Final Examination
2017/2018 Academic Session

May/June 2018

JIF314 – Thermodynamics
[Termodinamik]

Duration : 2 hours
[Masa : 2 jam]

Please ensure that this examination paper contains **TWELVE** printed pages before you begin the examination.

Answer **ALL** questions. You may answer **either** in Bahasa Malaysia or in English.

In the event of any discrepancies, the English version shall be used.

Read the instructions carefully before answering.

Each question carries 100 marks.

*Sila pastikan bahawa kertas peperiksaan ini mengandungi **DUA BELAS** muka surat yang bercetak sebelum anda memulakan peperiksaan ini.*

*Jawab **SEMUA** soalan. Anda dibenarkan menjawab soalan **sama ada** dalam Bahasa Malaysia atau Bahasa Inggeris.*

Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai.

Baca arahan dengan teliti sebelum anda menjawab soalan.

Setiap soalan diperuntukkan 100 markah.

…2/-

Constants:

1 atm = 101.325 kPa

1 Pa = 1 $N.m^{-2}$

PV = nRT

$$Q = \int_{t2}^{t1} \dot{Q} dt$$

$$\dot{Q}_{cond} = -k_t A \frac{\Delta T}{\Delta x}$$

$$\dot{Q}_{conv} = hA(T_s - T_f)$$

$$\dot{Q}_{rad} - s\sigma A(T_s^4 - T_{surr}^4)$$

$$\dot{m} = \rho \dot{V}$$

$$x = \frac{m_{vapor}}{m_{total}}$$

$$x = \frac{V_{avg} - V_f}{V_{fg}}$$

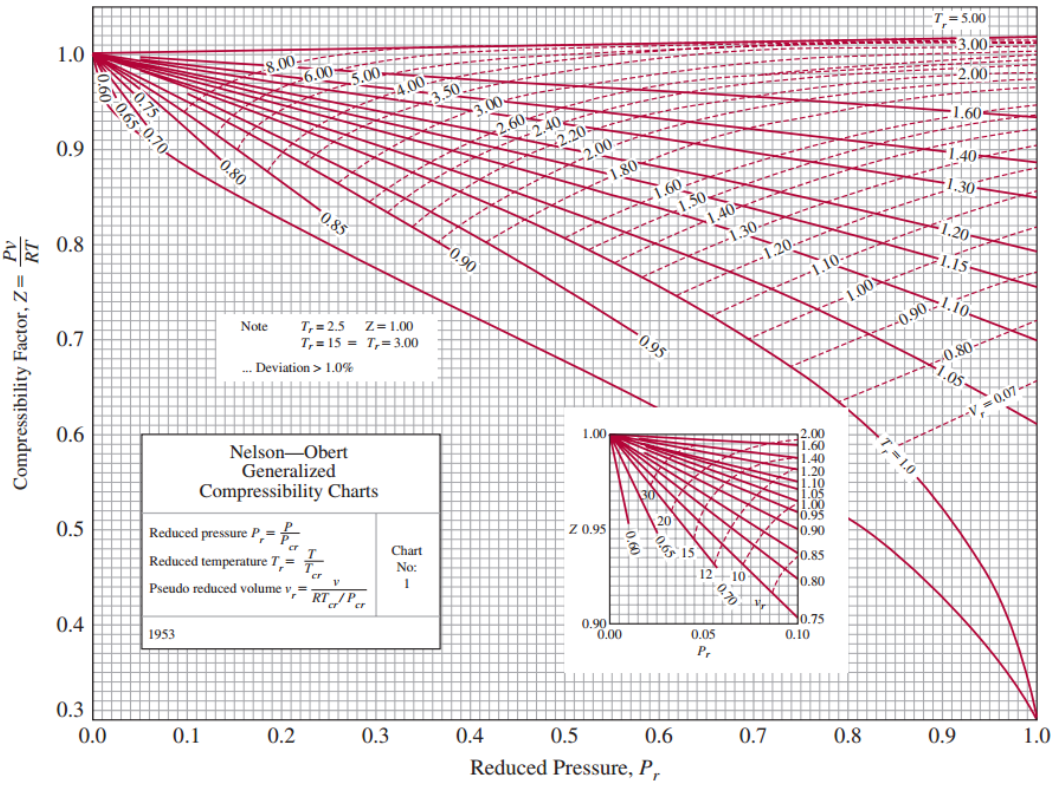
$$V = V_f + V_{fg}$$

$$\dot{m}_{in} - \dot{m}_{out} = \frac{dm_{cv}}{dt}$$

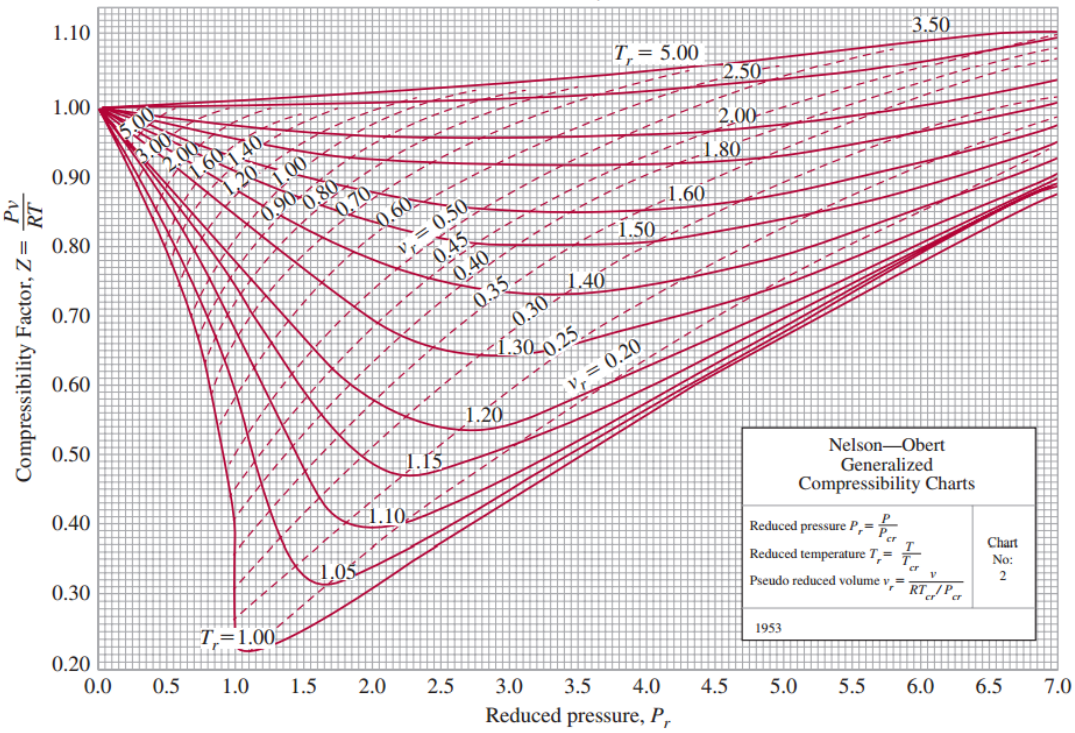
…3/-

Nelson-Obert generalized compressibility chart

(a) $0 < P_r < 1.0$



(b) $0 < P_r < 7$



1. (a). Describe a thermodynamic system by defining:

(i). Boundary,

(ii). Surrounding,

(iii). Isolated,

(iv). Open system, and

(v). Closed system

Include illustration support for the descriptions.

Terangkan sistem termodinamik dengan mendefinisikan

(i). Sempadan

(ii). Sekeliling

(iii). Terpencil

(iv). Sistem terbuka, dan

(v). Sistem tertutup

Sertakan sokongan ilustrasi untuk penerangan.

