The Open University of Sri Lanka
B.Sc. Degree Programme, Level – 04
Final Examination – 2024/25
PHU4301 – Electronics
Duration: 2 hours

Date: 30th May 2025 **Time: 2.00 p.m. to 4.00 p.m.**

Answer all the questions in part A and any 3 questions from part B
Non-programmable calculators are allowed.

(Charge of an electron $1.6 \times 10^{-19} C$)

Part A

1.

a. Fill the following table explaining how you can use a multimeter to check the given components. Copy the table to your answer script before answering. (02 Marks x 5)

Item to check	Multimeter settings/ Range to select	How to check and what to expect if the component is working
(i) A 100 Ohm Resistor		
(ii) A wire (check if it is broken)		
(iii) 1N4001 Diode		
(iv) 9 V dry cell ('battery')		
(v) A push button		

b. A student wants to observe the output characteristics of an NPN transistor.

i. Draw a schematic that can be used to take measurements of output characteristics of an NPN transistor. (05 Marks)

ii. List the steps needed to collect the data to draw the output characteristic curve. (05 Marks)

iii. Draw a sketch of the output characteristic curve you expect from the experiment. (05 Marks)

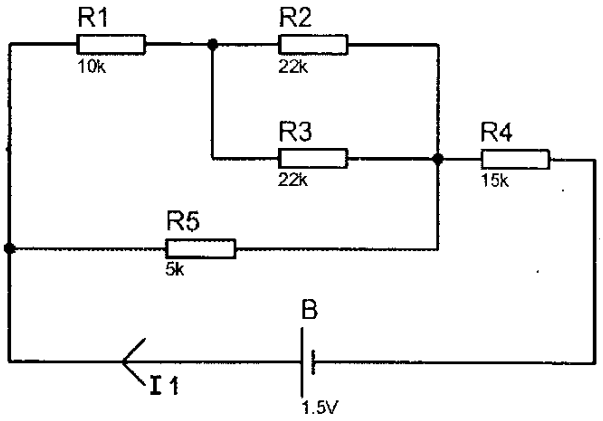
Part B

1.

a.

i. State Kirchoff's laws. (10 Marks)

ii. Using Kirchoff's laws or any other method calculate the current I_1 in the following circuit. ($R_1 = 10k\Omega$, $R_2 = 22\ k\Omega$, $R_3 = 22k\Omega$, $R_4 = 15k\Omega$, $R_5 = 5\ k\Omega$, $B = 1.5\ V$) (10 Marks)



iii. What should be the value of R_4 resistor, to reduce the Current I_1 to half its previous value: (10 Marks)

b.

i. DIACs and TRIACs are widely used in applications such as lamp dimmers. Sketch a circuit diagram of a lamp dimmer circuit for an AC supply using a DIAC and a TRIAC and any other components necessary. (10 Marks)

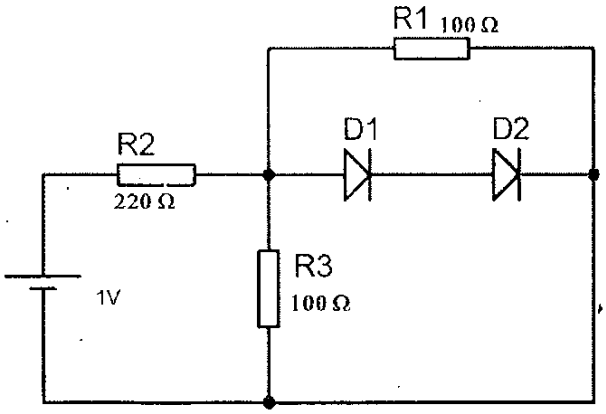
ii. Draw the output wave pattern received by the bulb of your circuit. (10 Marks)

2.

a.

i. In the following circuit, there are two silicon diodes, each with 0.7 V potential barrier. Calculate the total current drawn from the 1 V battery. ($R_1 = R_3 = 100\ \Omega$, $R_2 = 220\ \Omega$) (10 Marks)

ii. If the battery voltage was increased to 2 V, Calculate the new total current drawn from the battery. (10 Marks)



b.

i. State the De-Morgans Law. (10 Marks)

ii. Simplify following Boolean expression.
$F = (A + \bar{B})(A + B + C)(A + \bar{C})$ (10 Marks)

