Faculty of Engineering and Technology
Department of Pure & Applied Sciences
UNIVERSITY EXAMINATION FOR:
BSc.
EMG 2401 : INDUSTRIAL HYDRAULICS
SPECIAL/SUPPLEMENTARY EXAMINATION
SERIES: SEPTEMBER 2018
TIME: 2 HOURS
DATE: Pick Date **Sep 2018**

Instruction to Candidates:
You should have the following for this examination
- *Answer booklet*
- *Non-Programmable scientific calculator*

This paper consists of **FIVE** questions. Attempt question **ONE** and any other **TWO** questions.
Maximum marks for each part of a question are as shown.
Do not write on the question paper.

Question ONE (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.   (8 Marks)

c) 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. (9 Marks)

d) 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. (8 Marks)

QUESTION TWO (20 Marks)

a) $10 \; {m^3}/{h}$ of water flows through a pipe of 100 mm inside diameter. The pipe is later reduced to an inside diameter of 80 mm. Calculate the flow velocity in each pipe. (4 Marks)

b) A new sewer line plan calls out a 0.6% slope of the line. An elevation reading of 108.8 feet at the manhole discharge and an elevation of 106.2 feet at a distance of 200 feet from the manhole are recorded. What is the existing slope of the line that has been installed? (2 Marks)

c) Hydraulic oil ISO 68 is flowing through a hydraulic line with inside diameter 0.05m at a rate of 200 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 $6.8 \times 10^{-5} \; {m^2}/{s}$ at 104 F. (6 Marks)

d) 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. (3 Marks)

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

f) 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) 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)

b) 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 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)   Hydraulic Jack   (3 Marks)

    ii)   Flow divider   (3 Marks)

    iii)   Close Center System   (3 Marks)

b) With the aid of diagram, state the following:

    i)   Interaction of hydraulic and atmospheric pressures.   (3 Marks)

    ii)   Effect of friction on pressure   (3 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) i) Mention FOUR 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 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) 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?   (7 Marks)

<u>**USEFUL RELATIONSHIPS:**</u>

TABLE 1: Conversion between Pressure Units

	Pascals	Megapascal	Bar	lbs-sq-in
	(Pa)	(MPa)	(Bar)	(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	liter/minute	cubicmeter/sec
(gpm)	(lpm)	(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