TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY SPECIAL/SUPPLEMENTARY EXAMINATION FOR:
BSc. Mechanical Engineering
EMG 2401 : INDUSTRIAL HYDRAULICS
SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: AUGUST2017
TIME: 2 HOURS
DATE: Pick Date**Aug2017**

Instruction to Candidates:

You should have the following for this examination

- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions.
Question **ONE** is **COMPULSORY**
Attempt any other **TWO** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.
Mobile phones are not allowed in the examination room.

Question ONE (COMPULSORY: 30 Marks)

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

c) 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? (5 Marks)

d) 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
- Safety Valve
- Manually operated spring centered three position four way directional control valve
- Throttle check valve
- Hydraulic cylinder

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

Question TWO (20 Marks)

a) i) Mention FOUR (4) major functions of a hydraulic accumulator (2 Marks)
ii) Assisted by diagrams, differentiate between a spring-loaded accumulator and a bag-type accumulator. For any of these accumulators, describe its operations and the limitations. (4 Marks)

b) i) Differentiate between filters and strainers and name the THREE (3) 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)

c) A 30 cm diameter pipe carries lubrication oil of 0.9 specific gravity at a velocity of 3 m/s. Find the mass flow rate of oil. What will be the oil velocity at another section where diameter is reduced to 20 cm. (4 Marks)

d) Water under a pressure of 29.43 N/cm^2 (g) and velocity of 2 m/s is flowing through a 5 cm diameter pipe. Find the total head of water at a section 5 m above datum line. (3 Marks)

Question THREE (20 Marks)

a) Explain the working principles of the following devices:
   I. Hydraulic Press (3 Marks)
   II. Hydraulic Lift (3 Marks)
   III. Hydraulic Intensifier (3 Marks)

b) A certain machinery is operated with a hydraulic accumulator through a pipe 180 m long and 100 mm diameter. The accumulator has ram 250 mm diameter and 3 m stroke and is loaded with 345 kN weight. It is fed with water from a three throw pump at 45 rpm. The plunger of the pump has a diameter of 45 mm and stroke of 350 mm; the slip being 3 per cent. If the machinery absorbs 36.8 kW

power, calculate the longest period for which it can be operated continuously. Take friction factor, f=0.032. (11 Marks)

Question FOUR (20 Marks)

a) Outline two possible causes and remedies for each of the following trouble in hydraulic systems:
   i) Absence of proper speed and torque of the hydraulic motor.
   ii) Sudden drop of pressure in the accumulator. (6 Marks)

a) A jet of water is discharged through a nozzle with an effective diameter of 75 mm and a velocity of 22.5 m/s. Calculate the power of the issuing jet.
   If the nozzle is supplied from a reservoir which is 30 m above it, what is the loss of head in the pipeline and nozzle and the efficiency of power transmission? (14 Marks)

Question FIVE (20 Marks)

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

   With the aid of a sketch, explain the operation of lobe pump. (8 Marks)

b) State Seven (7) requirements imposed on a hydraulic liquid that make it acceptable to be used in hydraulic systems. (7 Marks)

c) With the aid of a diagram, state the following:
   i) Interaction of hydraulic and atmospheric pressures
   ii) Effect of friction on pressure (5 Marks)

<u>USEFUL RELATIONSHIPS:</u>

Table 1: Conversion between Pressure Units

	Pascals (Pa)	Megapascal (MPa)	Bar (Bar)	lbs-sq-in (Psi)
I 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