First Semester Examination
2022/2023 Academic Session

February 2023

EMH 341 – Applied Thermodynamics
(Termodinamik Gunaan)

Duration: 3 hours
(Masa: 3 Jam)

Please check that this examination paper consists of THREE (3) pages of printed material before you begin the examination.

[Sila pastikan bahawa kertas peperiksaan ini mengandungi TIGA (3) muka surat yang bercetak sebelum anda memulakan peperiksaan ini.]

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

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

Note: Thermodynamic Formula Booklet is given during the exam.

...2/-

1. (a) Discuss FOUR (4) limitations of Dalton's law for the gas mixture undergoes thermodynamic process.

(40 marks)

(b) An ideal-gas mixture of CO_2 (33.3%), CO (50%), and O_2 (16.7%), by volume enters a steady-state compressor at 30°C and 60m/s and leaves at 120°C and 90m/s.

Calculate:

(i) The shaft-work input required to run the compressor if a heat loss of 9.5kJ/kg occurs during the process.

(ii) The power input to the compressor in kilowatts, if the volume flow rate at the entry is $12m^3$/min and the atmospheric pressure is 101kPa,

(60 marks)

2. (a) What is a comfortable environment in terms of temperature, relative humidity and air motion? Justify your reasons.

(40 marks)

(b) A psychrometer gives the following readings of an air stream:

Dry bulb temperature = 28°C
Moisture content = 0.016 kg of vapor/kg of dry air
Barometric pressure = 101.3kPa

Calculate:
(i) Partial pressure of water vapor
(ii) Relative humidity
(iii) Dew point
(iv) Specific enthalpy
(v) Water density

(60 marks)

3. (a) Distinguish between exothermic and endothermic reactions citing ONE (1) example of each type.

(20 marks)

(b) A 1kg of butane (C_4H_{10}) is used in the combustion, calculate both the stoichiometric air-fuel ratio required and air-fuel ratio for combustion with 50% excess air.

(30 marks)

...3/-

(c) Ethyl alcohol (C_2H_5OH) vapor is burnt in a combustion chamber using oxygen as oxider. Calculate the heat of reaction at 25°C and 101.3kPa.

(50 marks)

4. (a) What is the range of volumetric efficiency values in a well-design naturally aspirated spark ignition engine? Discuss TWO (2) primary factors which may contribute to the volumetric efficiency.

(30 marks)

(b) The Rover M16 four-stroke four cylinder spark ignition engine has a swept volume of 2.0 litres. When the vehicle speed is 120 km/h corresponds to 3669 rpm, a torque of 71.85 Nm was recorded and the brake specific fuel consumption is 298 g/kWh. The air-fuel ratio is 20:1. Calculate:

(i) the brake mean effective pressure
(ii) the brake thermal efficiency
(iii) the fuel consumption (litres/100km)
(iv) the volumetric efficiency

The calorific value of the fuel is 43 000 kJ/kg and its density is 795 kg/m^3. Ambient conditions are 27°C and 1.05 bar.

(70 marks)

5. (a) Single stage compression at very high pressure is highly ineffective compared with multistage compression. Discuss TWO (2) difficulties in single stage compression at very high pressure and the solutions which are practically applied to multistage compression.

(30 marks)

(b) A single acting two stage compressor draws in free air and compresses it to 8.5 bar. The compressor runs at 600 rev/min. The atmospheric conditions are 1.013 bar and 15°C. The intermediate pressure is 3 bar and the intercooler cools the air back to 30°C. The polytropic index for all compressions and expansions is 1.28. Due to the effect of warming from the cylinder walls, the induction pressure and temperature at the start of the low pressure compression stroke is 0.96 bar and 25°C. The clearance volume for each stage is 4% of the swept volume of that stage. The diameter of the low pressure cylinder is 300 mm and the stroke for both low and high pressure cylinders is 160 mm. Calculate:

(i) the free air delivery, FAD
(ii) the volumetric efficiency of the low pressure stage
(iii) the diameter of the high pressure cylinder

(70 marks)

- oooOOOooo -