POLITEKNIK
Jabatan Pengajian Politeknik

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

MECHANICAL ENGINEERING DEPARTMENT

FINAL EXAMINATION

DECEMBER 2011 SESSION

J5106 : THERMODYNAMIC 2

DATE : 30 APRIL 2012 (MONDAY)
DURATION : 2 HOURS (2.30 PM - 4.30 PM)

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

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STRUCTURED (100 marks)

Instruction: This section consists of 6 structured questions. Answer 4 questions only.

QUESTION 1

A steam power plant operates at a boiling pressure of 43 bar and temperature of 500°C. The steam condition expands in the first turbine until it becomes a dry saturated. Then, it is reheated to its initial temperature of 500° C and finally it is expanded in the second turbine until the pressure decreased to the same level of the condenser pressure of 0.05 bar

Based on the power plant statement above.

a) Sketch the T-s diagram

(5 marks)

b) Find the h_1, h_2, h_3, and h_4.

(12 marks)

c) Calculate the heat required during the reheating process

(2 marks)

d) Calculate the work output

(2 marks)

e) Determine the thermal efficiency of the cycle and the specific steam consumption per kW h.

(4 marks)

QUESTION 2

a) What are the differences between internal combustion engine and heat engine?

(4 marks)

b) What are the assumptions made in analyzing the real gas cycle?

(4 marks)

c) If the temperature and pressure of the air standard Diesel cycle for the beginning of the compression process are respectively 300 K and 0.1 MPa, the compression ratio is 18 and cut of ratio is 2, calculate:

i. Thermal efficiency (11 marks)

ii. The mean effective pressure in MPa. (6 marks)

QUESTION 3

During a test on a four stroke cycles of single cylinder engine, the following results were obtained :

Mean height of indicator diagram	: 23 mm
Indicator spring number	: 25 kN/m^2/mm
Swept volume of cylinder	: 14 litre
Speed of engine	: 6.6 rps
Effective brake load	: 78 kg
Effective brake radius	: 0.8 m
Fuel consumption	: 0.002 kg/s
Calorific value of fuel	: 44000 kJ/kg
Cooling water circulation	: 0.20 kg/s
Cooling water inlet temperature	: 35 ^{o}C
Cooling water outlet temperature	: 71 ^{o}C
Specific heat capacity of wate	: 4.18 kJ/kg.K
Energy to exhaust gases	: 20.6 kJ/s

a) Determine the indicated mean effective pressure.

(3 marks)

b) Determine the indicated power.

(3 marks)

c) Calculate the brake power.

(3 marks)

d) Calculate the mechanical efficiency.

(3 marks)

e) Determine the overall energy balance in kJ/s and show it in the form of a table

(13 marks)

QUESTION 4

In a marine gas turbine unit, a high pressure (HP) stage turbine drives the compressor and a low pressure (LP) stage turbine drives the propeller through suitable gearing. The overall pressure ratio is 4/1, the mass flow rate is 60 kg/s, the maximum temperature is 650 °C, and the air intake conditions are at 1.01 bar and 25 °C. The isentropic efficiencies of the compressor, HP turbine, and LP turbine, are 0.8, 0.83, and 0.85 respectively, and the mechanical efficiency of both shafts are 98%. Neglecting kinetic energy changes, and the pressure loss in combustion, calculate;

a) The pressure between turbine stages

(15 marks)

b) The cycle efficiency

(7 marks)

c) The shaft power

(3 marks)

Takes c_p and γ as 1.005 kJ/kg K and 1.4 for air and 1.15 kJ/kg K and 1.333 for combustion and expansion processes

QUESTION 5

In the vapor compression cycle system, Ammonia is used as a working fluid that operates between compressor pressure and condensor pressure, 0.2465 MPa and 0.6585 MPa respectively. The working fluids enter the compressor at superheated condition at 3K and exit from the condenser at 8°C.

a) Sketch T-s diagram for the system.

(4 marks)

Calculate:-

b) Enthalpy for each point.

(12marks)

c) Work input for compressor.

(3marks)

d) Cooling effect for the system.

(3marks)

e) Coefficient of performance.

(3marks)

QUESTION 6

A furnace wall is made up of three layers of thicknesses 250 mm, 100 mm and 150 mm with thermal conductivities of 1.65, k and 9.2 W/m°C respectively. The inside is exposed to gases at 1250°C with a convection coefficient of 25 W/m^2 °C and the inside surface is at 1100°C. The outside surface is exposed to air at 25°C with convection coefficient of 12 W/m^2 °C.

a) Sketch the layers of furnace wall

(4 marks)

b) Calculate:

i. The unknown thermal conductivity 'k'.

(6 marks)

ii. The overall heat transfer coefficient

(6 marks)

iii. All surface temperatures

(9 marks)