(30 marks/*markah*)

(b). Show that the work done by an ideal gas during the quasi-static isothermal expansion from an initial pressure P_i to a final pressure P_f, which is given by:

Tunjukkan bahawa kerja yang dilakukan oleh gas ideal semasa pengembangan isotermal kuasi statik, dari tekanan awal P_i kepada tekanan akhir P_f, yang diberikan oleh:

$$w = nRTIn\frac{P_f}{P_i}$$

(30 marks/*markah*)

(c). Describe the enthalpy of a homogeneous thermodynamic system.

Terangkan entalpi sistem termodinamik homogen.

(10 marks/*markah*)

(d). Determine the specific volume of refrigerant-134a at 1 MPa and 50°C, using

(i). The ideal-gas equation of state.

(ii). The generalized compressibility chart.

Compare the values obtained to the actual value of 0.021796 $m^3.kg^{-1}$ and determine the error involved in each cases.

Thermodynamic parameters for refrigerant-134a are given as follow;

$R = 0.0815\ kPa.m^3.kg^{-1}.K^{-1}$

$P_{cr} = 4.059\ MPa$

$T_{cr} = 374.2\ K$

Tentukan isipadu tertentu bahan penyejuk-134a pada 1 MPa dan 50 °C, menggunakan

(i). Keadaan persamaan gas unggul.

(ii). Carta kebolehmampatan umum.

Bandingkan nilai yang diperolehi dengan nilai sebenar 0.021796 $m^3.kg^{-1}$ dan tentukan kesilapan yang terlibat dalam setiap kes

Parameter termodinamik bagi bahan penyejuk-134a diberikan sebagai berikut;

$R = 0.0815\ kPa.m^3.kg^{-1}.K^{-1}$

$P_{cr} = 4.059\ MPa$

$T_{cr} = 374.2\ K$

(30 marks/*markah*)

2. (a). Define Zeroth Law of Thermodynamics.
Takrifkan Hukum Sifar Termodinamik.

(30 marks/*markah*)

(b). Determine the pressure of water vapour at 350 °C and 0.035262 $m^3.kg^{-1}$, using

(i). The ideal-gas equation of state.

(ii). The generalized compressibility chart.

Thermodynamic parameters for water vapour are given as follow;

$R = 0.4615\ kPa.m^3.kg^{-1}.K^{-1}$

$P_{cr} = 22.06\ MPa$

$T_{cr} = 647.1\ K$

$v = 0.035262\ m^3.kg^{-1}$

$T = 350°C$

$P = 7.0\ MPa$

Tentukan tekanan wap air pada 350 °C dan 0.035262 $m^3.kg^{-1}$, menggunakan

(i). Keadaan persamaan gas unggul

(ii). Carta kebolehmampatan umum

Parameter termodinamik untuk wap air diberikan sebagai berikut;

$R = 0.4615\ kPa.m^3.kg^{-1}.K^{-1}$

$P_{cr} = 22.06\ MPa$

$T_{cr} = 647.1\ K$

$v = 0.035262\ m^3.kg^{-1}$

$T = 350°C$

$P = 7.0\ MPa$

(40 marks/*markah*)

(c). A rigid tank contains 10 kg of water at 90 °C. If 8 kg of the water is in the liquid form and the rest is in the vapor form, determine the

(i). volume of the tank,
(ii). volume of saturated liquid,
(iii). volume of saturated vapor,

Thermodynamic parameters for saturated water are given as follow;
$P_{sat\ @\ 90°C}$ = 70.183 kPa
V_f = 0.001036 $m^3.kg^{-1}$
V_g = 2.3593 $m^3.kg^{-1}$

Tangki tegar mengandungi 10 kg air pada 90 °C. Sekiranya 8 kg air dalam bentuk cecair dan selebihnya dalam bentuk wap, tentukan

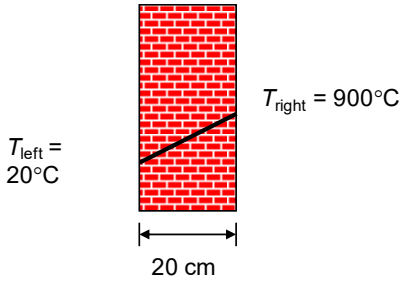
(i). Ispadu tangki,
(ii). Isipadu cecair tepu,
(iii). Isipadu wap tepu,

