

DIPLOMA IN BIOMEDICAL ENGINEERING

LEVEL 6 YEAR II EXAMINATIONS

FINAL INTEGRATED SUMMATIVE EXAMINATIONS

SITTING: JULY/AUGUST 2025

SUBJECT: PNEUMATICS & HYDRAULICS

TIME: THREE (3) HOURS **TOTAL MARKS: 100**

PASS MARK: 50

INSTRUCTIONS TO CANDIDATE

1. Write your Examination number and National Registration Card (NRC) number on the answer booklet provided. Ensure you append your signature in the space provided on the answer booklet.
2. Write the ANSWER SCRIPT SERIAL NUMBER on the examination register and on the entry slip.
3. There are EIGHT (8) questions in this paper. Answer FIVE (5) questions.
4. Diagrams may be used where necessary to clarify your answer.
5. Cell phones and programmable calculators are not allowed in the examination room.

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S6

QUESTION 1

Figure Q1 shows a circuit schematic of a pneumatic device.

a) Identify the device [2 marks]
b) Identify the features A, B, C and D. [4 marks]
c) Explain the operation of the device. [4 marks]
d) Draw the simplified version of this device. [2 marks]
e) Outline the maintenance measures taken for features A and B. [4 marks]
f) Indicate the malfunctions that may occur due to excessive lubrication in the device. [4 marks]

[TOTAL MARKS 20]

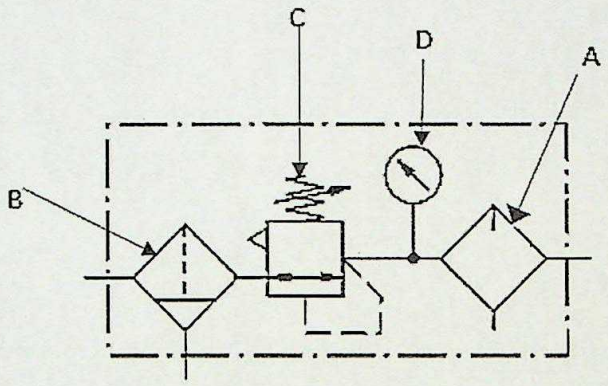


Figure Q1 circuit Schematic

QUESTION 2

a) State the law of volumes. [2 marks]
b) Define an ideal gas. [2 marks]
c) State the ideal gas law. [3 marks]
d) Outline five (5) differences between a real gas and an ideal gas. [5 marks]
e) The mass of nitrogen is 28 kg at S.T.P. Calculate the density of nitrogen, when the temperature decreases to 24°C and the pressure increases to 1.86 bars. [8 marks]

[TOTAL MARKS 20]

QUESTION 3

a) Apart from gear pumps state **two (2)** other types of hydraulic pumps. [2 marks]
b) Draw a gear pump. [4 marks]
c) Explain the operation principle of the gear pump. [8 marks]
d) A gear pump has a 75 mm outside diameter, a 50 mm inside diameter, and a 25 mm width. If the actual pump flow at 1800 rpm and rated pressure is 0.106 m^3/s, compute the volumetric flowrate. [6 marks]

[TOTAL MARKS 20]

QUESTION 4

Figure Q4 shows a cross-sectional area of a pneumatic valve.

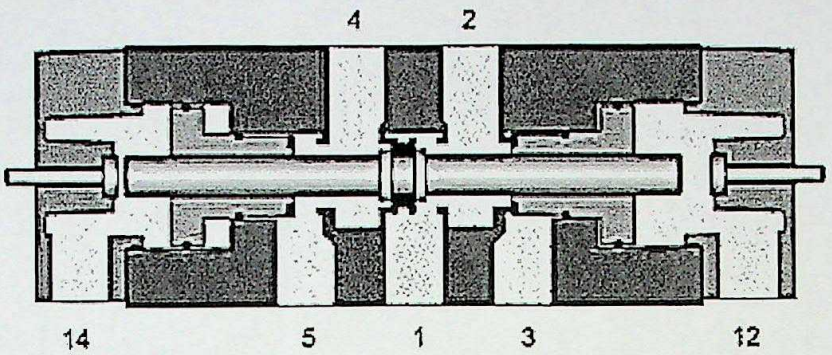


Figure Q4: Pneumatic valve

a) Identify the pneumatic valve in Figure Q4 in full. [5 marks]
b) Identify the ports **1,2,3,4** and **5.** [5 marks]
c) State the functions of ports **1, 2, 4** and **5.** [5 marks]
d) Draw a schematic symbol showing the pneumatic valve in Figure Q4. [5 marks]

[TOTAL MARKS 20]

QUESTION 5

a) Draw circuit schematics for the following pneumatic valves.
   i) Pressure regulating valve. [3marks]
   ii) One way flow control valve. [2marks]
b) Figure Q5 shows the cross-section of a pneumatic valve.

