MACHAKOS UNIVERSITY

University Examinations for 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

FIRST YEAR SECOND SEMESTER EXAMINATION FOR

CERTIFICATE IN MOTOR VEHICLE ENGINEERING

APPLIED SCIENCE

DATE: 18/12/2020 **TIME: 2:30 – 5:30 PM**

INSTRUCTIONS TO CANDIDATES

- This paper consists of FIVE questions
- Answer all questions

1. (a) State the following laws:
   i. Boyle's Law
   ii. Charles' Law (4 marks)

   (b) A gas whose original pressure and volume were 350 kN/m^2 and 0.15 m^2 respectively is expanded until its new pressure is 50 kN/m^2 with its temperature remaining constant. Calculate its new volume. (3 marks)

   (c) The volume of a gas trapped in a glass apparatus was 1000 mm^3 when the temperature was 20^0 C. The temperature of the gas was then raised to 90^0 C. Calculate the new volume if the pressure exerted remained constant. (5 marks)

   (d) (i) A quantity of gas has a pressure of 350 kN/m^2 when its volume is 0.3 m^3 and its temperature is 35^0 C. If the value of the characteristic gas constant R is 0.29 KJ/kg, determine the mass of the gas present.

   (ii) If the pressure of this gas in (d) (i) above is now increased to 1.05 MN/m^2 while the volume remains constant, determine the new temperature of the gas in ^{0}C. (8 marks)

2. (a) With reference to simple machines,

i. Differentiate between

I. input and output

II. load and effort

ii. Explain the following terms:

I. velocity ratio

II. mechanical advantage

III. efficiency (7 marks)

(b) With aid of a sketch, describe the operation of a simple wheel and axle, indicating how its efficiency is determined. (5 marks)

(c) Table below shows results obtained in an experiment using a simple machine.

Load, W (N)	50	100	150	200	250	300	350	400
Effort F (N)	5	7	8	10	12	13	15	17

Plot the load-effort graph and determine:

(i) The law of the machine,

(ii) The load that can be raised by an effort of 30 N,

(iii) The efficiency of the machine if the velocity ratio is 30. (8 marks)

3. (a) A lorry hauls a trailer at 72 km/h when exerting a steady pull of 800 N on the tow-rope. Calculate: -

(i) The work done in 20 minutes

(ii) The power required (8 marks)

(b) Find the mass of cooling water required to condense 5 kg of steam at atmospheric pressure and a temperature of 100^0C, and then to cool the resulting water to 60^0C. If the permissible rise in temperature of the cooling water is 30K.

Take: specific heat capacity for water = 4.2kJ/kg K

Specific latent heat of vaporization = 2260 kJ/kg (12 marks)

4. (a) Explain what is meant by 'absolute "pressure" (2 marks)

(b) A volume of 84 litres of gas initially at a pressure of 14 bar absolute is expanded until the pressure is 2.8 bar absolute. What is the new volume if the temperature subsequently changes from 25^0 C to 10^0 C at constant pressure of 2.8 bar absolute. (8 marks)

c) The compression ratio of a compression engine is 12 to 1, the bore diameter is 110 mm and stroke is 140 mm. Calculate the clearance volume of the engine.

(10 marks)

5. (a) Define the following terms:

i) Specific latent heat of fusion,

ii) Specific heat capacity.

iii) Specific latent heat of vaporization (6 marks)

(b) A steel component having a mass of 20 kg and temperature of 700^0 C is dropped into a tank containing 40 kg of water at 15^0 C. Neglecting the heat energy absorbed by the tank and any loss of heat energy to the surrounding air, determine

i. The final temperature of the water

ii. The heat energy absorbed by the water (14 marks)

Take the specific heat capacities of steel and water as 0.48kJ/kg K and 4.2 kJ/kg K respectively.