MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOOGY

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2024/2025ACADEMIC YEAR

THIRD YEAR **FIRST** SEMESTER EXAMINATION FOR BACHELOR

OF TECHNOLOGY EDUCATION AND BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING

EMT 301- THERMODYNAMICS II

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question ONE and any other two questions.
2. You are allowed to have a steam table and a calculator
3. Mobile phones are not allowed in the examination room.
4. You are not allowed to write on this examination question paper.

SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) Define the following terms:
   i. Indicated Power (ip)
   ii. Brake Power (bp) (4 marks)

b) Briefly explain the working principle of a four stroke cycle compression-ignition (CI) engine. (6 marks)

c) Show that for an Otto cycle.

$\eta = 1 - \frac{1}{r_v^{\gamma-1}}$ (4 marks)

d) Briefly describe the processes in the Otto cycle with the help of a P-V diagram. (6 marks)

e) Calculate the cycle efficiency and mean effective pressure of an air standard diesel cycle with a compression ratio of $^{15}/_{1}$ Given that the maximum and minimum cycle temperatures are, 1650 ^{0}C and 15 ^{0}C , the maximum cycle pressure is 45 bar,$\gamma = 1.4$, and R=0.287$^{KJ}/_{Kg}$ (10 marks)

ECTION B– ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a) Briefly describe the processes in a dual combustions cycle with the help of a P-v diagram. (6 marks)

b) An oil engine takes in air at 1.01bar, 20^{0}C and maximum cycle pressure is 69 bar. The compressor ratio is, $^{18}/_{1}$. Calculate the air standard thermal efficiency and the mean effective pressure based on the dual-combustion cycle. Assume the heat added at constant volume is equal to the heat added at constant pressure. (14 marks)

QUESTION THREE (20 MARKS)

a) For a Polytropic compression process shows that.

$P_i = \sqrt{(P_2 P_1)}$ (6 marks)

b) In a single acting, two stage reciprocating compressor, 4.5kg of air per minute are compressed from 1.013bar and 15^{0}C through a pressure ratio of 9 to 1. Both stages have the same pressure ratio, and the law of compression and expansion in both stages is

$PV^{1.3}$=constant. If intercooling is complete, calculate the indicated power and the swept volumes required. Assume that the clearance volumes of both stages are 5% of their respective swept volumes and that the compressor funs at 300 rev/min. (14 marks)

QUESTION FOUR (20 MARKS)

a) Describe how each of the methods listed below are used to determine the Mechanical efficiency of an internal combustion engine. (6 marks)

   i. The Morse test

   ii. Williams line

b) A four-cylinder petrol engine has a bore of 57 mm and a stroke of 90 mm. Its rated speed is 2800rev/min and it is tested at this speed against a brake which has a torque arm of 0.356m. The net brake load is 155N and fuel consumption is 6.74 l/h. The specific gravity of the petrol used is 0.735 and it has a lower calorific value, $Q_{net, v}$ of 44200 $^{KJ}/_{Kg.}$ A Morse test is carried out and the cylinders are cut out in the order 1,2,3,4 with corresponding brake loads of 111, 106.5, 104.2 and 111N, respectively.

   Calculate for this speed, the engine toque, the bmep, the brake thermal efficiency, the specific fuel consumption, the mechanical efficiency and the imep. (14 marks)