



MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR DIPLOMA IN

MECHANICAL ENGINEERING

SUPPLEMENTARY EXAMINATION

MED-PR 212: THERMODYNAMICS II

DATE:

TIME:

INSTRUCTIONS

Answer all questions in Section A and choose any other TWO in Section B

SECTION A

1. 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)

SECTION B

2. A quantity of gas has an initial pressure, volume and temperature of 140 kN/m^2 , 0.14 m^3 and 25°C respectively. It is compressed to a pressure of 1.4 MN/m^2 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 $C_p = 1.041\text{ kJ/kgK}$, $C_v = 0.743\text{ kJ/kgK}$)
3. A gas engine is supplied with coal gas of the following composition: $53.6\% \text{ H}_2$; $9\% \text{ CO}$; 25% ; $\text{CH}_4 3\%$; C_4H_2 ; $0.4\% \text{ O}_2$; $3\% \text{ CO}_2$; $6\% \text{ N}_2$. 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 $6.5/1$ (20 marks)
4. A four-cylinder stroke diesel engine has a compression ratio of $16:1$, a bore of 180 mm and a stroke of 320 mm . At a speed of 750 rev/min , the brake mean effectiveness pressure is 9.5 bar and the specific fuel consumption is 0.201 kg/kWh . The calorific value of the fuel is 44200 kJ/kg . The atmospheric conditions are 25°C and 0.98 bar respectively. If the mechanical efficiency of the engine is 83% , determine the:
- a) Indicated power
 - b) Indicated thermal efficiency
 - c) Volumetric efficiency
- (Take $R = 287\text{ J/KgK}$) (20 marks)
5. 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 98 kN/m^2 and 44°C respectively. The pressure at the end of the adiabatic expansion is 258 kN/m^2 . Determine:
- a) The maximum temperature attained during the cycle (10 marks)
 - b) The thermal efficiency of the cycle. (10 marks)
- (Take $\gamma = 1.4$)