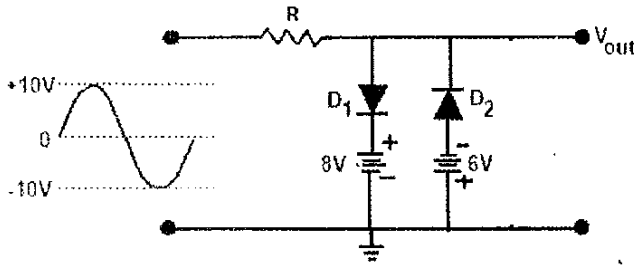
iii. Write a truth table for the above expression. (10 Marks)

3.

a. Consider the following circuit. All diodes are silicon diodes with a 0.7 V potential barrier.

i. Briefly explain the behavior of the circuit. (10 Marks)

ii. Sketch the output waveform for the given input. Clearly indicate important voltage levels. (10 Marks)



b.

i. A conductor with a cross-sectional area of 5 mm^2 is conducting a current of 2 A. How many electrons are crossing a given cross section in a second? (10 Marks)

ii. An intrinsic semiconductor has 5×10^{28} Atoms per cubic meter. One atom in 10^{12} atoms in semiconductor creates a free electron hole pair at room temperature. Calculate the conductivity of the intrinsic semiconductor. Mobility of electrons and

holes in the semiconductor is $\mu_e = 1300\ cm^2\ V^{-1}s^{-1}$ and $\mu_h = 500\ cm^2\ V^{-1}s^{-1}$, respectively. (10 Marks)

iii. If phosphorous atoms were introduced to the semiconductor, with a ratio of 1 phosphorus atom for each 10^5 semiconductor atoms, what is the percentage increase of the conductivity. Assume that at room temperature, every Phosphorus atom donates its extra electron to the conduction band. (10 Marks)

4.

a.

i. List two advantages of using a digital electronic circuit over an analogue electronic circuit. (10 Marks)

ii. Draw a circuit diagram of a S-R latch. (10 Marks)

b. Following paragraph describes how five different mocktails are made.

"Virgin Mojito, Shirley Temple, Virgin Pina Colada, Nojito, and Ginger Fizz offer a variety of refreshing mocktail combinations using a few core ingredients: mint, lime, sweetener, soda, and fruit juice. The Virgin Mojito includes mint, lime, sweetener, and soda, but no fruit juice. Shirley Temple is soda-based but contains none of the other listed ingredients. The Virgin Pina Colada is distinct for containing only fruit juice, without mint, lime, sweetener, or soda. Nojito blends all five components—mint, lime, sweetener, soda, and fruit juice—making it the most balanced and ingredient-rich option. Lastly, Ginger Fizz contains lime, soda, and fruit juice, while omitting mint and sweetener. These mocktails demonstrate how simple variations in a few ingredients can create a diverse range of flavors."

i. Fill the following table. If an ingredient is included fill, it with '1' otherwise fill the cell with '0'. First column is filled as an example. (10 Marks)

	Ingredients				
Mocktail Name	**Mint (P)**	**Lime (Q)**	**Sweetener (R)**	**Soda (S)**	**Fruit Juice (T)**
Virgin Mojito (A)	1	1	1	1	0
Shirley Temple (B)					
Virgin Pina Colada (C)					
Nojito (D)					
Ginger Fizz (E)					

ii. A student is building an automated mocktail making machine. It has five buttons labeled A, B, C, D and E respectively for different mocktails. When a person pushes a button, logic 1 is sent. Machine also has five small motors (P, Q, R, S, T) that are connected to each of the ingredients. When a motor receives a logic 1 it pumps the respective

