SULIT

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK
KEMENTERIAN PENDIDIKAN TINGGI

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2016

JJ507 : THERMODYNAMICS 2

TARIKH : 23 OKTOBER 2016
MASA : 8.30 AM – 10.30 AM (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.

Struktur (6 soalan)

Dokumen sokongan yang disertakan: Formula

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

INSTRUCTIONS:

This section consists of **SIX (6)** structured questions. Answer **FOUR (4)** questions only.

ARAHAN:

*Bahagian ini mengandungi **ENAM (6)** soalan berstruktur. Jawab **EMPAT (4)** soalan sahaja.*

QUESTION 1

SOALAN 1

A dual stage expansions steam power plant with high pressure turbine is supplied with steam at 5 MPa of pressure and 450 ˚C. The steam expands from the high pressure turbine to 1 MPa before reheated at constant pressure back to its initial temperature at 450˚ C. The steam then expands in the low pressure turbine to 40 k Pa condensate pressure. Assuming the process is ideal and neglect the feed pump.

Di dalam sebuah loji kuasa stim pengembangan 2 peringkat, stim dibekalkan kepada turbin tekanan tinggi pada tekanan 5 MPa dan suhu 450 ˚C. Stim keluar daripada turbin tekanan tinggi pada tekanan 1 MPa dan dipanaskan semula pada tekanan malar kepada 450 ˚C. Stim kemudiannya dikembangkan di dalam turbin tekanan rendah kepada tekanan pemeluwap 40 kPa. Anggapkan proses adalah ideal dan abaikan kerja oleh pam suapan

CLO2
C3

(a) Sketch the cycle T-s diagram.

Lakarkan gambar rajah T-s kitar

[3 marks]

[*3 markah*]

CLO1
C3

(b) For this power plant, determine :

Bagi loji kuasa ini. Tentukan :

i. The net work done by the turbine.

Kerja bersih bagi turbin .

[10 marks]

[*10 markah*]

ii. Thermal efficiency of the plant.
Kecekapan kitar.

[8 marks]
[*8 markah*]

iii. The condition of the exhaust steam from the low pressure turbine.
Keadaan stim keluar dari turbin bertekanan rendah.

[4 marks]
[*4 markah*]

QUESTION 2
SOALAN 2

Air standard Diesel cycle has a compression ratio of 15:1, where the maximum and minimum cycle temperature is 1650 °C and 15 °C respectively. The maximum cycle pressure is 45 bar. Calculate :
Sebuah kitar Diesel mempunyai nisbah mampatan 15:1. Dimana suhu maksima dan minima kitar adalah 1650 °C dan 15 °C. Tekanan maksima bagi kitar adalah 45 bar. Kirakan

CLO2 C2
a) Sketch P-v and T-s diagram [4 *markah*]
Lakarkan gambarajah P-v dan T-s [*4 markah*]

CLO1 C3
b) Calculate

i. The cycle efficiency [11 marks]
Kecekapan kitar [*11 markah*]

ii. The mean effective pressure [10 marks]
Tekanan berkesan purata [*10 markah*]

QUESTION 3
SOALAN 3

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

Mean height of the indicator diagram	: 25 mm
Indicator spring number	: 30kN/m^2/mm
Swept volume of cylinder	: 15 Litre
Speed of engine	: 6.6 revolutions per second
Effective brake load	: 80kg
Effective brake radius	: 0.8 m
Fuel consumption	: 0.002kg/s
Calorific value of fuel	: 44000kJ/kg
Cooling water circulation	: 0.20 kg/s
Cooling water inlet temperature	: 32°C
Cooling water outlet temperature	: 70°C
Specific heat capacity of water	: 4.18 kJ/kg.k
Energy to exhaust gases	: 15.6kJ/s

Dalam ujian ke atas kitar empat lejang pada satu enjin silinder, keputusan berikut diperolehi:

Min ketinggian gambarajah penunjuk	*: 25 mm*
Penunjuk spring no.	*: 30kn/m^2/mm*
Isipadu sapuan silinder	*: 15 Litre*
Kelajuan enjin	*: 6.6 putaran per saat*
Tekanan berkesan brek	*: 80kg*
Kecekapan berkesan brek	*: 0.8 m*
Kadar penggunaan minyak	*: 0.002kg/s*
Nilai kalorific bahanapi	*:44000kj/kg*
Kitar air sejuk	*: 0.20 kg/s*
Suhu air masuk	*: 32°c*
Suhu air keluar	*: 70°c*
Muatan haba tentu air	*: 4.18 kj/kg.k*
Tenaga ke gas ekzos	*: 15.6kJ/s*

CLO1 C3

a) Determine:
Tentukan:

i. Indicated mean effective pressure
Tekanan berkesan min tertunjuk

[4 Marks]
[*4 Markah*]

ii. Indicated power
Kuasa tertunjuk

[4 Marks]
[*4 Markah*]

iii. Brake power
Kuasa brek

[4 Marks]
[*4 Markah*]

iv. Mechanical efficiency
Kecekapan mekanikal

[3 Marks]
[*3 Markah*]

CLO2 C3

b) Develop an overall heat energy balance sheet in kj/s and its percentage
Bina jadual imbangan tenaga keseluruhan dalam unit kJ/s dan peratusanya.

