The Open University of Sri Lanka
Faculty of Natural Sciences
B.Sc/ B. Ed Degree Programme
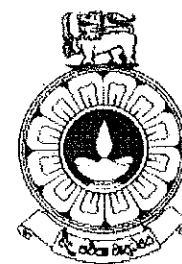
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Department	: Physics
Level	: 04
Name of the Examination	: Final Examination
Course Title and - Code	: PYU2262 – Electronics
Academic Year	: 2019/2020
Date	: 23rd Feb 2021
Time	: 1.30 p.m. to 4.30 p.m.
Duration	: 3 Hours

General Instructions

1. Read all instructions carefully before answering the questions.

2. This question paper consists of **(1+8)** questions in **(9)** pages.

3. **Answer all the questions in part A and any 5 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

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Part A

1)

a) Your friend had made the following electronic circuit on a prototype board. Using the skills, you learned at electronics laboratory, draw the circuit diagram (Schematic) of the below circuit. Part of the schematic is already completed for you. Pins of the BC547, which is an NPN transistor is labeled below. Values of resistors are labeled along the sides.

330 Ω
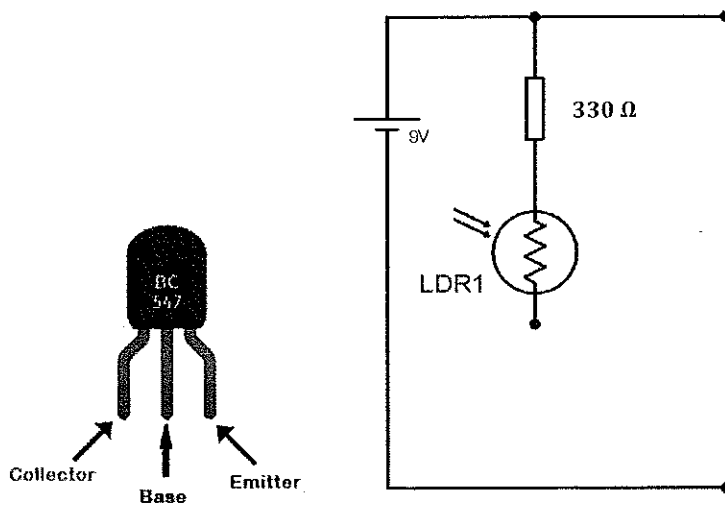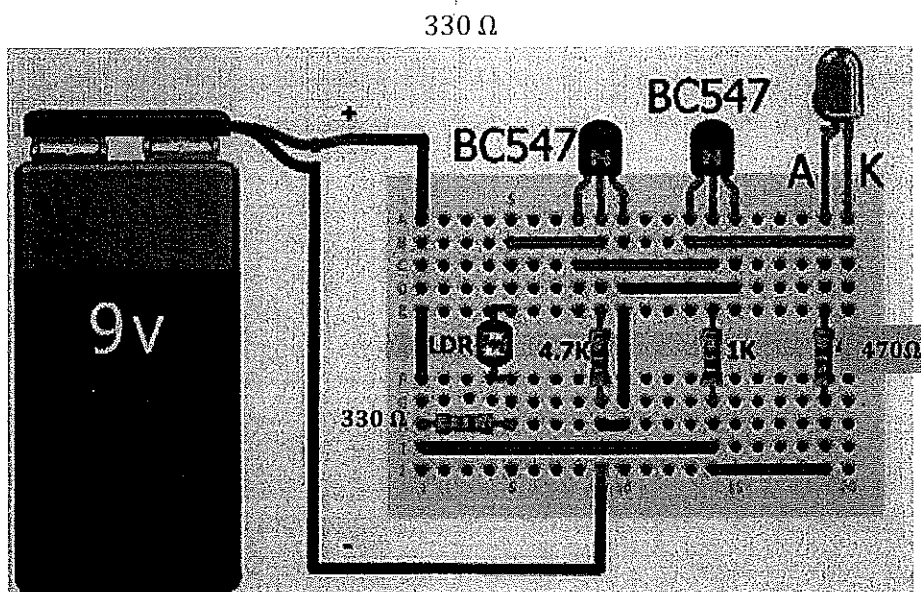
b) Explain how you can use a multimeter to check an LDR (Light Depended Resistor).

c) Write the main steps in soldering.

