SULIT

POLITEKNIK
Jabatan Pengajian Politeknik

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENGAJIAN POLITEKNIK
KEMENTERIAN PENDIDIKAN MALAYSIA

JABATAN KEJURUTERAAN MEKANIKAL

PEPERIKSAAN AKHIR

SESI JUN 2013

JJ507: THERMODYNAMICS 2

TARIKH : 30 OKTOBER 2013
TEMPOH : 2 JAM (11.15 AM - 1.15 PM)

Kertas ini mengandungi **SEBELAS (11)** halaman bercetak.
Bahagian ini mengandungi **ENAM (6)** soalan esei.
Jawab **EMPAT (4)** soalan sahaja.

Dokumen sokongan yang disertakan : Rumus

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SULIT

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

A steam power plant operated by a reheat system has a steam inlet condition of 70 bar and 500°C at the high pressure turbine and exit with a pressure of 5 bar. The exhaust steam is then reheated at a constant pressure to 450 ° C and then expanded in a low pressure turbine to a condenser pressure 0.04 bar.

(Please note that both expansion processes are isentropic and the feed water pump can be neglected)

Sebuah kitar loji kuasa stim yang beroperasi dengan system panas semula mempunyai keadaan masukan stim 70 bar dan 500°C pada bahagian turbin tekanan tinggi dan keluar pada tekanan 5 bar. Tekanan steam ekzos kemudiannya dipanaskan semula pada tekanan tetap kepada sushu 450° C dan kemudiannya dikembangkan dalam turbin tekanan rendah kepada tekanan pemeluwap 0.04 bar.

(Kedua – dua proses pengembangan adalah isentropic dan sebutan pam air suapan boleh diabaikan)

CLO2
C1

a) State the condition of exhaust steam from high pressure turbine
Nyatakan keadaaan stim yang keluar dari turbin tekanan tinggi

[4 marks]
[*4 markah*]

CLO2
C2

b) Sketch T-s diagram for the cycle.
Lakarkan rajah T-s bagi kitar.

[4 marks]
[*4 markah*]

CLO1
C3

c) Determine the following
i. Total heat supply to the system
Jumlah haba yang dibekal kepada system

[5 marks]

[*5 markah*]

ii. Total work output from the turbine
Kerja keluaran bersih

[5 marks]
[*5 markah*]

iii. Thermal efficiency
Kecekapan haba

[4 marks]
[4 *markah*]

iv. Specific steam consumption
Penggunaan steam tentu

[3 marks]
[*3 markah*]

QUESTION 2

SOALAN 2

An ideal Otto Cycle has a compression ratio of 8. At the beginning of the compression process, the air is at 100 kPa and 17°C, and 800 kJ/kg of heat is transferred to air during the constant volume heat addition process. Based on the variation of specific heats of air with temperature, determine:

Kitar Otto sempurna mempunyai nisbah mampatan 8. Pada awal mampatan proses, tekanan udara ialah 100 kPa dan suhu 17°C, dan 800 kJ/kg haba dipindahkan ke udara semasa isipadu malar proses penambahan haba. Berdasarkan variasi haba tentu udara dengan suhu. Tentukan:

Taken a Cp = 1.005 kJ/kgK, Cv = 0.718 kJ/kgK, γ = 1.4 R = 0.287 kJ/kgK
Ambil nilai C_p = 1.005 KJ/kgK, Cv = 0.718 kJ/kgK, γ = 1.4 R = 0.287 kJ/kgK

CLO1 C3 a) Sketch the P-V and T-s for the cycle.
Lakarkan P-V and T-s bagi kitar.

[4 marks]
[4 *markah*]

CLO1 C3 b) The maximum temperature that occur during the cycle.
Suhu maksimum semasa kitar.

[6 marks]
[*6 markah*]

CLO1 C3 c) The maximum pressure that occur during the cycle.
Tekanan maksimum semasa kitar.

[4 marks]
[*4 markah*]

CLO2 C1 d) The nett work output.
Kerja keluaran bersih.

[4 marks]
[*4 markah*]

CLO2 C2 e) The thermal efficiency.
Kecekapan terma.

