWO (2)** advantages of using superheated steam as compared to dry saturated steam.[CLO 1, C1] (4 marks)

b) A Rankine steam power plant operates between a boiler pressure of 40 bar and a condenser pressure of 0.035 bar. Steam at boiler pressure is heated and reached superheated condition at 500^0C. [CLO 1, C4]

i. Sketch the T – s diagram. (3 marks)

ii. Calculate:

a. The thermal efficiency. (14 marks)

b. The work ratio. (2 marks)

c. The specific steam consumption. (2 marks)

QUESTION 2

a) Classify **TWO (2)** types of internal combustion engine. [CLO2:C2] (3 marks)

b) Differentiate between the internal combustion engine and heat engine [CLO2: C4] (4 marks)

c) List **FOUR (4)** strokes involved in the internal combustion engine. [CLO2: C1] (4 marks)

d) A standard air Otto cycle in control with a compression ratio of 5.7/1. Air at the beginning of the compression process is 1.01 bar and temperature at 20^0C. If additional heat is 2500 kJ / kg. Given: - (γ = 1.4, R = 0.287 kJ / kg K, Cv = 0.718 kJ / kg K Calculate: [CLO1:C4]

i. The maximum temperature cycle. (7 marks)

ii. The pressure at point 2 (P_2). (4 marks)

iii. The efficiency of thermal cycles. (3 marks)

QUESTION 3

a) The performance of internal combustion engine can be explained by term and variable. Explain the meaning of the following terms: [CLO2: C4]

i. Indicated mean effective pressure. (2 marks)

ii. Volumetric efficiency (2 marks)

b) In an engine performance test of a single cylinder 4-stroke petrol engine, the following data were obtained:

[CLO1: C3]

Duration of trial	: 30 min.
Diameter of cylinder bore	: 0.103 m.
Length of stroke	: 0.9 m
Speed	: 1750 r.p.m.
Brake torque	: 330 Nm.
Fuel consumption	: 9.35 kg of calorific value 42,300 kJ/kg
Cooling water circulation	: 483 kg with inlet and outlet temperatures of 17°C and 77°C respectively.
Air consumption	: 182 kg.
Atmospheric pressure	: 1.013 bar.
Exhaust temperature	: 486°C
Ambient temperature	: 17°C

i. Calculate the brake power, the brake specific fuel consumption in kg/kWh, the indicated thermal efficiency if the mechanical efficiency is 83% and the volumetric efficiency of the engine. (11 marks)

ii. Present an energy balance in table form that represent the energy distribution during engine performance test kJ/min. Assuming that the mean specific heat capacity of the exhaust gas as 1.25kJ/kgK and the specific heat capacity of water as 4.18kJ/kgK. (10 marks)

QUESTION 4

In a gas turbine, the overall compression ratio is 7 and it expands into a two-stage turbine. High pressure turbine drives the compressor and low pressure turbine generates the net work. The air enters the compressor at 27°C. The hot gases leave the combustion chamber at 700°C and expand through the high pressure turbine. Upon leaving the turbine, the gas passes through the reheat combustion chamber, which raises the temperature of the gas to 650°C before it expands through the low pressure turbine. The isentropic efficiencies of the compressor and both turbines are 0.85 and 0.9 respectively.

[CLO 1: C4]

a) Sketch the process on T-s diagram (3 marks)

Calculate:

b) The actual temperature that exiting the compressor (3 marks)

c) The temperature that entering the low pressure turbine (6 marks)

d) The actual temperature that exiting the low pressure turbine (6 marks)

e) Net work done by the turbines (2 marks)

f) Heat supplied to the plant (3 marks)

g) Thermal efficiency of the plant (2 marks)

For compression process, use C_p =1.005 kJ/kg.K and γ =1.4.

For combustion and expansion process, use C_p =1.15 kJ/kg.K and γ =1.333.

QUESTION 5

A vapour compression refrigerator utilizing R12 operates between an evaporator pressure of 1.509 bar and a condenser pressure of 8.477 bar. The vapour entering the compressor is dry saturated and compressed isentropically to the condenser. The vapour has no undercooled effect after leaving the condenser. Based on the given information:

[CLO 1: C3]

a) Draw the block diagram of the refrigeration system and sketch a T-s diagram. (7marks)

b) Determined:-

i. The refrigerating effect. (4marks)

ii. The compressor work input. (10marks)

iii. The coefficient of performance (COP) of the refrigerator. (4 marks)

QUESTION 6

A furnace wall consists of 250mm firebrick, 125mm insulating brick and 250mm building brick. The temperature of the inside wall is 600°C and the atmospheric temperature is 20°C. The heat transfer coefficient for the outside surface is 10W/m²K and the thermal conductivities of the firebrick, insulating brick and building brick are 1.4, 0.2, and 0.7 W/mK respectively. [CLO1, C4]

a) Draw the temperature profile diagram. (3marks)

b) Calculate :-

i. Each heat resistance based on temperature profile of the material. (8marks)

ii. The rate of heat loss per unit wall surface by neglecting radiation. (5marks)

iii. Each temperature between the wall surfaces. (6marks)

iv. The outside wall surface of the furnace.6t (3marks)