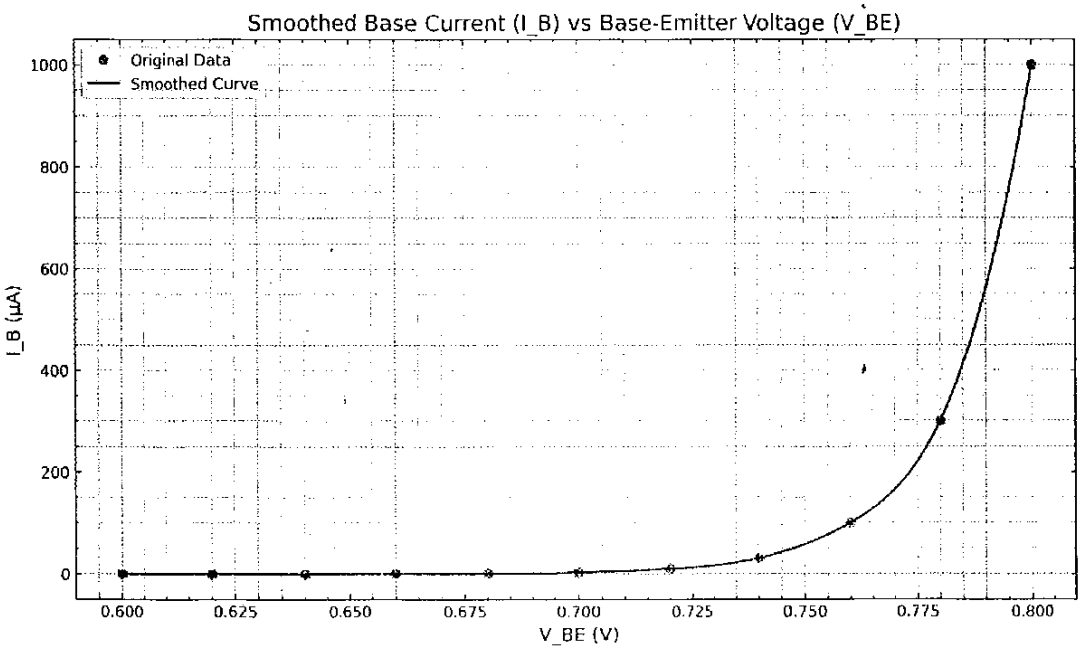
ingredient to the glass. Consider motor P (one connected to mint). Create a combinational logic circuit such that it will switch on if and only if when a button A or button D is pressed. (10 Marks)

iii. Expand your circuit to include all five mocktails and ingredients. (10 Marks)

5.

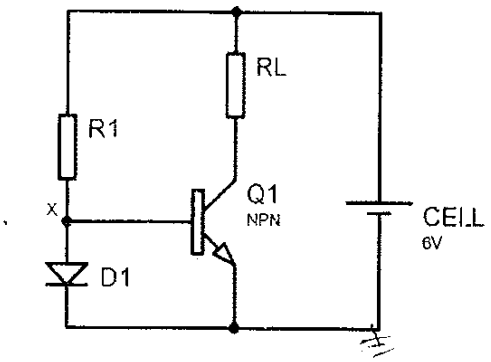
a. Define 'Constant current source'. (10 Marks)

b. A student had taken a dataset for the input characteristic of an NPN transistor and drawn a graph as follows.



Estimate I_B when V_{BE} is 0.750 V (10 Marks)

c. Same transistor was used in the following circuit. Assume $I_c \approx I_E$. V_{BE} value is not provided. Voltage of the cell is 6 V. Potential barrier of the diode (V_{D1}) for the given circuit is 0.750 V. Based on above description answer the questions below. (2x05 Marks)



i. What is the voltage at point X ?
ii. What is V_{BE} ?
iii. From the above graph find I_B
iv. If β is 100 calculate I_C
v. What is the current through R_L ?

d. A constant current of 20 mA needs to be sent through the R_L resistor. Calculate the new V_{D1}. (10 Marks)

6.

a. Use the words given below to fill the blanks in the following paragraph. Same word can be used multiple times. It is not necessary to use all the words in the list. (10 x 2 Marks)

The (i) ..... Transistor (FET) is a semiconductor device whose operation depends on the (ii) ..... carrier. Hence sometimes it is called a/an (iii) ..... transistor. The (iv) ..... in the FET is controlled by a/an (v) ..... . They are(vi) ..... sensitive devices and have extremely (vii) ..... Input impedance. On the other hand, (viii) ..... Transistors (BJT)s use (ix) ..... to control the (x) .....

Word list: minority, Unipolar, Field- Effect, majority, silicon, current, voltage, high, low, Junction, Bipolar-Junction

b.

i. Draw a circuit diagram for an inverting summing amplifier with three input voltages. (10 Marks)

ii. Derive an expression for its output. (10 Marks)

iii. List two applications /practical usages of a summing amplifier. (10 Marks)

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