[2 marks]
[*2 markah*]

CLO1 C3 f) The mean effective pressure for the cycle.
Kecekapan tekanan purata bagi kitar.

[5 marks]
[*5 markah*]

QUESTION 3

SOALAN 3

The following results are obtained during trial of a 4 cylinder engine:

Data-data berikut diperolehi dalam ujian percubaan ke atas enjin 4 silinder :

Cylinder bore	= 300 mm
Stroke	= 450 mm
Speed	= 200 rpm
Indicator effective pressure	= 200 kN/m^2
Fuel consumption	= 8.8 kg/hour
Calorific value of fuel	= 44 MJ/kg
Effective brake wheel diameter	= 1.25 m
Break mass	= 110 kg
Cooling water supplied	= 10.5 kg/min
Rise of temperature	= 20°C
Specific heat capacity for cooling water	= 4.18 kJ/kgK
Type of engine	= 4 stroke petrol engine

Garispusat silinder	*= 300 mm*
Lejang	*= 450 mm*
Halaju	*= 200 ppm*
Tekanan berkesan tertunjuk	*= 200 kN/m^2*
Pengunaan bahan api tentu	*= 8.8 kg/jam*
Nilai kalori rendah	*= 44 MJ/kg*
Garispusat berkesan roda brek	*= 1.25m*
Beban pada brek	*= 110 kg*
Kadar bekalan air penyejukan	*= 10.5 kg/min*
Kenaikan suhu purata air	*= 20°C*
Haba tentu air penyejukan	*= 4.18 kJ/kgK*
Jenis enjin	*= 4 lejang enjin petrol*

Determine :

Tentukan :

CLO1 C3

a) Brake power [3 Marks]
Kuasa brek [*3 Markah*]

CLO1 C3

b) Indicator power [3 Marks]
Kuasa tertunjuk [*3 Markah*]

CLO1 C3

c) Mechanical efficiency [3 Marks]
Kecekapan mekanikal [*3 Markah*]

CLO1 C3

d) Indicator thermal efficiency [4Marks]
Kecekapan haba tertunjuk. [*4Markah*]

CLO1 C3

e) Break thermal efficiency [4Marks]
Kecekapan haba brek [*4 Markah*]

CLO1 C3

f) Draw up an energy balance for the engine in kJ/min [8 Marks]
Lakarkan jadual imbangan tenaga dalam kJ/min [*8 Markah*]

QUESTION 4

SOALAN 4

A gas turbine draws in air from atmosphere at 1 bar and 10°C and compresses it to 5 bar with an isentropic efficiency of 80%. The air is heated to 1200 K at constant pressure and then expanded through two stages in series back to 1 bar. The high pressure turbine is connected to the compressor and produces just enough power to drive it. The low pressure stage is connected to an external load and produces 80 kW of power. The isentropic efficiency is 85% for both stages.

Sebuah unit turbin gas beroperasi di dalam tekanan atmosfera pada 1 bar dan suhu 10^0C dan dimampatkan kepada 5 bar dengan kecekapan isentropic 80%. Udara kemudiannya dipanaskan kepada 1200 K pada tekanan malar dan kemudiannya mengembang melalui turbin 2 peringkat dan kembali ke tekanan permulaan, 1 bar. Turbin tekanan tinggi memacu pemampat dan menghasilkan kuasa yang mencukupi untuk memacu. Manakala turbin tekanan rendah pula memacu beban kuasa untuk menghasilkan 80 kW.Kedua-dua turbin mempunyai kecekapan isentropik, 85%.

CLO2 C3

a) Sketch the process on T- s diagram

Lakarkan process pada rajah T-s

[4 marks]

[*4 markah*]

CLO1 C4

b) Determine:

i. The mass flow of air

Kadaralir jisim udara.

[7 marks]

[*7 markah*]

CLO1 C4

ii. The inter-stage pressure of the turbines

Tekanan antara dua peringkat turbin

[10 marks]

[*10 markah*]

CLO1 C4

iii. The cycle efficiency.

Kecekapan kitar.