Parameter termodinamik untuk air tepu diberikan seperti berikut;
$P_{sat\ @\ 90°C}$ *= 70.183 kPa*
$V_f = 0.001036\ m^3.kg^{-1}$
$V_g = 2.3593\ m^3.kg^{-1}$

(30 marks/*markah*)

3. (a). Figure 1 shows a flat wall is composed of 20 cm of brick having a thermal conductivity k_t = 0.72 W/m·K. The right face temperature of the brick is 900 °C, and the left face temperature of the brick is 20 °C. Determine the rate of heat conduction through the wall per unit area of wall.

Rajah 1 menunjukkan satu dinding rata terdiri daripada 20 cm bata yang mempunyai kekonduksian terma k_t = 0.72 W/m.K. Suhu muka kanan bata ialah 900 °C, dan suhu muka kiri bata ialah 20 °C. Tentukan kadar pengaliran haba melalui dinding per unit kawasan dinding.



Figure/*Rajah* 1

(30 marks/*markah*)

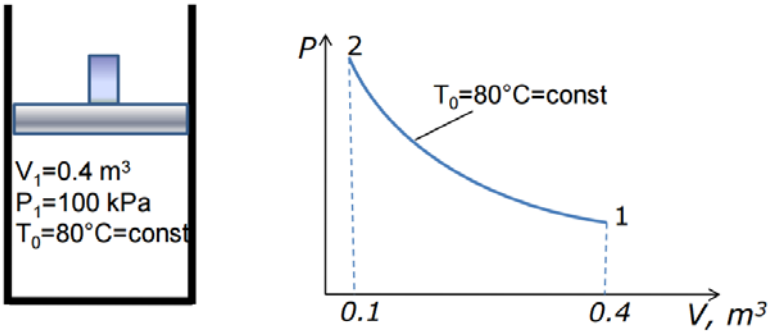
(b). Describe the Second Law of Thermodynamics based on Kelvin-Planck statement.

Terangkan Hukum Kedua Termodinamik berdasarkan penerangan Kelvin-Plank.

(10 marks/*markah*)

(c). Figure 2 shows piston–cylinder device initially contains 0.4 m^3 of air at 100 kPa and 80 °C. The air is now compressed to 0.1m^3 in such a way that the temperature inside the cylinder remains constant. Determine the work done during this process.

Rajah 2 menunjukkan satu alat piston silinder pada mulanya mengandungi 0.4 m^3 udara pada 100 kPa dan 80 °C. Udara kini dimampatkan kepada 0.1 m^3 sedemikian rupa sehingga suhu di dalam silinder kekal malar. Tentukan kerja yang dilakukan semasa proses ini.

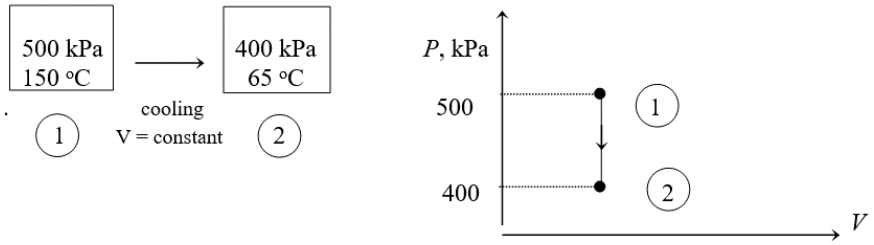


Figure/*Rajah* 2

(30 marks/*markah*)

(d). Figure 3 shows rigid tank contains air at 500 kPa and 150 ˚C. As a result of heat transfer to the surroundings, the temperature and pressure inside the tank drop to 65 ˚C and 400 kPa, respectively. Determine and discuss the boundary work done during this process.

