SULIT

POLITEKNIK
Jabatan Pengajian Politeknik

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENGAJIAN POLITEKNIK
KEMENTERIAN PENGAJIAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI DISEMBER 2012

JJ507 : THERMODYNAMICS 2

TARIKH :23 APRIL 2013
TEMPOH : 2 JAM(11.15 AM - 1.15 PM)

Kertas ini mengandungi **SEBELAS (11)**halaman bercetak.
Dokumen sokongan yang disertakan : Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTION:

This paper consists of **SIX (6)** structured questions. Answer any **Four (4)** questions.

ARAHAN:

*Kertas ini mengandungi **Enam (6)** soalan berstruktur. Jawab mana-mana **Empat (4)** soalan.*

QUESTION 1

SOALAN 1

The following data were obtained from a steam power plant.

Data-data berikut diperolehi dari sebuah loji kuasa stim;

Boiler pressure and superheated temperature	= 15 Mpa and 500 °C
Reheated pressure and temperature	= 4 Mpa and 500 °C
Condenser pressure	= 75kPa
Feed pump	= 14.93 kJ/kg

Tekanan dandang dan suhu panas lampau	*= 15 Mpa and 500 °C*
Tekanan pemanasan semula dan suhu	*= 4 Mpa and 500 °C*
Tekanan kondenser	*= 75kPa*
Pam suapan	*= 14.93 kJ/kg*

CLO2
C3

a) Sketch a schematic diagram for the reheat power plant.

Lakarkan gambar skematik bagi Janakuasa pemanasan semula.

[2 marks]

[*2 markah*]

CLO2
C1

b) State the condition of the exhaust steam from the high pressure turbine

Nyatakan keadaan stim yang keluar dari turbin tekanan tinggi.

[2 marks]

[*2 markah*]

CLO2
C3

c) Sketch T-s diagram for the cycle.

Lakarkan rajah T-s bagi kitar.

[2 marks]

[*2 markah*]

CLO1
C3

d) Determine the following

i. Total heat supply to the system

Jumlah haba yang dibekal kepada system

[12 marks]

[*12 markah*]

ii. Total gross work

Jumlah kerja kasar

[3 marks]

[*3 markah*]

iii. Network output

Kerja keluaran bersih

[2 marks]

[*2 markah*]

iv. Thermal efficiency

Kecekapan haba

[2 marks]

[*2 markah*]

QUESTION 2

SOALAN 2

CLO2
C1

a) Draw and label Otto cycle on a P-V diagram.

Lukis dan labelkan kitar piawai Otto pada rajah P-V.

[5 marks]
[*5 markah*]

CLO1
C4

b) A petrol engine works on a constant volume cycle and has a compression ratio of 9:1. The pressure and temperature at the beginning of the compression process are 112 kN/m^2 and 77°C respectively. The temperature at the beginning of the expansion process is 1500°C and $\gamma = 1.4$. Calculate the temperature and pressure at the important points based on the Otto cycle.

Sebuah enjin petrol yang bekerja pada kitar isipadu tetap mempunyai nisbah mampatan 9:1. Tekanan dan suhu pada permulaan proses mampatan ialah 112 kN/m^2 dan 77°C. Suhu pada permulaan pengembangan proses adalah 1500°C dan $\gamma = 1.4$. Kirakan suhu dan tekanan pada titik-titik penting merujuk kepada kitar Otto.

[20 marks]
[*20 markah*]

QUESTION 3

SOALAN 3

A four stroke, single cylinder gas engine has a 146 mm bore and a 280 mm stroke, at 475 rev/min and full load of the net load on the friction brake is 433 N, and the torque arm is 0.45 m. The indicator diagram gives a net area of 578 mm^2 and the length of 70 mm with a spring rating of 0.815 bar per mm. Calculate:

Enjin empat lejang, satu selinder mengandungi gerak 146 mm dan lejang 280 mm, pada 475 ppm pada beban penuh. Beban geseran brek ialah 433 N, dan lengan kilas 0.45 m. Gambarajah tertunjuk diberi luas bersih ialah 578 mm^2 dan panjangnya 70 mm dengan kadar pegas 0.815 bar per mm. Kirakan:

CLO1
C3

i. Indicator power.
Kuasa tertunjuk.

[12 marks]
[*12 markah*]

ii. Brake Power.
Kuasa brek.

[8 marks]
[*8 markah*]

iii. Mechanical efficiency.
Kecekapan Mekanikal.

[5 marks]
[*5 markah*]

QUESTION 4

SOALAN 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 nett 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. After 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 turbines are 0.85 and 0.9 respectively.

Dalam sebuah turbin gas, nisbah tekanan keseluruhan pemampat adalah 7/1 dan gas mengembang kedalam turbin dua peringkat.Turbin tekanan tinggi menjalankan pemampat dan turbin tekanan rendah menjanakan kerja bersih.Udara memasuki pemampat pada27°C manakala gas panas meninggalkan kebuk pembakaran pada700°C lalu mengembang menerusi turbin tekanan tinggi. Selepas meninggalkan turbin tersebut gas dipanaskan semula pada kebuk pembakaran yang menaikkan suhu gas kepada 650°C sebelum pengembangan melalui turbin tekanan rendah.Kecekapan isentropic pemampat dan turbin adalah 0.85 dan 0.9 masing – masing.

C_p and γ can be taken as 1.005 kJ/kg.K and 1.4 for compression process and as 1.15 kJ/kg.K and 1.333 for combustion and expansion processes.
C_p dan γ boleh diambil sebagai 1.005 kJ/kg.Kdan 1.4 untuk proses pemampatan dan1.15 kJ/kg.K dan 1.333 untuk pembakaran dan proses pengembangan.

