



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

DIPLOMA IN MECHANICAL ENGINEERING

MED-PR 204: THERMODYNAMICS I

DATE: 30/7/2019

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) i) Define the following terminologies as used in applied thermodynamics;
 - a) System.
 - b) Phase.
 - c) Boundary
 - d) Enthalpy
 - e) Thermalstatic property (5 marks)
- ii) A fluid at a pressure of 3 bar and with specific volume of $0.18\text{m}^3/\text{kg}$ contained in a cylinder behind a piston expands reversibly to a pressure of 0.6 bar according to a law, $P = \frac{C}{v^2}$ where C is a constant. Calculate the work done by the fluid on the piston. (5 marks)
- iii) At a speed of 50km/h, the resistance to motion of a car is 900N. Neglecting losses, what is the power output of the engine of the car (3 marks)
- b) i) From first principles and with aid of a sketch derive the steady flow energy equation. (6 marks)

- ii) During the working stroke of an engine the heat transferred out of the system was 150kJ/kg of working substance. The intrinsic energy also decreased by 400kJ/kg of working substance. Determine the work done and state whether it is work done on or by the engine. (4 marks)
- iii) Lead is extruded slowly through a horizontal die. The pressure difference across the die is 154.45MN/m². Assuming that there is no cooling through the die, determine the temperature rise of the lead. Assume the lead is incompressible and to have a density of 11360kg/m³ and a specific heat capacity of 130kJ/KgK. (5 marks)
- c) It is impossible to have an engine having the perpetual motion of the first kind. Explain. (2 marks)
- 2 a) i) State the following Laws as used in Applied Thermodynamics
- a) Boyles Law.
- b) Charles Law. (2 marks)
- ii) Show from the first principles that the specific heat capacity of a gas at a constant pressure is given by
- $$C_P = \frac{R\gamma}{\gamma - 1}$$
- Where R is the specific gas constant
- γ is the adiabatic index (8 marks)
- iii) A certain perfect gas has a molecular weight of 26kg/Kmol and a value of $\gamma = 1.26$. Calculate the heat rejected per kg of gas;
- (i) When the gas is contained in a rigid vessel at 3 bar and 315°C and is then cooled until the pressure falls to 1.56 bar.
- (ii) When the gas enters the pipe line at 280°C and flows steadily to the end of the pipe where the temperature is 20°C.
- Neglect velocity changes in the pipeline. (7 marks)
- 3 a) Define the following terms as used in thermodynamics
- i) two phase fluid
- ii) saturated steam
- iii) dry steam

- iv) dry fraction (4 marks)
- b) Steam 0.95 dry at a pressure of 0.7MN/m^2 is supplied to a heater through a pipe of 25mm internal diameter, the velocity of the steam in the pipe being 12m/s. water enters the heater at 20°C , the steam is blown into it and the mixture of water and condensate leaves the heater at 90°C . Calculate
- i) the mass of the steam entering the heater in kg/h (8 marks)
- ii) the mass of water entering the heater in kg/h (8 marks)
4. A nozzle is a device for increasing the velocity of a steadily flowing stream of fluid. At the inlet to a certain nozzle the enthalpy of fluid is 3025kJ/kg and the velocity is 60m/s. At the exit from the nozzle, the enthalpy is 2790 kJ/kg . The nozzle is horizontal and there is negligible heat loss from it.
- a) Find the velocity at the nozzle exit (6 marks)
- b) If the area is 0.1m^2 and the specific volume at inlet is $0.19\text{m}^3/\text{kg}$, find the rate of fluid flow (8 marks)
- c) If the specific volume at the nozzle exit is $0.5\text{m}^3/\text{kg}$, find the exit area of the nozzle. (6 marks)
5. 0.05 kg of CO_2 (molar mass 44kg/mol), occupying a volume of 0.03m^3 at 1.025 bar , is compressed reversibly until the pressure is 6.15 bar . Calculate the final temperature, the work done on the CO_2 and the heat flow to or from the cylinder walls,
- a) When the process is according to the law $p v^{1.4} = c$,
- b) When the process is isothermal,
- c) When the process takes place in a perfectly thermally insulated cylinder.
- (assume CO_2 to be a perfect gas and take $\gamma=1.3$) (20 marks)