Part B

1)

a) Express the current density (*j*)at a given location in a resistive material, in terms of electric field at that point (**E**), and the conductivity of the material(σ).

b) Calculate the total number of electrons stored in a 100uF capacitor when it is charged from 0 V to 3V. Charge of an electron is $1.602 \times 10^{-19}\,C$

$$Q(total\ charge\ in\ Columbs) = capacity\ in\ Farads \times Voltage$$

c) Simplify the following Boolean expressions

   i) $\overline{(AB)}.(A + B)$

   ii) $AC + C + (AD + A\bar{D})(A + C)$

   iii) $AB + A(B + C) + B(B + C)$

2)

a) Draw an energy band diagram for n-type semiconductor. Draw the fermi level on the same diagram.

b)

   i) Draw the characteristic diagram of a silicon diode. Identify all the important points.

   ii) Draw the schematic of a negative clipper.

c) Consider the following circuit. D1 and D2 are silicon diodes without leakage current. R1 is 10 Ω and R2 is 50 Ω. E is a cell with 3 V output.
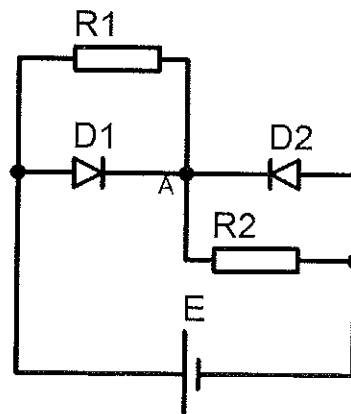
   i) Calculate the voltage at point A.

   ii) What is the total current drawn from the cell?

   iii) If the voltage of the cell E is increased to 6 V, what will be the total current drawn from it?

3)

VCC
30 V

R3 180k
R1 5.6k
Q1 2N3904
Volts
R4 120k
R2 10k
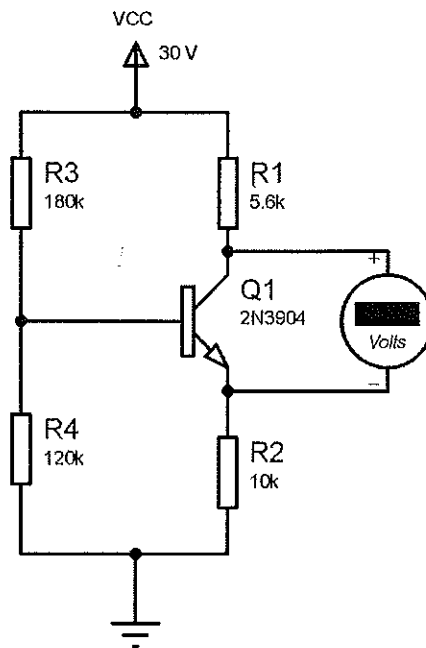
a) In the above diagram a voltmeter is connected to the emitter and collector of the transistor. Assume $V_{BE} = 0.7\ V$.

   i)   Calculate V_B.

   ii) Calculate I_E .

   iii) Calculate the voltmeter reading.

b) Sine wave signal shown below was applied to the input of the following circuit. Draw the output signal at output A and output B separately. Assume that the transistor operates in in the linear region at all the times.


VCC
30 V

R3 180k
R1 5.6k
C1 1nF
Input
Q1 2N3904
Output A
Output B
R4 120k
R2 10k
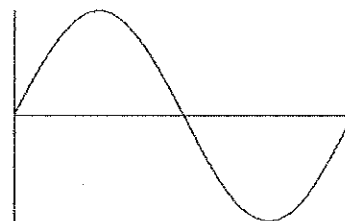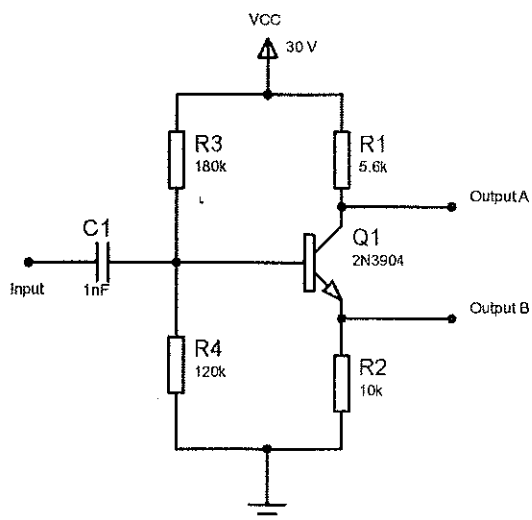
4)

   a) State Golden rules of operational amplifiers.

   b) Consider following circuit.
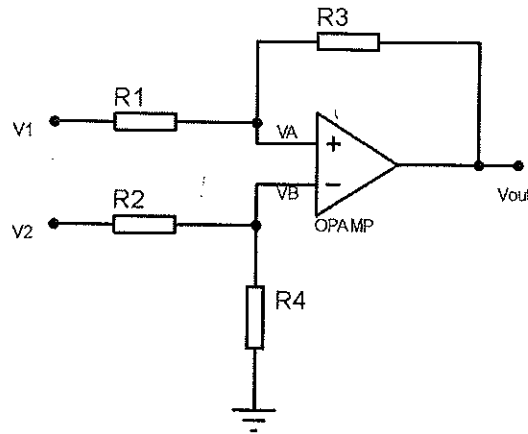
    i) Obtain an expression for V_B as a function of V_2, R_2 and R_4.

