Tutorial-1
EE 101: Electrical Sciences

DEPARTMENT OF ELECTRONICS & ELECTRICAL ENGINEERING

INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI

*(First question is the **Pre-Tutorial Assignment problem** to be solved in the space provided.)*

Name: Roll No.: Tutorial Group:

1. Write simplified Boolean expressions for the logic gate networks shown below.

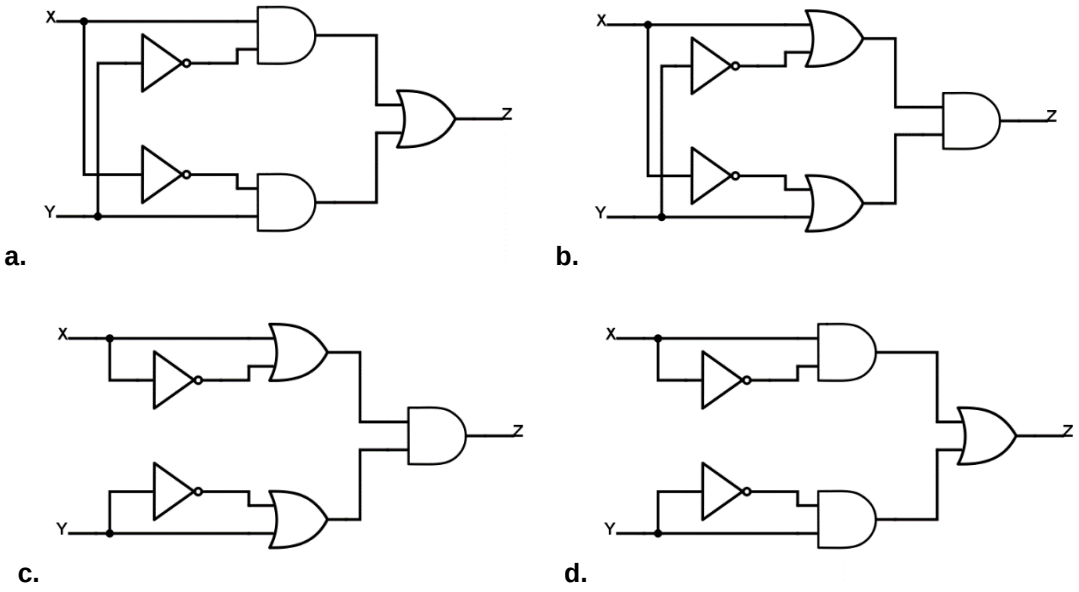

Fig.1

2. If a piece of wire with a high resistance is connected in series with a torch bulb in a circuit what happens to the brightness of the bulb?

3. Suppose you were to build this circuit and take measurements of current through the resistor and voltage across the resistor *(shown in Fig. 2):*

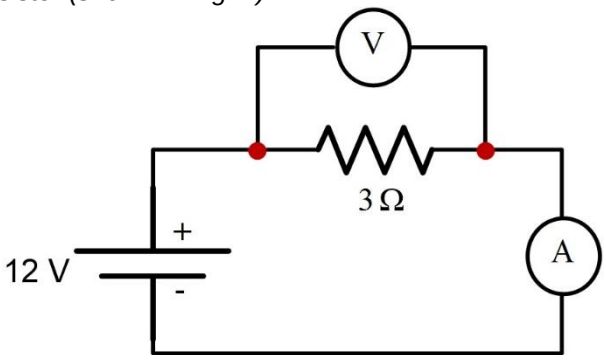

Fig. 2

Recording these numerical values in a table, the results look something like this:

Current [Amp]	Voltage [Volts]
0.22	0.66
0.47	1.42
0.85	2.54
1.05	3.16
1.50	4.51
1.80	5.41
2.00	5.99
2.51	7.49

Plot the values given in the table on a graph paper. What mathematical relationship do you see between voltage and current in this simple circuit?

4. Plot the relationships between voltage and current for resistors of three different values **(1 Ω, 2 Ω, and 3 Ω)**, all on the same graph.

a. What pattern do you see represented by your three plots? What relationship is there between the amount of resistance and the nature of the voltage/current function as it appears on the graph?

b. In calculus, the instantaneous rate-of-change of an (x, y) function is expressed through the use of the derivative notation: $[\frac{dy}{dx}]$. How would the derivative for each of these three plots be properly expressed using calculus notation?
Explain how the derivatives of these functions relate to real electrical quantities.

5. One style of light bulb, very different from the ïncandescent" design which works on the principle of a super-heated wire filament emitting light, is called a gas discharge tube. In this design of light bulb, light is produced by the direct ëxcitation" of gas molecules as electric current passes between two electrodes *(Refer Fig. 3)*:

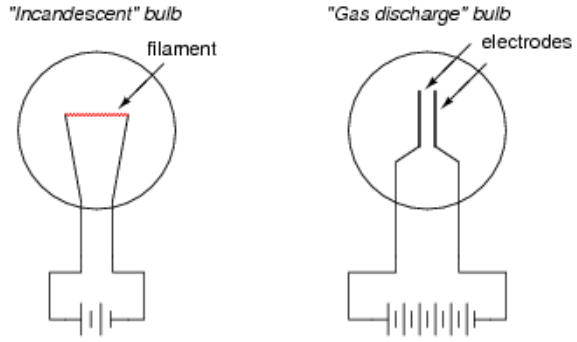

Fig. 3

Both types of light bulbs have interesting voltage/current plots, neither one being identical to the voltage/current plot of a resistor. First, the voltage/current plot for an incandescent light bulb *(as shown in Fig. 3)*:

