THE PNG UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL & COMMUNICATIONS ENGINEERING DEPARTMENT

SECOND SEMESTER (2022)

EN123 INTRODUCTION TO CIRCUITS AND ELECTRONICS

TIME ALLOWED: 3 HOURS

INFORMATION FOR STUDENTS:

1. You have **TEN (10) MINUTES to** read this paper. Do not write during this allocated time

2. There are **Five (5) Questions** in this Exam Booklet**. Answer ALL Questions in any order. The total mark available is 100 marks. Marks for each question is indicated.**

3. All answers must be written in the **Answer Booklet**

4. **COMPLETE STUDENT DETAILS ARE TO BE FILLED ON THE ANSWER BOOKLET-DO THIS NOW**

5. Only drawing instruments and calculators are allowed on your desk. Textbooks and notebooks are **NOT** allowed

6. If you are found **Cheating** in this Exam, penalties specified by the **University** shall be applied.

7. TURN OFF all your mobile phones and place them on the floor under your seat before you start the examination

QUESTION 1

(a) Given three resistors 10 ohms, 2 ohms and 5 ohms. Supply voltage is Vs= 10 V.

(i) If the resistors are connected in series across Vs, find the volt drop across each resistor.

(ii) If the resistors are connected in parallel across Vs, find the currents in each resistor.

(ii) In both cases if the 10-ohm resistor becomes burnt, explain what happens to the circuits.

[8 Marks]

(b) Using the reactance equation for a capacitor, explain how a capacitor may be used to block both (i) DC currents and (ii) high frequency currents. Use appropriate sketches to show how the capacitor must be connected for each case.

[5 Marks]

(c) With appropriate circuit diagram and signal waveforms, show how a full wave bridge rectifier may be constructed using four diodes. Explain how a sinusoidal signal entering four-diode rectifier is converted into a full wave rectified signals.

[7 Marks]

[Total 20 Marks]

QUESTION 2

(a) With appropriate sketches, show how the Analysis, Plan and Measure (APM) technique may be used to troubleshoot any electronic device or system. You may choose your own electronic device or system. You may give your answer in point form, rather than as an essay.

[6 Marks]

(b) Given the following transistor connection (Figure 1), determine the volt drops and currents along each resistor. Comment on the results.

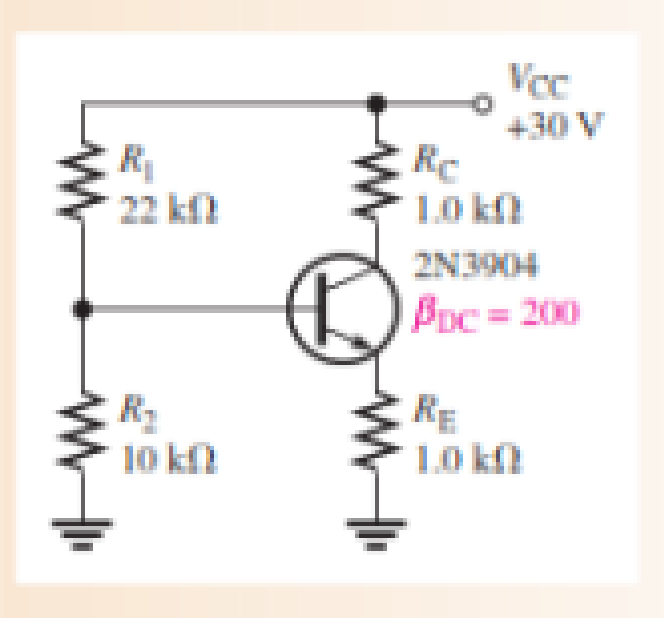

Figure 1 Use with Question 2, (b)

[8 Marks]

(c) With appropriate sketches, describe how an electronic system may be used to count the number of boxes being carried by a conveyer belt moving at a slow speed.

[6 Marks]

[Total Marks 20]

QUESTION 3

(a) Sketch a circuit diagram showing how an operational amplifier may be used to amplify signals from an electronic sensor. Explain how the circuit works.

[6 Marks]

(b) With appropriate circuit diagrams, show how an inverting amplifier and a non-inverting amplifier may be constructed using an operational amplifier. Write down the equations for the gain of the two amplifiers.