    ii) Show $V_{out} = V_2 \left(\frac{R_4}{R_4+R_2}\right) \left(\frac{R_1+R_3}{R_1}\right) - V_1 \left(\frac{R_3}{R_1}\right)$.

   c) A sensor is used to measure the body temperature of employees as they enter in to the university. Output of the sensor is a voltage level which is linearly related to the temperature. At 30 °C the output is 3V. For each 1 °C increase in temperature, output voltage is increased by 0.1 V.

    i) What is the output voltage when temperature is 39 °C ?

    ii) Using your knowledge in comparators and Op-Amps, design a circuit to sound an alarm when temperature is 39 °C or above. Assume the Alarm can be triggered by a 5V signal. You may use other components like Zener diodes or resistors. Indicate the values of components used.

5)

   a) Write the characteristic table for active high JK flip flop.

   b) Due to a pandemic, number of peoples attend needs to be limited. Group of students are developing a circuit to count the number of people attending. A light beam crosses the entrance and a sensor detects it. Each time a person crosses the beam it is broken and a 5 V pulse is generated. Create a binary counter using flip flops to count at least to 50 people.
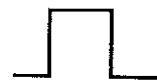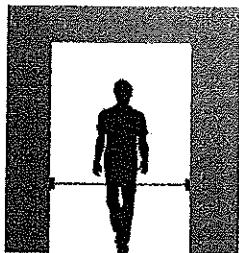

Voltage pulse generated as a person passing by

c) An alarm is to be sounded when the number of people reach 30 or more. Alarm can be activated by sending logic 1 (5V) . Create a circuit for this. You may use other digital gates for this design.

d) Modify your circuit such that it can be reset to 0 by pressing a button.

6)

a)

   i) Write the Boolean expression for 2 input XOR gate.

   ii) Design an XOR gate using only NAND gates.

   iii) Create a full adder using digital gates.

b) When sending binary data, noise can introduce errors. A parity bit can be used to detect such errors. It is an extra check bit added to the end of the original binary string. Consider "even parity" variation. If the total number of '1's in the original message is an odd number parity bit is set to 1. If the total number of '1's in the original message is an even number parity bit is set to 0. Hence the total number of 1s in the final message (including parity bit) is always even.

   i) Fill the following table, some rows are filled as an example

Original Message	Parity bit
0000	0
1010	0
0111	1
1100	
0011	
1011	
0100	

   ii) Consider a 4 bit number, Each bit in the number is represented by a separate input (A,B,C,D). Parity bit is represented by the output Q. Create a circuit to automatically calculate the parity bit.

7) H-parameters (hybrid parameters) can be used to mathematically model a device or a circuit including transistors. Following diagram represents an unknown two port device. V_1 and I_1 are the input voltage and current while V_2 and I_2 represent output voltage and output current respectively.
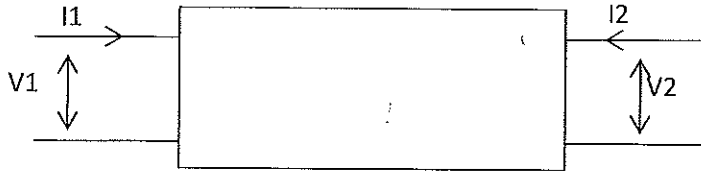
Relationship between these parameters are given by

$$\begin{bmatrix} V_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} h_i & h_r \\ h_f & h_o \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \end{bmatrix}$$

a) By simplifying the above matrix obtain two expressions for V_1 and I_2.

b) Explain how you can determine h_i. Clearly specify any conditions applied.

c) Explain how you can determine h_r. Clearly specify any conditions applied.

d) When the output port is short-circuited $V_1 = 25V, I_1 = 1\,A\ and\ I_2 = 2\,A.$ When the input port is open-circuited $V_1 = 10\,V, V_2 = 50\,V\ and\ I_2 = 2A$. Find the values of

i) h_i

ii) h_r

iii) h_f

iv) h_o

8) Following is a truth table of a combinational logic circuit where A,B,C and D are inputs and Q is an output.

A	B	C	D	Q
0	0	0	0	1
0	0	0	1	1
0	0	1	0	0
0	0	1	1	0
0	1	0	0	1
0	1	0	1	0
0	1	1	0	1
0	1	1	1	0
1	0	0	0	1
1	0	0	1	1
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	0

a) Fill a Karnaugh map (K – Map) using above truth table.

b) Clearly show the different groups (sets) used for the simplification on it. (you may use different shading patterns to mark cells belonging to different sets)

c) Using your knowledge on K-Maps obtain the simplified Boolean expression.

-END -