



MACHAKOS UNIVERSITY

University Examinations 2017/2018

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR FIRST SEMESTER EXAMINATION FOR DIPLOMA IN

MECHANICAL ENGINEERING

MED-PR 204: THERMODYNAMICS I

DATE: 13/12/2017

TIME: 8:30 – 10:30 AM

INSTRUCTIONS

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

SECTION A

1. a) i Define the following terms as used in applied thermodynamics.
 - I. System
 - II. Property
 - III. Cycle (3 marks)
- ii Show that work done by a fluid undergoing a polytropic process is given by $w = \frac{P_1 V_1 - P_2 V_2}{n-1}$ (6 marks)
- b) 0.014m³ gas at a pressure of 2070kN/m² expands to a pressure of 207kN/m² according to the law $PV^{1.35}=C$. Determine the work done by the gas during the expansion. (5 marks)
- c) In a steady flow open system, a fluid substance flows at the rate of 4kg/s. It enters the system at a pressure of 600kN/m², a velocity of 220m/s, internal energy 2200kJ/kg and a specific volume 0.42m³/kg. It leaves the system at a pressure of 150kN/m², a velocity of 145m/s, internal energy 1650kJ/kg and specific volume 1.5m³/kg. During its passage through the system, the substance has a heat loss by transfer of 40kJ to the surroundings. Determine the power of the system, stating whether it is from or to the system. Neglect any change in gravitational potential energy (10 marks)

- d) A quantity of dry saturated steam occupies 0.3951m^3 at 1.5MN/m^2 . Determine the final condition of the steam if it is compressed until the volume is halved;
- if the compression is carried out in an isothermal manner (3 marks)
 - if the compression follows the law $PV=C$ (3 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTIONS

2. A quantity of steam at a pressure of 2.1 MN/m^2 and 0.9 dry occupies a volume of 0.427m^3 . It is expanded according to the law $PV^{1.25}=C$ to a pressure of 0.7 MN/m^2 . Determine
- The mass of the steam present and work transfer (10 marks)
 - The change in internal energy (5 marks)
 - The heat exchange between the steam and surroundings, stating the direction of transfer. (5 marks)
3. 0.25 kg of air at a pressure of 140kN/m^2 occupies 0.15m^3 and from this condition, it is compressed to 1.4MN/m^2 according to the law $pV^{1.25}=c$. Determine
- The change of internal energy of the air (8 marks)
 - The work done on or by the air (6 marks)
 - The heat received or rejected by the air (6 marks)
- (Take $C_p=1.005\text{kJ/kgK}$, $C_v=0.718\text{kJ/kgK}$)*
4. A closed vessel of 0.8 m^3 capacity contains dry saturated steam at 360kN/m^2 . The vessel is cooled until the pressure is reduced to 200kN/m^2 . Calculate the mass of steam in the vessel and the final dryness of the steam. Calculate also the heat transferred during the cooling process. (20 marks)
5. Air passes through a gas turbine system at the rate of 4.5kg/s . It enters the turbine system with a velocity of 90m/s and a specific volume of $0.85\text{m}^3/\text{kg}$. It leaves the turbine system with a specific volume of $1.45\text{m}^3/\text{kg}$. The exit area of the turbine system is 0.038m^2 . In its passage through the turbine system, the specific enthalpy of the air is reduced by 200kJ and there is a heat transfer loss of 40 kJ/kg . Determine
- The inlet area of the turbine in m^2 (6 marks)
 - The exit velocity of the air in m/s (6 marks)
 - The power developed by the turbine system (8 marks)