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

MED-PR 212: THERMODYNAMICS II

DATE: 31/5/2017 **TIME: 2:00 – 4:00 PM**

INSTRUCTIONS

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

SECTION A

1. a) An engine works on the constant volume cycle. It has a bore of 80mm and a stroke of 85mm. the clearance volume of the bore of the engine is 0.06 litres. The actual thermal efficiency of the engine is 22%. Determine the relative efficiency of the engine. (Take γ=1.4) (10 marks)

   b) A gas engine is supplied with coal gas of the following composition: 53.6% H_2 ; 9% CO ; 25% ; $CH_4$3% ; C_4H_2 ; 0.4%O_2 ; 3%CO_2 ; 6% N_2. If the air fuel ratio is 6.5/1by 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 (10 marks)

   c) 0.3 kg of air at a pressure of 350 KN/m^2 and a temperature of 35^{o}c respectively receives heat energy at constant volume until its pressure becomes 700KN/m^2. It then receives heat energy at constant pressure until its volume becomes 0.2289m^3. Determine the change of entropy during each process.
   (***Take C_p =1.006kJ/Kg K and C_v= 0.717 kJ/Kg K***) (10 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTIONS

2. One kilogram of air is taken through a constant volume cycle. At the commencement of the adiabatic compression, the pressure and temperature are 103 KN/m² and 100ºc respectively. The adiabatic compression has a volume ratio of 6:1. The maximum pressure of the cycle is 3.45 MN/m². Determine, for the cycle;

   a) The pressure, volume and temperature at each of the cycle process change points. (9 marks)

   b) The heat transferred to and rejected by the air. (5 marks)

   c) The ideal thermal efficiency and work done (3 marks)

   d) The mean effective pressure. (3 marks)

   (Take R = 0.287 KJ/KgK, γ= 1.4)

3. 4.5 kg of steam has an initial pressure of 3MN/m² and temperature of 300º. The steam then expands reversibly to a new pressure of 0.1MN/² with a dryness fraction of 0.96. The expansion of the steam appears as a straight line when plotted on a temperature – entropy chart. Determine:

   a) The heat transfer during the expansion. (10 marks)

   b) The work done during the expansion. (10 marks)

4. A four-cylinder stroke diesel engine has a compression ratio of 16:1, a bore of 180 mm and a stroke of 320mm. 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 44200kJ/kg. the atmospheric conditions are 25^0c and 0.98bar respectively. If the mechanical efficiency of the engine is 83%, determine the:

   a) Indicated power (7 marks)

   b) Indicated thermal efficiency (7 marks)

   c) Volumetric efficiency (6 marks)

   (Take R=287 j/KgK)

5. 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. (20 marks)