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The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc/ B. Ed Degree Programme

Department	: Physics
Level	: 04
Name of the Examination	: Final Examination
Course Title and - Code	: PHU4301– Electronics
Academic Year	: 2020/2021
Date	: 03rd April 2022
Time	: 1.30 pm. – 3.30.pm
Duration	: 2 Hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **(1+6)** questions in (6) pages.
3. **Answer all the questions in part A and any 3 questions from part B**
4. All questions carry equal marks.
5. Answer for each question should commence from a new page.
6. Draw fully labelled diagrams where necessary
7. Involvement in any activity that is considered as an exam offense will lead to punishment
8. Use blue or black ink to answer the questions.
9. Clearly state your index number in your answer script
10. Non-programmable calculators are allowed

Part A

1)

a) What are the three bands of color that represent the following resistor values ? (You may neglect the tolerance band) (6 marks)

i) $220\ \Omega$

ii) $1.5\ k\Omega$

iii) $67\ k\Omega$

b) You have a digital multimeter. How do you check whether the test leads of the multimeter are working properly without using additional equipment'? (9 marks)

c) Following is a labeled diagram of an oscilloscope (Figure 1).

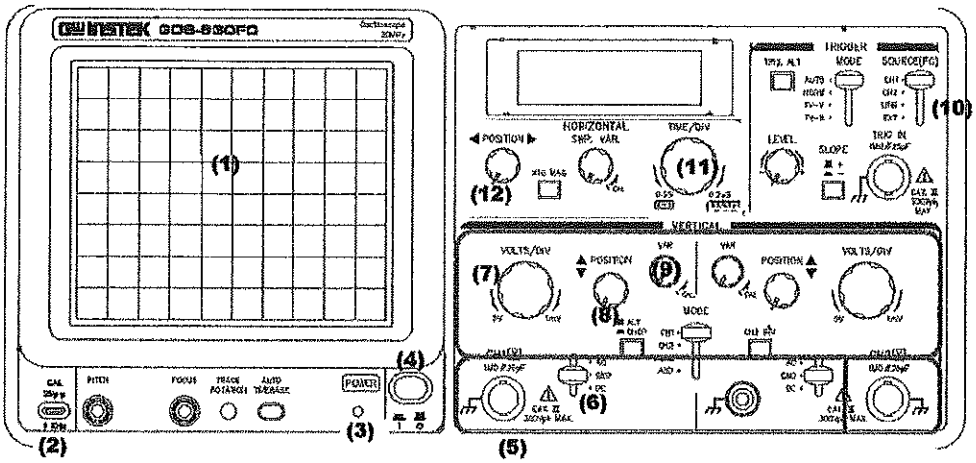

Figure 1

Explain the functionality of the following numbered items/parts (10 marks)

Item Label	Function
(1)	
(2)	
(4)	
(7)	
(10)	

Part B

1)

a) A 9 V battery is short circuited using a wire (Figure 2). Calculate the current through the wire using the Ohms law. Explain why your answer differs from real observations. (5 marks)

b) Consider the schematic in Figure 3. The Load resistor (R_L), has a 3 Ω resistance. The 9 V and 12 V cells have internal resistances of 1 Ω and 2 Ω respectively. (3x5 = 15 marks)

i) Draw the Norton's equivalent circuit for the said circuit.

ii) Calculate the Norton current.

iii) Calculate the equivalent resistance.

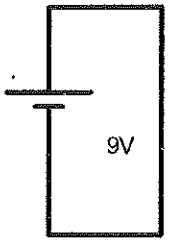

Figure 2

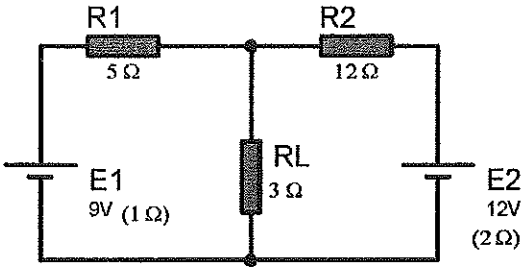

Figure 3

c) Copper is a good electric conductor. Its atomic number is 29. According to Bohr's atomic model

i) How many electrons are in each of K , L, M and N shells ? (3 marks)

ii) How many valance electrons does copper have? (2 marks)

2) Consider the following circuit (Figure 4). D_1 and D_2 are silicon diodes with 0.7 V potential drop. Assume that the 3 V battery does not have any internal resistance. Voltage at point Y is V_Y. Voltage at point X is V_X.