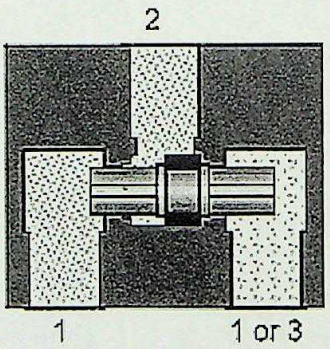


Figure Q5: Pneumatic valve

i) Identify the valve in Figure Q5 [2 marks]
ii) Draw a schematic symbol for Figure Q5. [2 marks]
iii) Identify parts 1 and 2 [2 marks]
iv) State the functions of parts 1 and 2 [2 marks]
v) State the logic operation performed by the pneumatic valve [2 marks]
vi) Explain the operating principle of the pneumatic valve in point form. [5 marks]

[TOTAL MARKS 20]

QUESTION 6

a) Draw the schematic symbols of the following electro pneumatic components.
   i) Relay. [2 marks]
   ii) Solenoid valve. [2 marks]
   iii) Switch **(NC).** [2 marks]
   iv) Push button (**NO).** [2 marks]

b) A single acting cylinder is indirectly controlled by a 3/2-way directional control valve. The directional control valve should be **NC** and spring retuned, the extension and retraction speed must be adjustable.
   i) State the apparatus. [2 marks]
   ii) Draw a pneumatic circuit and an electric circuit controlling the pneumatic circuit above indirectly label the two circuits correctly. [10 marks]

[TOTAL MARKS 20]

QUESTION 7

a) Define electro-pneumatics. [2 marks]
b) Explain the difference between pneumatics and hydraulics. [2 marks]
c) State two (2) medical equipment in the hospital which make use of electro-pneumatics. [2 marks]
d) The piston rod of a double acting cylinder advances if either a foot pedal or manual push button is operated, the cylinder returns to its initial position slowly after fully extending. The piston will return provided the manual actuators have been released.
   i) State the device used to regulate the cylinder speed. [2 marks]
   ii) Draw a well labelled pneumatic circuit for this operation. [12 marks]

[TOTAL MARKS 20]

QUESTION 8

a) Define the following:
   i) Fluid [2 marks]
   ii) Cavitation [2 marks]
   iii) Viscosity [2 marks]
b) Indicate four (4) factors that affect viscosity. [4 marks]
c) Differentiate between a hydraulic motor and a hydraulic pump [4 marks]
d) In the hydraulic press shown in Figure Q8, a force of 100 N is exerted on the small piston. The area of the small piston is 50 x 102 mm^2.Determine the:
   i) Upward force on the large piston. [3 marks]
   ii) Distance moved by the large piston when the small piston moves through a distance of 100 mm. [3 marks]

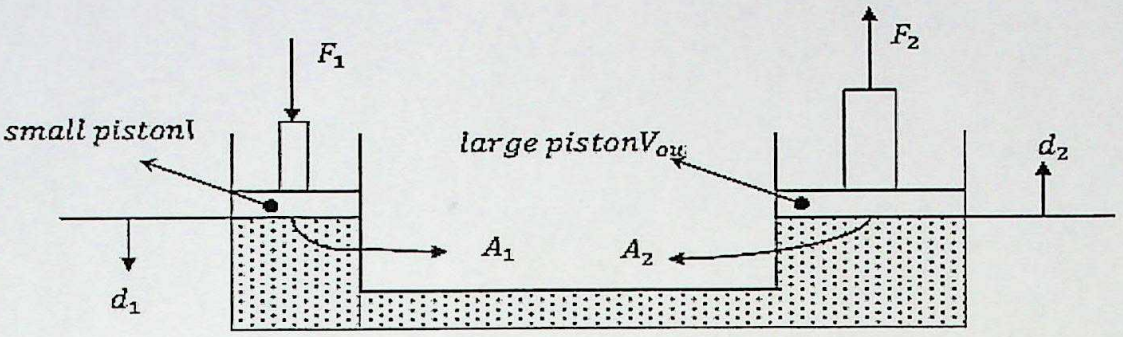


Figure Q8 – hydraulic device

[TOTAL MARKS 20]