TECHNICAL UNIVERSITY OF MOMBASA

DEPARTMENT OF MECHANICAL AND AUTOMOTIVE ENGINEERING

UNIVERSITY EXAMINATIONS 2015/2016

FOURTH YEAR FIRST SEMESTER UNIVERSITY EXAMINATION FOR THE DEGREE
IN BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING (BSME)

EMG 2401: INDUSTRIAL HYDRAULICS

SERIES: MAY 2016

TIME: 2 HOURS

<u>INSTRUCTION TO CANDIDATES:</u>

1. You should have the following for this examination:-
   - Answer Booklet
   - Scientific Calculator
2. This paper consists of FIVE Questions
3. Question ONE is COMPULSORY
4. Answer any other TWO Questions
5. Question ONE carries 30 Marks and the other FOUR questions carry 20 Marks each
6. All symbols have their usual meaning unless specified otherwise

<u>QUESTION ONE:</u> (COMPULSORY: 30 Marks)

a) State FIVE (5) advantages of hydraulic systems over other methods of power transmission. (5 Marks)

b) i) Name two types of hydraulic pump in each of the following categories:
   - Non-Positive Displacement
   - Positive Displacement

   ii) With the aid of a sketch, explain the operation of a lobe pump. (10 Marks)

c) A hydraulic system is to be designed for clamping work and to perform drilling operation. The system is to consist of the following components:
   - Reservoir
   - Pump
   - Relief Valve

- Manually operated spring centered three position four way directional control valve.
- Two sequence valves
- Two double acting actuators

Using two line diagram and hydraulic symbols, design and draw a suitable circuit diagram for the system.   (15 Marks)

QUESTION TWO: (20 Marks)

a) The hose supplying the cylinder operating the bucket of a large excavator has fluid at 1000 psi flowing at 5 gpm. What is the available power in the line?
(6 Marks)

b) Hydraulic oil ISO 68 is flowing through a hydraulic line with inside diameter 0.05m at a rate of 300 gpm. Find the pressure drop in psi for a 3m length of hose.
Given: Hydraulic oil ISO 68 has a density of 880 kg/cu-m and a kinematic viscosity of $6.8 \times 10^{-5} \, m^2 \Big/ s$ at 104 F.   (6 Marks)

c) A hydraulic hose with internal diameter of 25 mm is carrying oil with kinematic viscosity of $5.0 \times 10^{-5} \, m^2 \Big/ s$ at a flow rate of 20 gpm. Calculate the Reynolds number and determine if the flow is laminar or turbulent.   (3 Marks)

d) Mention TWO different types of pressure control valves and state their use in a hydraulic system.   (2 Marks)

e) Assisted by a graphical diagram, state the meaning of the following terms as applied to a pressure relief valve:
- Cracking pressure   (1 Mark)
- Full-flow pressure   (1 Mark)
- Pressure over-ride   (1 Mark)

QUESTION THREE: (20 Marks)

a) Illustrate the operations of the following types of cylinders as used in hydraulic systems:

i) Double rod cylinder

ii) Single acting cylinder with spring.

With the aid of a sketch, explain the construction of a Tie-Rod Cylinder.

(10 Marks)

b) i) Differentiate a Relief valve from a Sequence valve in pressure control valves.

ii) Outline the FOUR variables upon which the flow of hydraulic fluid depends on in a Throttle valve. (10 Marks)

QUESTION FOUR: (20 Marks)

a) There are several hydraulic systems used in the industries. Explain the working principles of the following basic hydraulic systems (use sketches):
   i)   Open Center system   (3 Marks)
   ii)   Motor Reversing system   (3 Marks)
   iii)   Closed Center system   (3 Marks)

b) i) Outline three functions of hydraulic system reservoirs.
   ii)   Explain the principle of operation of the following hydraulic filters.
   - Surface filtration
   - Depth filtration   (6 Marks)

c) Outline two possible causes and remedies for each of the following trouble in hydraulic system:
   i)   Absence of proper speed and torque of the hydraulic motor.
   ii)   Sudden drop of pressure in the accumulator.   (5 Marks)

QUESTION FIVE: (20 Marks)

a) A hydraulic hose with internal diameter of 25 mm is carrying oil with kinematic viscosity of $5.0 \times 10^{-5} \, m^2/s$ at a flow rate of 20 gpm. Calculate the Reynolds number and determine if the flow is laminar or turbulent. (4 Marks)

b) Mention TWO different types of pressure control valves and state their use in a hydraulic system. (2 Marks)

c) i) Differentiate between filters and strainers and name the THREE parts of a Full-flow hydraulic filter and their functions. (4 Marks)

ii) Describe the structure and operation of a proportional flow filter and state when it can be used. (3 Marks)

d) i) In addition to flexible hoses, mention TWO other types of hydraulic fluid conductors and give THREE reasons why hoses are the best form of the fluid power plumbing. (3 Marks)

ii) List down FOUR requirements of the fluid power plumbing. (4 Marks)

USEFUL RELATIONSHIPS:

TABLE 1: Conversion between Pressure Units

	Pascals (Pa)	Megapascal (MPa)	Bar (Bar)	lbs-sq-in (Psi)
1 Pa	1	10^{-6}	10^{-5}	145×10^{-6}
1 MPa	10^{6}	1	10	145
1 Bar	10^{5}	0.1	1	14.5
1 Psi	6895	6.895×10^{-3}	0.06895	1

TABLE 2: Conversion between Volume Flow Rate Units

	gallons/minute (gpm)	liter/minute (lpm)	cubicmeter/sec (m^3/s)
1 gpm	1	3.785	6.31×10^{-5}
1 lpm	0.264	1	1.67×10^{-5}
$1 m^3/s$	1.585×10^{4}	6×10^{4}	1