a) If a current flows through the D_1 diode, what is V_Y ? (3 mrks)

b) If the current through the R4 resistor is I_1, Obtain an expression for I_1. (3 marks)

c) Obtain an expression for I_2. (3 marks)

d) Obtain an expression for I_3. (3 marks)

e) Solve the above expressions and calculate V_X. (3 marks)

f) What is the current through R_3 resistor? (5 marks)

g) Calculate the current through D_1 diode (I_4). (5 marks)

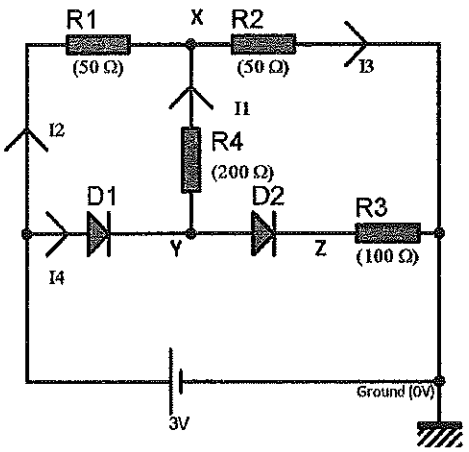

Figure 4

3)

a) Draw and label the internal structure of a Metal Oxide Field Effect Transistor (MOSFET). (5 marks)

b) Consider the following circuit (Figure 5). According to the datasheet, 2N222 transistor has a V_{BE} of 0.7V. (3x5 = 15 marks)

i) Calculate the I_B

ii) If β is 70, What is the expected I_C ?

iii) Assume that the transistor might reach the saturated state. The red LED has a potential drop of 2 V at 20 mA. Calculate the minimum resistance required for R_3 to protect the LED at 20 mA.

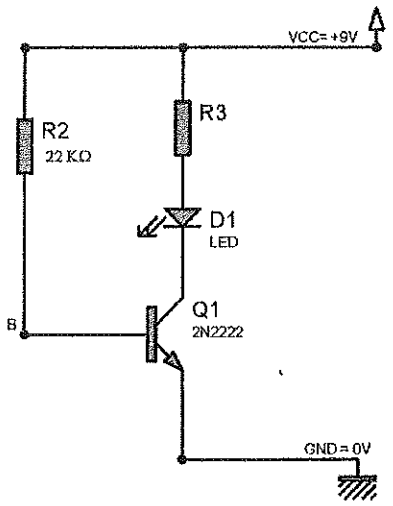

Figure 5

c) The student turns this circuit in to a simple timer circuit by adding another resistor, capacitor and a switch (Figure 6). When the switch is closed the LED switches off. After a delay LED switches on again. Explain how this circuit works. (5 marks)

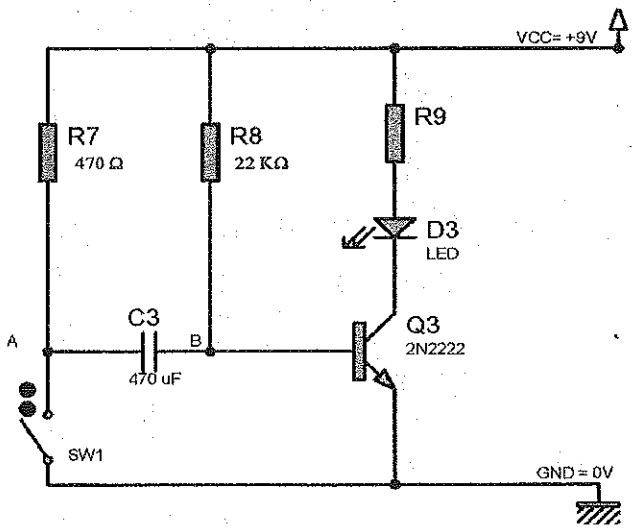

Figure 6

4)

a) What are the characteristics of an ideal Op-Amp? (5 marks)

b) Derive an expression for the output of the following circuit (Figure 7) (5 marks)

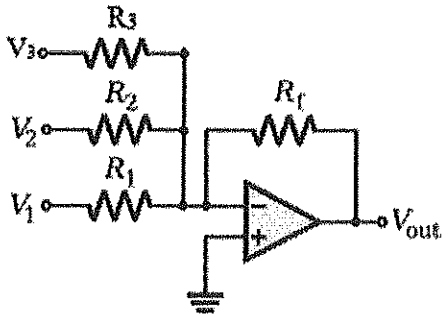

Figure 7

c)