CLO2
C3

a) Sketch the process on a T-s diagram
Lakarkan proses pada rajah T-s

[3 marks]
[*3markah*]

b) Determine;

Tentukan:

CLO1
C3

i. Nett work done by the low pressure turbine

Kerja bersih yang dilakukan pada turbin tekanan rendah

[17marks]

[*17 markah*]

ii. Heat supplied

Haba yang dibekalkan

[4 marks]

[*4 markah*]

iii. Thermal efficiency of the plant

Kecekapan haba loji tersebut

[1 marks]

[*1 markah*]

QUESTION 5

SOALAN 5

CLO2
C2

The pressure in the evaporator of a Freon-12 refrigerator is 1.509 bar and the pressure in the condenser is 10.84 bar. Dry saturated vapour is delivered to the compressor where it is compressed isentropically. After condensation the liquid is subcooled by 10°C. Sketch the process on a T-s diagram and calculate the:

Tekanan di dalam penyejat sebuah peti sejuk yang menggunakan gas bahan pendingin Freon-12 ialah 1.509 bar dan tekanan di bahagian pemeluwapnya pula ialah 10.84 bar.
Wap Freon-12 dalam keadaan tepukering dimasukkan kedalam pemampat di mana pemampatan secara isentropic berlaku.Cecair Freon-12 selepas proses kondensasi disejuklampau sebanyak 10°C. Kirakan:-

CLO1
C3

a) Work done per kg of refrigerant
Kerja yang dilakukan oleh gas pendingin per kg

[15 marks]
[*15 markah*]

b) Refrigerating effect
Kesan penyejukan

[3 marks]
[*3 markah*]

c) Coefficient of performance ($C.O.P_r$)
Pekali prestasi ($C.O.P_r$)

[3 marks]
[*3 markah*]

d) Refrigerant flowrate per kW of refrigerating effect
Kadaralir bahan pendingin per kW kesan penyejukan

[4 marks]
[*4 markah*]

QUESTION 6

SOALAN 6

CLO2
C1

a) Define the following terms:

Definasikan istilah-istilah berikut:

i) Conduction

Pengaliran

[2 marks]

[*2 markah*]

ii) Convection

Perolakan

[2 marks]

[*2 markah*]

iii) Radiation

Pancaran

[2 marks]

[*2 markah*]

b) A furnace wall consists of 250 mm firebrick, 125 mm insulating brick, and 250 mm 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/m^{2}K, and the thermal conductivities of the firebrick, insulating brick, and building brick are 1.4, 0.2 and 0.7 W/m K respectively. Calculate

Sebuah dinding relau terdiri daripada bata api 250 mm, bata penebatan 125 mm, dan bata bangunan 250 mm. Suhu dinding dalaman ialah 600°C dan suhu udarakasa ialah 20°C. Pekali pemindahan haba untuk permukaan luar ialah 10 W/m^{2}K, dan pengaliran termal untuk bata api, bata penebatan dan bata bangunan adalah 1.4, 0.2 dan 0.7 W/m K masing-masing. Hitungkan

CLO1
C4

i. The heat loss per m^2 of wall area, and
Kehilangan haba setiap m^2 luas dinding, dan

[12 marks]
[*12 markah*]

ii. The temperature of the outside wall surface of the furnace.
Suhu permukaan luar relau.

[7 marks]
[*7 markah*]

SOALAN TAMAT

POLITEKNIK KEMENTERIAN PENGAJIAN TINGGI

MALAYSIA

JABATAN KEJURUTERAAN MEKANIKAL

J5106/JJ507 - TERMODINAMIK 2

ADVANCE STEAM PLANT

$$\eta_{cycle} = \frac{\text{Net work}}{\text{Heat supplied}}$$

$$\text{s.s.c.} = \frac{3600}{W_{net}}$$

Pump Work = $V_f(P_2-P_1)$

$$\text{Work ratio} = \frac{W_{Net}}{W_{Gross}}$$

AIR STANDARD CYCLE

Otto Cycle

$$\eta_{th} = 1 - [1/r^{(\gamma-1)}]$$

Diesel Cycle

$$\eta_{th} = 1 - \frac{C_v(T_4-T_1)}{C_p(T_3-T_2)}$$

INTERNAL COMBUSTION ENGINE

Indicated Power, i.p. = P_iLANn (2-stroke)

= $P_iLANn / 2$ (4-stroke)

Brake Power, b.p. = $2\pi NT$

$$\eta_{Mechanical} = \frac{b.p}{i.p}$$

$$\text{S.F.C.} = \frac{\text{Fuel consumption / hour}}{\text{Power developed}}$$

Energy supplied = Mass of fuel x c.v.

GAS TURBINE

Isentropic Process

$$[T_2/T_1] = [(P_2/P_1)]^{(\gamma-1)/\gamma}$$

Isentropic efficiencies

$$\eta_c = \frac{T_2-T_1}{T_2'-T_1} \qquad \eta_t = \frac{T_3-T_4'}{T_3-T_4}$$

Compressor work = $C_p(T_2'-T_1)$

Turbine Work = $C_p(T_3-T_4')$

$$\eta_{Heat} = \frac{W_{Nett}}{Q_{Supplied}}$$

REFRIGERATION

$$C.O.P_r = \frac{T_1}{T_2-T_1}$$

$$C.O.P_{hp} = \frac{T_2}{T_2-T_1}$$

Refrigerating Effect, $Q_{14} = h_1 - h_4$

Work input, $W_{12} = h_2-h_1$

HEAT TRANSFER

$$\frac{1}{U} = \frac{1}{h_A} + \frac{x}{K} + \frac{1}{h_B}$$

$$Q = \frac{t_A - t_B}{R_T}$$

$R_T = 1/h_AA + \sum x/KA + 1/h_BA$