[10 Marks]
[*10 markah*]

QUESTION 4
SOALAN 4

In a gas turbine unit, the air is inserted at 1.02 bar, 15 °C and is compressed to 6.12 bar. If the maximum cycle temperature is limited to 800 °C.
Dalam sebuah unit turbin gas, udara dimasukkan pada 1.02 bar, 15 °C dan dimampatkan kepada 6.12 bar. Jika suhu maksimum kitar dihadkan kepada 800 °C.

CLO2 C3

(a) Draw a schematic block diagram depicting the flow process and Brayton cycle on a T-s diagram.
Lakarkan gambarajah blok skema yang menggambarkan proses aliran dan Kitaran Brayton pada gambarajah T- s

[6 marks]
[*6 markah*]

CLO1 C3

(b) Calculate:
Kirakan:

i. The thermal efficiency
Kecekapan haba

[5 marks]
[*5 markah*]

ii. The net work output
Kerja bersih

[8 marks]
[*8 markah*]

iii. The gross work output
Kerja kasar

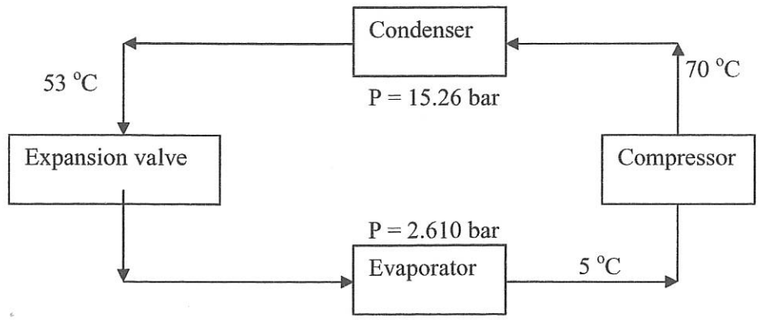
[3 marks]
[*3 markah*]

iv. The work ratio
Nisbah kerja

[3 marks]
[3 *markah*]

QUESTION 5

SOALAN 5



Based on the schematic diagram,

Berdasarkan gambarajah skematik

CLO2 C2

a) Sketch T-s and P-h diagram [6 marks]

Lakarkan gambarajah T-s dan P-h [6 *markah*]

CLO1 C3

b) Calculate

Kirakan

i. Work input to compressor [5 marks]

Kerja masukan pemampat [*5 markah*]

ii. Cooling effect [5 marks]

Kesan penyejukan [*5 markah*]

iii. Coefficient of performance (COP) [4 marks]

Pekali pretasi [*4 markah*]

iv. Compressor power if the refrigerant flow rate is 0.048 kg/s [5 marks]

Kuasa pemampat jika kadar alir bahan pendingin 0.048 kg/s [5 *markah*]

QUESTION 6

SOALAN 6

CLO2 C1

a) Define:

Definisikan:

i) Conduction

Pengaliran

[3 Marks]
[*3 Markah*]

ii) Convention

Olakan

[3 Marks]
[*3 Markah*]

iii) Radiation

Sinaran

[3 Marks]
[*3 Markah*]

CLO1 C3

b) A furnace wall consists of 250 mm firebrick, 125 mm insulating brick and 250 mm building brick. The inside wall's temperature is 600° C and the atmospheric temperature is 20° C. The heat transfer coefficient for the surface is 10 W/m^{2}K and the thermal conductivities of the firebrick, insulating brick and building brick are 1.4, 0.2 and 0.7 W/mK respectively. Neglecting radiation, calculate the rate of heat loss per m^2 unit wall surface and the temperature of the outside wall surface of the furnace.

Sebuah relau mempunyai dinding terdiri daripada batu api tebalnya 250 mm, bata penebat tebalnya 125 mm dan bata bangunan tebalnya 250 mm. Suhu pada bahagian dalam dinding relau adalah 600° C manakala suhu atmosfera ialah 20° C.

Pekali pemindahan haba pada permukaan luar relau tersebut ialah 10 W/m^{2}K manakala keberaliran haba batu api, bata penebat dan bata bangunan masing-masing adalah 1.4, 0.2 dan 0.7 W/mK. Hitungkan kehilangan haba per m^2 unit luas dinding relau dan suhu pada luar dinding relau tersebut. Diabaikan sinaran yang berlaku.

[16 Marks]
[*16 Markah*]

SOALAN TAMAT

FORMULA / RUMUS

JJ507 – THERMODYNAMICS 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

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

INTERNAL COMBUSTION ENGINE

Indicated Power, i.p. = $P_i LANn$ (2-stroke)

= $P_i LANn / 2$ (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

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

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

$R_T = 1/h_A A + \sum x/KA + 1/h_B A$