[4 marks]

[*4 markah*]

QUESTION 5

SOALAN 5

An ordinary household refrigerator uses R12 as a refrigerant operator between evaporator pressure 1.826 bar and condenser pressure 12.19 bar for cooling system. Dry saturated vapors enter the compressor and the liquid come out from the condenser with undercooling process about 10 °C.

Penyejuk isi rumah biasa menggunakan R 12 sebagai operasi penyejukan di antara tekanan pemeluwap 1.826 bar dan tekanan condenser 12.19 bar bagi system penyejukan. Wap tepu kering memasuki pemampat dan cecair yang keluar melalui kondenser dengan proses penyejukan 10 °C.

CLO2 C2

a) Draw a schematic diagram using R12 as a refrigerant gas.

Lukiskan gambarajah skematik menggunakan R12 sebagai gas penyejuk.

[2 marks]

[*2 markah*]

CLO2 C3

b) Sketch T-s diagram for the cooling system with labels

Lakarkan gambarajah T-s bagi penyejukan beserta penunjuk

[3 marks]

[*3 markah*]

CLO1 C3

c) Determine the temperature for evaporator.

Tentukan suhu pemeluwapan.

[1 mark]

[*1 markah*]

CLO1 C4

d) Calculate

i. Work input for the compressor.

Kerja masukan bagi pemampat.

[8 marks]

[*8 markah*]

ii. Heat removal from refrigerated space.

Haba buangan daripada ruang penyejukan.

[5 marks]

[*5 markah*]

iii. Heat rejection from refrigerant to environment.
Haba dibuang daripada penyejuk ke persekitaran.

[3 marks]
[*3 markah*]

iv. Coefficient of performance of the refrigerator.
Pekali prestasi penyejukan.

[3 marks]
[*3 markah*]

QUESTION 6
SOALAN 6

A furnace has a composite wall, consisting of 3 different materials. The thermal conductivity of the inner layer (material A) and the outer layer (material C) are 20 W/mK and 50 W/mK respectively. The thickness for the materials for both layers are 300mm and 150mm. Layer 2 (material B) is constructed between layer 1 (material A) and 3 (material C) with a thickness of 150mm. The temperature for the outer surface and inner surface of the furnace are 20°C and 600°C respectively, while the air temperature inside the furnace is 800°C. Coefficient of heat transfer for air inside the furnace is 25 W/m^{2}K. Determine:
Sebuah relau mempunyai dinding komposit yang terdiri daripada 3 bahan yang berbeza. Pekali keberaliran haba bagi lapisan dalaman (bahan A) dan lapisan dinding luaran (bahan C) adalah20 W/mK dan50 W/mK masing-masing. Ketebalan bahan untuk kedua-dua lapisana dalah 300mm dan 150 mm masing-masing. Lapisan yang kedua (bahan B) terletak di antara lapisan dalaman (bahan A) dan lapisan luaran (bahan C)dengan ketebalan 150 mm. Suhu permukaan luaran dan dalaman untuk relau adalah 20°C dan 600°C manakala suhu udara di dalam relau ialah 800°C. Pekali permindahan haba untuk udara di dalam relau adalah25 W/m^{2}K. Tentukan:

CLO2
C4

a) The steady rate of heat transfer per m^2 area from inside of the furnace across the composite wall.
Kadar permindahan haba secara mantap per m^2 luas dari bahangian dalaman relau merentasi dinding komposit tersebut.

[9 marks]
[*9 markah*]

CLO1
C4

b) The temperature between the surface of:
Suhu di antara permukaan:
i. Material A and B
Bahan A dan B
ii. Material B and C
Bahan B dan C

[10 marks]
[*10 markah*]

CLO1
C4

c) The thermal conductivity for layer 2 (material B)
Pekali keberaliran haba bagi lapisan yang kedua (bahan B)

[6 marks]
[*6markah*]

SOALAN TAMAT

FORMULA / *RUMUS*

ADVANCE STEAM PLANT

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

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

Pump Work $= V_f(P_2-P_1)$

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. $= 2\pi NT$

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

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

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

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

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

Turbine Work $= C_p(T_5-T_4')$

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

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

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

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

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