Consider the following Digital to Analogue Converter Circuit (Figure 8). The Inputs (A, B, C, D) can be logic 1 (=5V) or logic 0 (=0 V). R_1 is 2kΩ. Input A is the most significant bit. Voltage resolution of the ADC should be 1.25 V. Assume the Op-amp is ideal and is powered by a suitable dual power supply. Calculate suitable values for resistors R2, R3, R4 and R5. (10 marks)

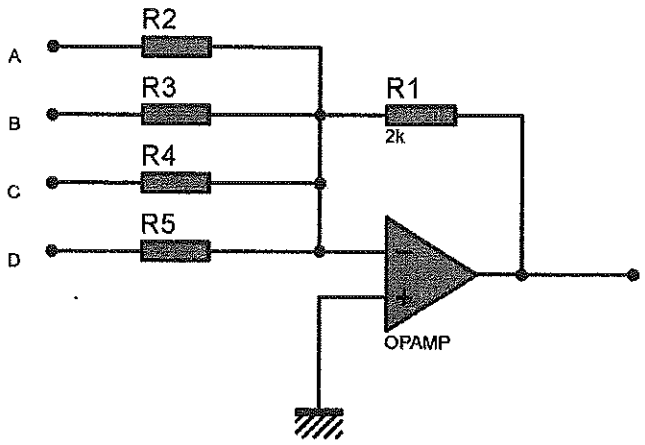

Figure 8

d) Calculate the maximum output for above ADC (5 marks)

5)

a) Design a full adder using logic gates. (5 marks)

b) Tic-Tac-Toe is a simple game. Two players take turns marking the spaces in a three-by-three grid with X or O. The first player who succeeds in placing three of his marks in a horizontal, vertical, or diagonal row is the winner. A student wants to detect the winner automatically. He creates an electronic playing board for this. Instead of making X marks one player places a red card on the square, other player puts a green card. Each of the 9 cells on the grid is equipped with a red color sensor and a green color sensor (Fig 9). If a red color card is placed on a square the red sensor attached to that square will out put logic 1. Else it will output logic 0. Same for the green color. Each square is marked with a letter from A to I. Red

Sensors are labeled with a subscript of R, and Green sensors with a subscript of G. For example red sensor on square E is marked as E_R , Green sensor on square F is F_G.

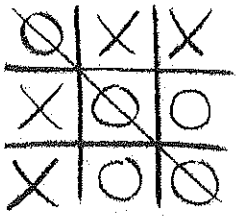

Figure 9

A	B	C
D	E	F
G	H	I

i) Fill a table to show the combinations where the red player is winning. You don't need to show the loosing combinations. Two examples are provided. Add more rows as required. (10 marks)

A_R	B_R	C_R
C_R	F_R	I_R

ii) Design a digital circuit to indicate when the red player had won the match. (5 marks)

iii) Design a digital circuit to indicate when the green player had won the match. (5 marks)

6)

a) Write the characteristic table for an active high JK flip flop. (5 marks)

b) Draw the schematic of an R-S latch. (5 marks)

c) You are designing a countdown circuit for a car race. At first, red light is on, after one second red switches off and yellow switches on. After another second the yellow switches off and green light switched on. You already have a circuit to generate a pulse each second. Design a circuit to switch on and off the lights as described above (Figure 10). (10 marks)

d) Modify your circuit such that the green light is kept on once the race starts (5 marks)

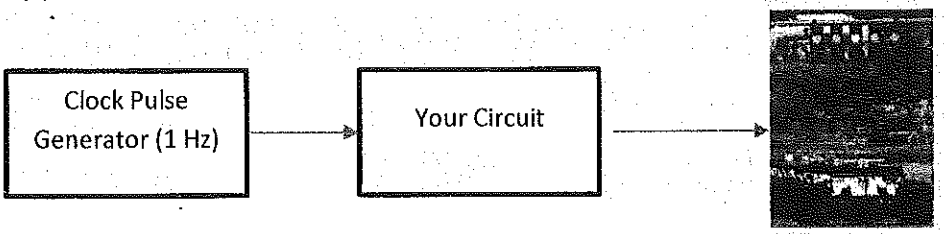

Figure 10

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