UNIVERSITI SAINS MALAYSIA

Second Semester Examination
Academic Session 2005/2006

April/May 2006

IEK 107 – Thermodynamics
[Termodinamik]

Duration: 3 hours
[Masa: 3 jam]

Please check that the examination paper consists of SEVEN pages of printed material before you begin this examination.

Instructions:

1. Answer **FIVE (5)** questions.
2. Answer **THREE** questions from Section A.
3. Answer **TWO** questions from Section B.
4. All questions can be answered either in Bahasa Malaysia OR English.

Sila pastikan bahawa kertas peperiksaan ini mengandungi TUJUH mukasurat yang bercetak sebelum anda memulakan peperiksaan ini.

Arahan:

*1. Jawab **LIMA (5)** soalan.*
*2. Jawab **TIGA** soalan Bahagian A.*
*3. Jawab **DUA** soalan Bahagian B.*
4. Semua soalan boleh dijawab samada dalam Bahasa Malaysia ATAU Bahasa Inggeris.

...2/-

SECTION A. Answer THREE questions only.

1. (a) Give a list of basic dimensions and mention their symbols and units in SI as well as British systems of units.

   (b) Give an account of the microscopic forms of internal energy. How microscopic form of internal energy is different from macroscopic one?

   (20 marks)

2. (a) Define system, boundary and surrounding. Explain different types of systems with examples.

   (b) Explain what is meant by the terms state, equilibrium, process and path.

   (c) A mercury manometer (ρ = 13600 kg/m^3) is connected to an air duct to measure the inside pressure. The difference in the manometer levels is 15 mm, and the atmospheric pressure is 100 kPa.

   (i) Determine the absolute pressure in the duct.
   (ii) Determine if the pressure in the duct is above or below the atmospheric pressure.

   (20 marks)

3. (a) A piston-cylinder device containing 0.1 m^3 of liquid water and 0.9 m^3 of water vapor is in equilibrium at 800 kPa. Heat is transferred at constant pressure until the temperature reaches 350°C.

   (i) What is the initial temperature of the water?
   (ii) Determine the total mass of the water.
   (iii) Calculate the final volume of the vapor inside the cylinder.
   (iv) Show the process on a P-v diagram with respect to saturation lines.

   (b) What is a phase diagram? Explain phase diagram of water in detail.

   (20 marks)

4. (a) Explain what is meant by state properties. Write names of three state properties.

(b) Is work a state property? Justify your answer with the help of suitable diagrams.

(c) A friction less piston-cylinder device initially contains 0.8 m^3 of air at 200 kPa and 100 °C. The air is now compressed to 0.08 m^3. Determine the work done during this process.

(20 marks)

SECTION B. Answer TWO questions only.

5. (a) Is it possible for a heat engine to operate without rejecting any waste heat to a low-temperature reservoir? Explain.

(4 marks)

(b) A household refrigerator with a Coefficient of Performance (COP) of 1.8 removes heat from the refrigerated space at a rate of 90 kJ/min. Determine

(i) The electric power consumed by the refrigerator and
(ii) The rate of heat transfer in the kitchen.

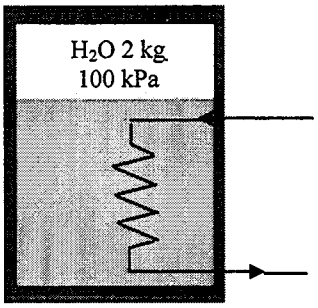
(6 marks)

(c) A Carnot heat engine operates between a source at 1000K and a sink of 300K. If the heat engine is supplied with heat at a rate of 800 kJ/min, determine

(i) The thermal efficiency.
(ii) The power output of this heat engine.

(10 marks)

6. (a) A well-insulated rigid tank contains 2 kg of a saturated liquid-vapor mixture of water at 100 kPa as shown in Figure 1. Initially, three-quarters of the mass is in the liquid phase. An electric resistance heater placed in the tank is now turned on and kept on until all the liquid in the tank is vaporized. Determine the entropy change of the steam during this process.



Rajah 1

(6 marks)

(b) Steam enters an adiabatic turbine steadily at 3MPa and 400°C and leaves at 50 kPa and 100°C. If the power output of the turbine is 2MW, determine

(i) The isentropic efficiency of the turbine.
(ii) The mass flow rate of the steam flowing through the turbine.
(iii) Sketch the process on a T-s diagram.

(14 marks)

7. (a) Explain why is the Carnot cycle not a realistic model for steam power plants?

(4 marks)

(b) Consider a steam power plant operating on the simple ideal Rankine cycle. The steam enters the turbine at 3 MPa and 350°C and is condensed in the condenser at a pressure of 75 kPa. Determine the thermal efficiency of this cycle. Sketch the schematic and T-s diagrams of this power plant.