Rajah 3 menunjukkan satu tangki tegar mengandungi udara pada 500 kPa dan 150 °C. Akibat pemindahan haba ke persekitaran, suhu dan tekanan di dalam tangki masing-masing turun ke 65 °C dan 400 kPa. Tentukan dan bincangkan kerja sempadan yang dilakukan semasa proses ini.



Figure/*Rajah* 3

(30 marks/*markah*)

4. (a). Define the first law of thermodynamics as an expression of the conservation of energy principle which relate to the sum of three separate energies.
Takrifkan Hukum Pertama Termodinamik sebagai satu ungkapan terhadap prinsip keabadian tenaga yang berkaitan dengan jumlah tiga tenaga berasingan.

(30 marks/*markah*)

(b). A steam power plant operates on a thermodynamic cycle in which water circulates through a boiler, turbine, condenser, pump, and back to the boiler. For each kilogram of steam (water) flowing through the cycle, the cycle receives 2000 kJ of heat in the boiler, rejects 1500 kJ of heat to the environment in the condenser, and receives 5 kJ of work in the cycle pump. Determine the work done by the steam in the turbine, in kJ/kg. Given:
Loji kuasa stim beroperasi pada kitaran termodinamik di mana air beredar melalui dandang, turbin, kondenser, pam, dan kembali ke dandang. Bagi setiap kilogram stim (air) yang mengalir melalui kitaran, kitaran menerima 2000 kJ haba dalam dandang, menolak 1500 kJ haba ke persekitaran dalam kondenser, dan menerima 5 kJ kerja dalam pam kitaran. Tentukan kerja yang dilakukan oleh stim di turbin, dalam kJ / kg. Diberikan:

$$Q_{net} - W_{net} = \Delta E_{cycle}, \quad w = \frac{W}{m} \quad \text{and} \quad q = \frac{Q}{m}$$

(30 marks/*markah*)

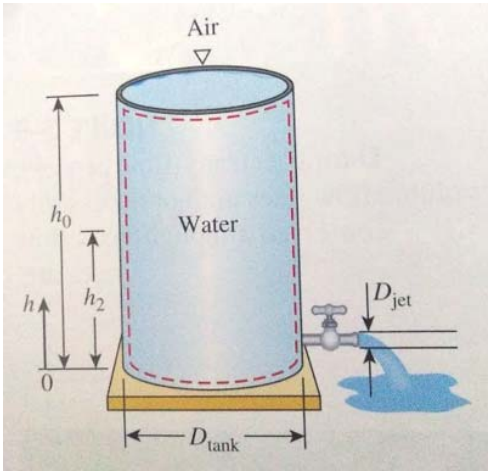
(c). A 1.2 m high 0.9 m diameter cylindrical water tank top is open to the atmosphere is initially filled with water. Now the discharge plug near bottom of the tank is pulled out, and water jet whose diameter is 1.27 cm streams out. The mean velocity of the jet is given by $v = \sqrt{2gh}$, where h is the height in the tank measured from the centre of the hole and g is the gravitational acceleration. Determine how long it will take for the water level in the tank to drop to 0.6 m level from the bottom.

Given;

Atas tangki air silinder 1.2 m tinggi berdiameter 0.9 m terbuka ke atmosfera pada awalnya diisi dengan air. Sekarang plag pelepasan berhampiran bahagian bawah tangki ditarik keluar, dan air mengalir keluar melalui jet air dengan diameter 1.27 cm. Halaju rata jet diberikan oleh v = √2gh, di mana h ialah ketinggian dalam tangki yang diukur dari pusat lubang dan g ialah pecutan graviti. Tentukan berapa lama ia akan mengambil untuk paras air dalam tangki untuk jatuh ke tahap 0.6 m dari bawah.

Diberikan;

$$dt = -\frac{D_{tank}^2}{D_{jet}^2}\frac{dh}{\sqrt{2gh}}$$



Figure/*Rajah* 4

(40 marks/*markah*)

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