



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

DIPLOMA IN MECHANICAL ENGINEERING

MED-PR 212: THERMODYNAMICS II

DATE: 03/05/2019

TIME: 8.30-10.30 AM

INSTRUCTIONS:

Answer Question One (Compulsory) and Any Other Two Questions

QUESTION ONE (30 MARKS)

- a) From first principles show that the change in entropy of one kilogram of a gas is given by

$$S = C_v \ln \frac{P_2}{P_1} + C_p \ln \frac{V_2}{V_1} \quad (8 \text{ marks})$$

- b) 0.3 kg of air at a pressure of 350 kN/m² and a temperature of 35°C respectively receives heat energy at constant volume until its pressure becomes 700 kN/m². It then receives heat energy at constant pressure until its volume becomes 0.2289 m³. Determine the change of entropy during each process.

(Take $C_p = 1.006 \text{ kJ/Kg K}$ and $C_v = 0.717 \text{ kJ/Kg K}$). (12 marks)

- c) An engine works on the constant volume cycle. It has a bore of 80 mm and a stroke of 85 mm. the clearance volume of the bore of the engine is 0.06 litre. The actual thermal efficiency of the engine is 22%. Determine the relative efficiency of the engine.

(Take $\gamma = 1.4$) (10 marks)

QUESTION TWO (20 MARKS)

A quantity of gas has an initial pressure, volume and temperature of 140 kN/m², 0.14 m³ and 25°C respectively. It is compressed to a pressure of 1.4 MN/m² according to the law $PV^{1.25} = C$. Determine

- a) The change of entropy (10 marks)
- b) The approximate change of entropy contained by dividing the heat transferred by the gas by the mean absolute temperature during the compression. (10 marks)

(Take $C_p=1.041\text{kJ/kgK}$, $C_v=0.743\text{kJ/kgK}$)

QUESTION THREE (20 MARKS)

A gas engine is supplied with coal gas of the following composition: 53.6% H_2 ; 9% CO ; 25% CH_4 ; 3% C_4H_8 ; 0.4% O_2 ; 3% CO_2 ; 6% N_2 . If the air fuel ratio is 6.5/1 by volume, calculate the analysis of the dry products of combustion. It can be assumed that the stoichiometric air fuel ratio is less than 6.5/1

QUESTION FOUR (20 MARKS)

In an ideal diesel cycle the volume ratios of the adiabatic expansion and compression are 7.5:1 and 15:1, respectively. The pressure and temperature at the beginning of compression are 98kN/m^2 and 44°C respectively. The pressure at the end of the adiabatic expansion is 258kN/m^2 . Determine:

- a) The maximum temperature attained during the cycle (10 marks)
- b) The thermal efficiency of the cycle. (10 marks)

(Take $\gamma=1.4$)

QUESTION FIVE (20 MARKS)

The analysis of dry exhaust gas from a 4-stroke, 4-cylinder internal combustion engine gave the following result; 12% CO_2 , 2% CO , 4%, CH_4 , 1% H_2 , 4.5% O_2 and the remainder nitrogen. The engine has a bore of 180mm and a stroke of 380mm, with a compression ratio of 18:1. The specific fuel consumption and brake mean effective pressure at an engine speed of 780rpm are 0.2064kg/kWh and 9.3 bar. The calorific value of fuel is 44.2MJ/kg and air inlet conditions are 25°C and 1.7 bar. If the mechanical efficiency of the engine is 85%, determine the ratio of carbon to hydrogen by mass in the fuel assuming it to be a pure hydrogen.