MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2024/2025 ACADEMIC YEAR

FOURTH YEAR **FIRST** SEMESTER EXAMINATION FOR BACHELOR OF TECHNOLOGY IN MECHANCIAL ENGINEERING

EMT 403 FLUID POWER CONTROL

DURATION:2 HOURS

INSTRUCTIONS TO CANDIDATES:

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

SECTION A – ANSWER ALL QUESTIONS IN THIS SECTION

QUESTION ONE (30 MARKS)

a) With the aid of a block diagram, illustrate the energy conversion in basic hydraulic system. (4 marks)

b) Explain any four main requirements imposed on hydraulic liquids. (2 marks)

c) Define the term Viscosity Index (VI) and state tits significance with regard to variation of Viscosity of hydraulic fluid with temperature. (3 marks)

d) Using hydraulic symbols, illustrate the use of return flow filler in a hydraulic circuit with a single rod cylinder, a pressure relief value, a directional control value and a fixed displacement pump driven by electric motor. (3 marks)

e) A pump has displaced volume of $100cm^2$. It delivers 0.0015m/s at 1000 RPM at 70 bars. If the prime mover input torque is 120N.m. Find the:
   i) Overall efficiency of the pump. (5 marks)
   ii) Theoretical torque required to operate the pump. (2 marks)

f) With the aid of a well labelled sketch, illustrate the basic parts of hydraulic oil tank and state their main functions. (4 marks)

g) Highlight the three main actions that can be taken to avoid cavitation phenomena in displacement pumps.

h) A hydraulic cylinder is to compress a car body in 10 seconds. The operation requires a stroke of 3 m and force of 40,000N. if a 7.5 N/mm^2 pump has been selected, Find the following
   i. Required piston area and piston dimeter (1.5 marks)
   ii. The necessary pump flow (2 marks
   iii. The hydraulic power capacity in Kw (2 marks)

SECTION B– ANSWER ANY TWO QUESTIONS IN THIS SECTION

QUESTION TWO (20 MARKS)

a) State four factors that should be considered when selecting a hydraulic cylinder. (2 marks)

b) With the aid of a steeped piston cylinder diagram, describe cushioning process at the end of the cylinder. (5 marks)

c) Operator of a hydraulic jack makes one complete cycle per second using hand pump (figure Q2©. Each complete cycle consists of two punch strokes (intake and power stroke). The pump has a 25mm diameter cylinder and load cylinder is of 90mm diameter. If the average hand force is 150N during power stroke determine
   i. The load that can be lifted. (2 marks)
   ii. The number of cycles required to lift the load through 250mm, assuming the pump piston has 50mm stroke and there is no leakage. (3 marks)
   iii. The power exerted by the operator assuming 100% efficiency. (2 marks)

d) A hydraulic motor has an $82cm^3$ volume metric displacement. It has a pressure rating of 70 bars and it receives oil from a 0.0006 m^3 /s pump, find the motor.

i. Speed. (2 marks)
ii. Torque Capacity. (2 marks)
iii. Power Capacity (2 marks)

QUESTION THREE (20 MARKS)

a) State four main function of accumulators as used in hydraulics systems. (4 marks)
b) Describe the construction and operation of the following types of accumulators
   i. Weight loaded type (3 marks)
   ii. Bladder type (3 marks)
c) An accumulator is loaded with 500 kN weight. The ram has a diameter of 30 cm and stroke of 6 m. Its friction may be taken as 3%. |It takes 120 seconds to fall through its full stroke. Find the total work supplied and power delivered to the hydraulic appliance by the Accumulator, when 7.5 litres of fluid per minute is delivered by a pump while accumulator descends with the stated velocity. Take specific weight and density of oil as 100 units. (10 marks)

QUESTION FOUR (20 MARKS)

a) i) Mention three characteristics that distinguish positive displacement pumps from non-positive displacement pumps. (3 marks)
   ii) With the aid of a Sketch, explain the construction and operation of the following pumps.
      I. External gear pump
      II. Balanced Vane pump (10 marks)
b) A hydrostatic transmission operating at 70 bar has the following characteristics
   Pump displacement=81.95cm^3/revolution
   Pump Volumetric efficiency=82%
   Pump Mechanical efficiency =88%
   Pump speed is 500 RPM
   Motor volumetric efficiency 92%
   Motor Mechanical efficiency 90%
   Motor speed =400 RPM
   Calculate:
   a) The motor displacement (5 marks)
   b) The motor output Torque (2 marks)