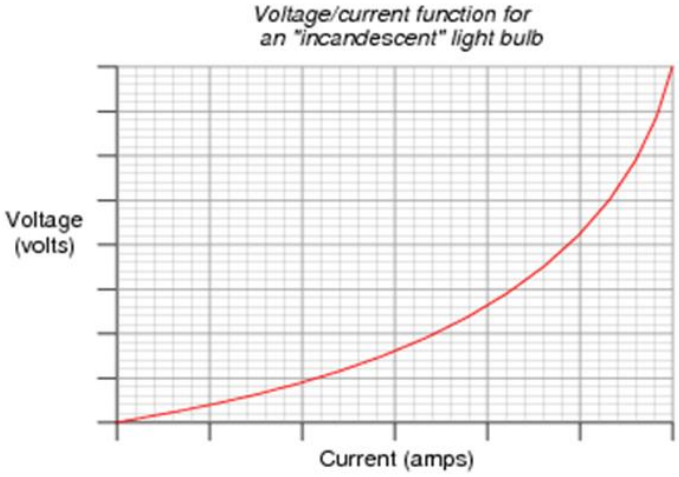

Fig. 4

Next, the voltage/current plot for a gas-discharge light bulb as shown below in Fig. 4:

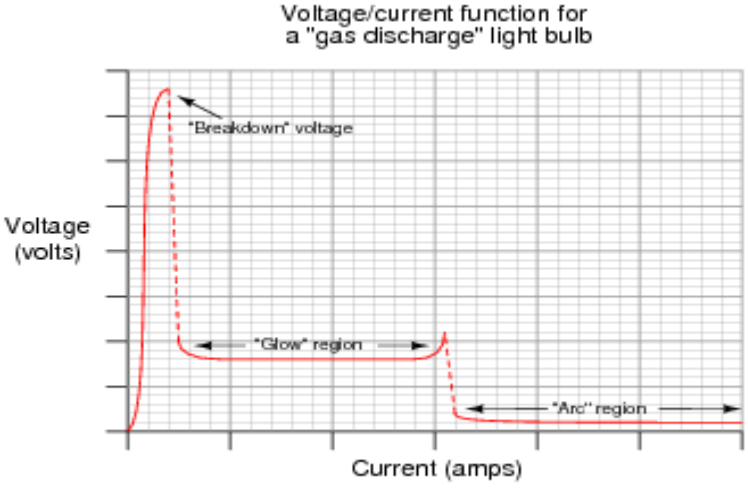

Fig. 5

Based on these two graphs, what can you say about the electrical resistance of each bulb type over its operating range?

6. Consider the following circuit involving four switches S1, S2, S3 and S4 and a lamp **L**. (A switch/lamp is ON being denoted by '1')

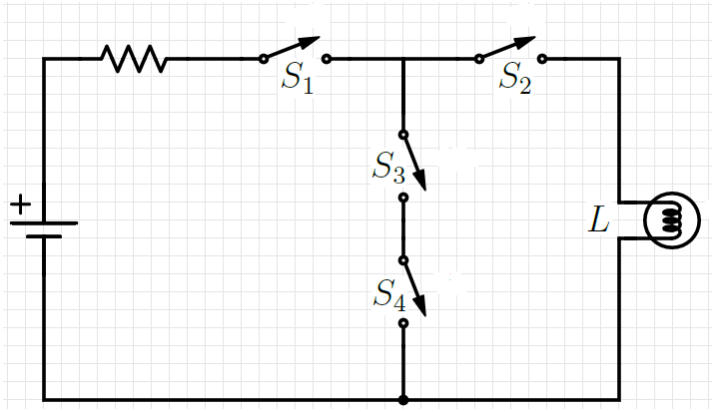

Fig.6

Write Boolean expressions for **L** in the standard SOP form.

7. Write Boolean expression for the output of the logic gate network shown below in the standard SOP and in the standard POS form.

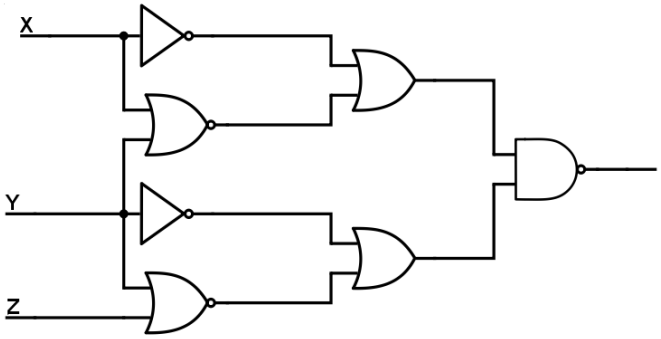

Fig. 7

8. For a Boolean function F of n variables, prove the following Boolean identities known as Shannon expansions.

a. $\boldsymbol{F(X_1, X_2, \cdots, X_n) = X_1 . F(1, X_2, \cdots, X_n) + \overline{X_1} . F(0, X_2, \cdots, X_n)}$

b. $\boldsymbol{F(X_1, X_2, \cdots, X_n) = [X_1 + F(0, X_2, \cdots, X_n)] . [\overline{X_1} + F(1, X_2, \cdots, X_n)]}$