(16 marks)

BAHAGIAN A. *Jawab TIGA soalan sahaja.*

1. *(a) Senaraikan dimensi-dimensi asas dan tuliskan simbol dan unit masing-masing dalam unit SI dan British.*

   (b) Jelaskan mengenai tenaga dalaman dari sudut mikroskopik. Bagaimanakah tenaga dalaman dari sudut mikroskopik berbeza dari makroskopik ?

   (20 markah)

2. *(a) Takrifkan sistem, sempadan dan sekeliling. Jelaskan jenis-jenis sistem yang berbeza dengan memberi contoh-contohnya.*

   (b) Jelaskan apa yang dimaksudkan dengan keadaan, keseimbangan, proses dan laluan.

   (c) Manometer merkuri (ρ = 13600 kg/m^3) terhubung kepada suatu saluran udara untuk mengukur tekanan bahagian dalam saluran itu. Perbezaan paras ialah 15 mm dan tekanan atmosfera ialah 100 kPa.

      (i) Tentukan tekanan mutlak dalam saluran.

      (ii) Tentukan sama ada tekanan di dalam saluran berada di atas atau di bawah tekanan atmosfera.

   (20 markah)

3. *(a) Suatu silinder beromboh mengandungi 0.1 m^3 cecair air dan 0.9 m^3 wap air dalam keseimbangan pada tekanan 800 kPa. Haba dipindahkan pada tekanan malar sehingga suhu meningkat kepada 350 °C.*

      (i) Apakah suhu awal air ?
      (ii) Tentukan jumlah jisim air.
      (iii) Kira isipadu akhir wap dalam silinder.
      (iv) Tunjukkan proses yang berlaku di atas satu gambarajah P-v sambil mengaitkan dengan garisan tepu

   (b) Apakah gambarajah fasa ? Jelaskan gambarajah fasa air dengan terperinci.

   (20 markah)

4. (a) *Jelaskan apa yang dimaksudkan dengan sifat-sifat keadaan. Namakan tiga (3) sifat keadaan.*

(b) *Adakah kerja suatu sifat keadaan ? Beri justifikasi dengan bantuan gambarajah yang sesuai.*

(c) *Suatu silinder beromboh tanpa geseran yang pada mulanya mengandungi 0.8 m^3 udara pada tekanan 200 kPa, suhu 100 oC. Udara di dalam silinder dimampatkan sehingga menjadi 0.08 m^3. Tentukan kerja yang telah dibuat dalam proses tersebut.*

(20 markah)

BAHAGIAN B. *Jawab <u>DUA</u> soalan sahaja.*

5. (a) *Bolehkah satu enjin haba beroperasi tanpa menyingkirkan sebarang sisa haba kepada takungan suhu rendah? Huraikan.*

(4 markah)

(b) *Satu peti sejuk dengan Koefisyen Prestasi (COP) 1.8 mengeluarkan haba daripada ruang tersejuk pada kadar 90 kJ/min. Tentukan:*

(i) Kuasa elektrik yang digunakan oleh peti seju.
(ii) Kadar pindahan haba ke udara di dapur.

(6 markah)

(c) *Satu enjin haba Carnot beroperasi di antara sumber 1000K and sinki 300K. Jika enjin haba dibekalkan dengan haba pada kadar 800 kJ/min, tentukan:*

(i) Kecekapan terma.
(ii) Output kuasa enjin haba tersebut.

(10 markah)

6. (a) *Satu tangki tegar tertebat mengandungi 2kg campuran cecair-wap tepu pada 100 kPa seperti ditunjukkan di Rajah 1. Pada mulanya, tiga perempat daripada jisim ialah dalam fasa cecair. Satu perintang elektrik di dalam tangki dihidupkan dan dibiarkan hidup sehingga kesemua cecair di dalam tangki mengeluwap. Tentukan perubahan entropi bagi stim semasa proses ini.*

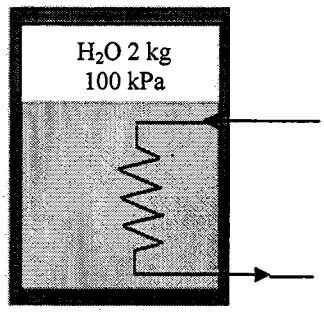


Figure 1

(6 markah)

(b) *Stim memasuki satu turbin adiabatic secara mantap pada 3 MPa dan 400°C dan keluar daripadanya pada 50kPa dan 100°C. Jika kuasa output turbin ialah 2MW, tentukan:*

(i) Kecekapan isentropic turbin
(ii) Kadar aliran jisim melalui turbin
(iii) Lakarkan proses dalam gambarajah T-s

(14 markah)

7. (a) *Kenapakah kitar Carnot bukannya model realistik bagi loji kuasa stim? Huraikan.*

(4 markah)

(b) *Satu loji kuasa stim beroperasi kitar Rankine unggul. Stim memasuki turbin pada 3 MPa dan 350°C dan dipeluwap dalam pemeluwap pada tekanan 75 kPa. Tentukan kecekapan terma kitaran ini. Lakarkan gambarajah skema dan gambarajah T-s bagi loji kuasa ini.*

(16 markah)

- oooOOOooo -