First Semester Examination
2023/2024 Academic Session

February 2024

# EMH 341 – Applied Thermodynamics
***(Termodinamik Gunaan)***

Duration: 3 hours
*(Masa: 3 Jam)*

Please check that this examination paper consists of FOUR (4) pages of printed material before you begin the examination.

*[Sila pastikan bahawa kertas peperiksaan ini mengandungi EMPAT (4) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]*

**Instructions**: Answer ALL **FIVE (5)** questions.

*[**Arahan**: Jawab **LIMA (5)** soalan]*

Thermodynamic table booklet is provided

*[Buku jadual termodinamik disediakan]*

...2/-

1. (a) A piston-cylinder device contains a mixture of 0.2kg of hydrogen, 1.6kg of nitrogen at 100kPa and 27°C. Heat is now transferred to the mixture at constant pressure until the volume is doubled. Assuming constant specific heats at average temperature, calculate:

   (i) The work done

   (ii) The heat transfer

   **(40 marks)**

   (b) A vessel of 0.3m$^3$ capacity contains a mixture of air and steam with dryness fraction of 0.75. The pressure and temperature of the vessel are 700kPa and 117°C respectively. If the vessel is cooled to 100°C, calculate:

   (i) The mass of vapor condensed

   (ii) The final pressure of vessel

   (iii) The heat rejected

   **(60 marks)**

2. (a) The specific humidity, ω is defined as the ratio of the mass of water vapor to the mass of dry air in a given air sample. Prove that the specific humidity ω can be calculated by:

$$\omega = 0.622\left(\frac{P_s}{P - P_s}\right)$$

   Where $P_s$= vapor pressure and P= barometric pressure

   **(40 marks)**

   (b) Dry saturated steam of 100°C is injected at the rate of 1.2kg/min into an air stream with 25°C of dry bulb temperature and 12°C of wet bulb temperature flowing at the rate of 200m$^3$/min through a duct. Calculate, at the exit:

   (i) Specific humidity **(10 marks)**

   (ii) Specific enthalpy **(10 marks)**

   (iii) Dry bulb temperature **(10 marks)**

   (iv) Wet bulb temperature **(15 marks)**

   (v) Relative humidity **(15 marks)**

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3. (a) In combustion process, ethane is burnt with 20% excess air. The combustion is carried out at a total pressure of 100kPa. Calculate:

(i) Air-fuel ratio **(20 marks)**

(ii) Dew point temperature of the products. **(20 marks)**

(b) Butane is combusted with 100% theoretical air at the pressure of 1atm and temperature of 25$^{o}$C. Calculate:

(i) Enthalpy of reaction **(10 marks)**

(ii) Enthalpy of combustion **(10 marks)**

(iii) Heat of combustion **(10 marks)**

(iv) Low heating value **(15 marks)**

(v) High heating value **(15 marks)**

4. (a) Explain the effects of compression ratio, engine speed, and stroke/bore ratio on the engine friction.

**(30 marks)**

(b) A four-stroke diesel engine with a swept volume of 2.5 liters has the performance curve shown in Figure 4 (b) below. Calculate:

(i) the maximum power output

**(20 marks)**

(ii) the air-fuel ratio, corresponding to maximum power output calculated in (b) (i)

**(20 marks)**

(iii) the maximum brake thermal efficiency

**(20 marks)**

(iv) the brake mean effective pressure at maximum torque

**(10 marks)**

The calorific value of the fuel is 44 MJ/kg, and the ambient temperature and pressure are 17°C and 1.02 bar respectively.

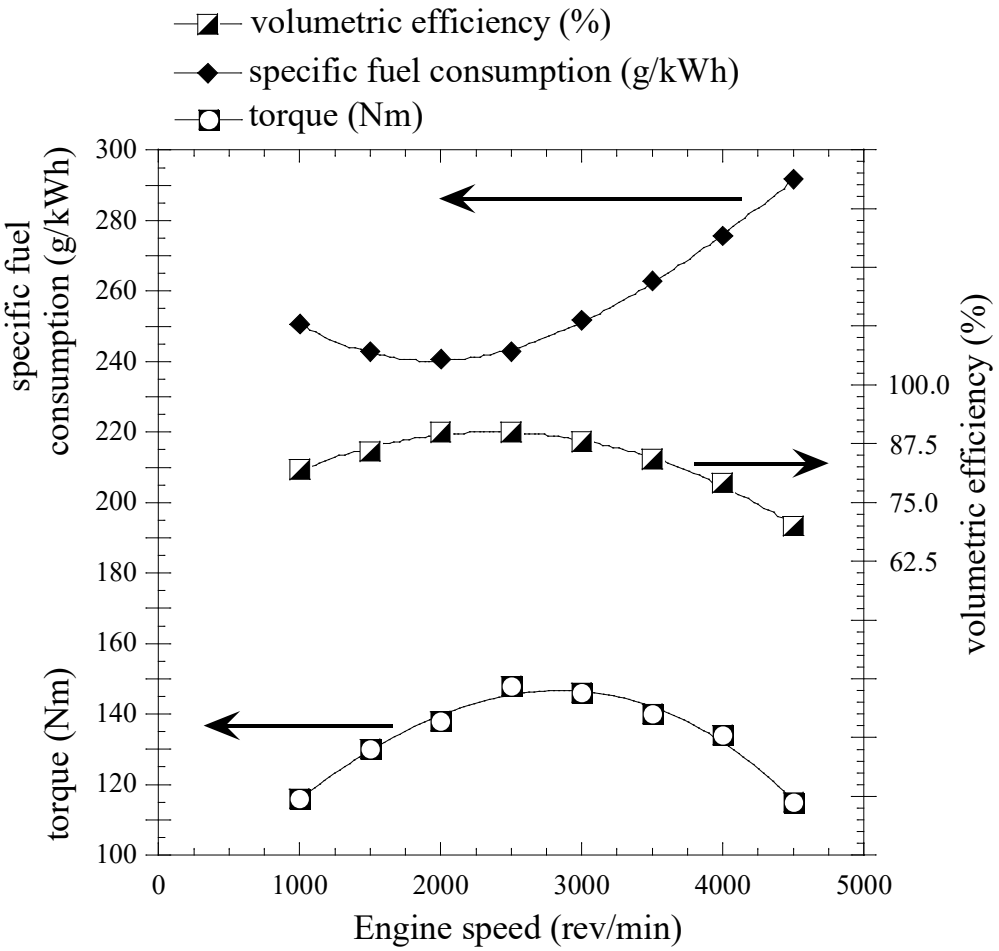


Figure 4 (b)

5. (a) List **THREE (3)** advantages of multi-stage compression compared with single-stage compression.

**(30 marks)**

(b) A single acting two stage compressor draws in 8.5 $m^3$/min of free air and compresses it to 40 bar. The compressor runs at 300 rev/min. The atmospheric conditions are 1.013 bar and 15°C. There is an intercooler between stages which cools the air back to 15°C. The polytropic index for all compressions is 1.3. The volumetric efficiency is 90% for the low pressure cylinder and 85% for the high pressure cylinder. Ignore the effect of the clearance volume. Calculate:

(i) the intermediate pressure for minimum indicated work **(20 marks)**

(ii) the theoretical indicated power for each stage **(20 marks)**

(iii) the swept volumes for both stages **(30 marks)**

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