



TECHNICAL UNIVERSITY OF MOMBASA

Faculty of Engineering and Technology
Department of Mechanical & Automotive Engineering
UNIVERSITY EXAMINATION FOR:
BSc. Mechanical Engineering
EMG 2418 : Pneumatics and Electro-Hydraulics
END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2016
TIME: 2 HOURS
DATE: Pick Date Dec 2016

Instruction to Candidates:

You should have the following for this examination

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

This paper consists of **FIVE** questions. Attempt any **THREE** questions.
Maximum marks for each part of a question are as shown.

Do not write on the question paper.

Question ONE

- Consider a volume V_o of air at pressure p_o , allowed to expand to a low pressure p . Deduce an expression for the energy, E_a released during the expansion process.
(7 marks)
- Deduce a similar expression for the energy, E_L stored in a volume V_o , of a liquid.
(7 marks)
- Using the expressions deduced for E_a and E_L above, calculate the energy stored in one liter of compressed air and liquid (under similar conditions) for $p_o = 30\text{MPa}$, $V_o = 10^{-4}\text{m}^3$, $n = \gamma = 1.4$ and $B_L = 1.4 \times 10^9\text{Pa}$.
How does E_a compare to E_L and what does it signify?

(6 marks)

Question TWO

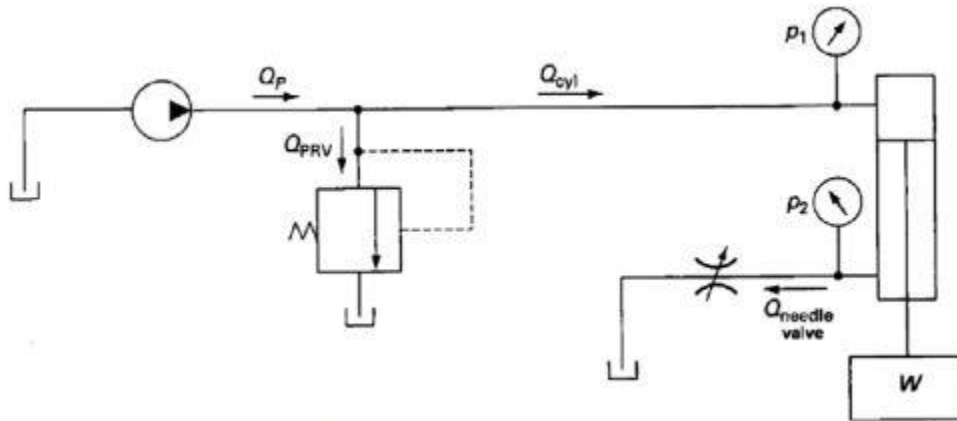
- State and discuss briefly the advantages and disadvantages of pneumatic systems. (10 marks)
- How do the two basic classes of air compressors; displacement and dynamic, achieve pressure build-up in pneumatic systems? (4 marks)
- Derive an expression for evaluating the increase in temperature, ΔT of the compressed air as a function of the initial temperature, T_1 , compression ratio, π and the polytropic constant, n . (6 marks)

Question THREE

The system below has a hydraulic cylinder with a suspended load W . The cylinder piston and rod diameters are 50.8 mm and 25.4 mm respectively. The pressure relief valve setting is 5150 kPa.

- Determine pressure p_2 for a constant cylinder speed if the weight of load is 8890N
- What will be the pressure p_2 for a constant cylinder speed when the load is removed?
- Determine the cylinder speeds if the flow control valve has a capacity coefficient of 0.8 Lpm/ $\sqrt{\text{kPa}}$.

Consider the fluid is hydraulic oil with a specific gravity of 0.9.



(20 marks)

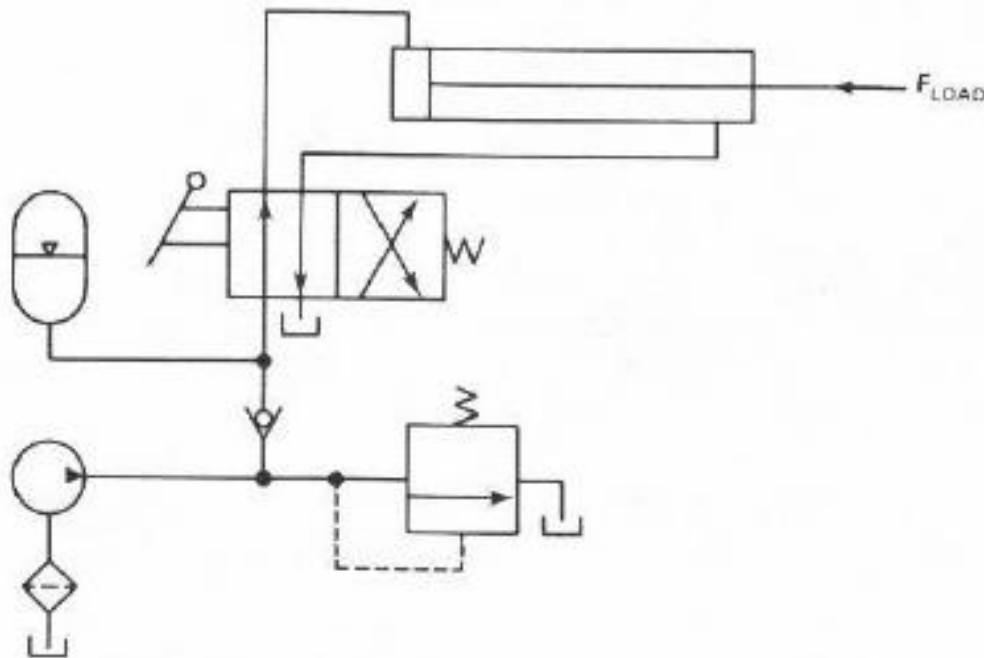
Question FOUR

- a. The below circuit has been designed to crush a car body into bale size using a 150 mm diameter hydraulic cylinder. The hydraulic is to extend 2.50 m during a period of 10s. The time between crushing strokes is 8 min. The following accumulator gas absolute pressures are given:

P1 = Gas precharge pressure 90 bar(abs),

P2 = Gas charge pressure when pump is turned on 200 bar(abs) = pressure relief value setting,

P3 = Minimum pressure required to actuate load 125 bar (abs).



Calculate:

- i. The required size of the accumulator (6 marks)
 - ii. What are the pump hydraulic kW power and the flow requirements with and without accumulator? Comment on the evaluated power and flow requirements for the two cases. (6 marks)
- b. State any two installation requirements for each of the following pneumatic components
- i. FRL (Filter-Regulator-Lubricator) unit
 - ii. Piping
 - iii. Cylinder
 - iv. Compressor

(4 marks)

Question FIVE

- a. Outline any four sectors where electro-hydraulic systems are used. (4 marks)
- b. State the three advantages of electrical or electronics control in hydraulics (3 marks)
- c. With the aid of a schematic diagram, describe the two principals sub-assemblies in an electro-hydraulic system (6 marks)
- d. Using sketches, illustrate how a 4/3 Directional control valve (DCV) works. (7 marks)