[6 Marks]

(c) (i) In Figure 2 is shown a Darlington pair. Explain its operation and application.

[3 Marks]

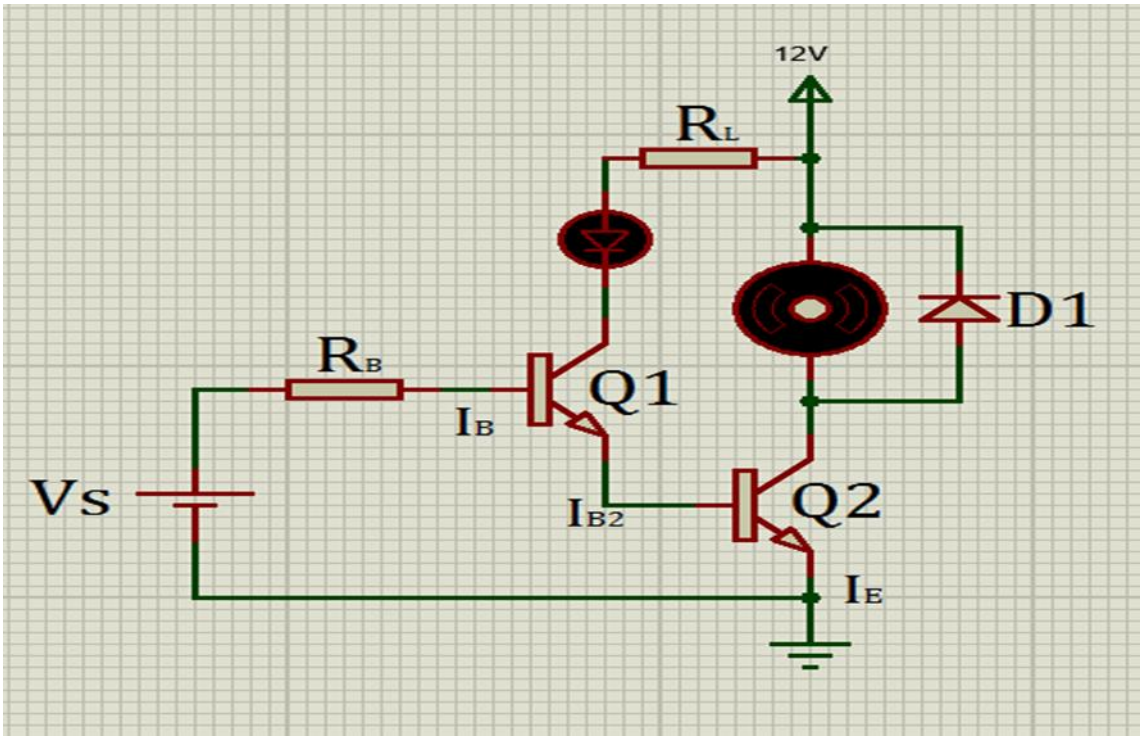

Figure 2 Use with Question 3, (C) (i)

(ii) A Darlington transistor is used to switch two loads, an LED and a DC motor. When the transistors are switch on, the two loads are fully connected. Given I_B = 4.8 mA, and gain for both transistor β = 80, calculate the base current I_{B2} for transistor Q1. Also calculate the emitter current I_E for the Darlington transistor.

[5 Marks]

[Total Marks 20]

QUESTION 4

(a) All digital circuits and systems use the binary number system. The number system is used for representing the information and their conversion from one number system to another is vital.

(i) Convert the decimal number $(569)_{10}$ into binary [2 Marks]

(ii) Convert the octal number $(4355)_{8}$ into decimal [2 Marks]

(iii) Convert the binary number $(11101110)_{2}$ into hexadecimal [2 Marks]

(iv) Convert the hexadecimal number $(AB4)_{16}$ into binary, then to octal [4 Marks]

(b) A logic gate is a device that acts as a building block for digital circuits. They perform basic logical functions that are fundamental to digital circuits. Determine the following:

(i) The definition and symbol of an input XOR gate [3 Marks]

(ii) The truth table [3 Marks]

(iii) Complete the output timing diagram of an XOR gate [4 Marks]

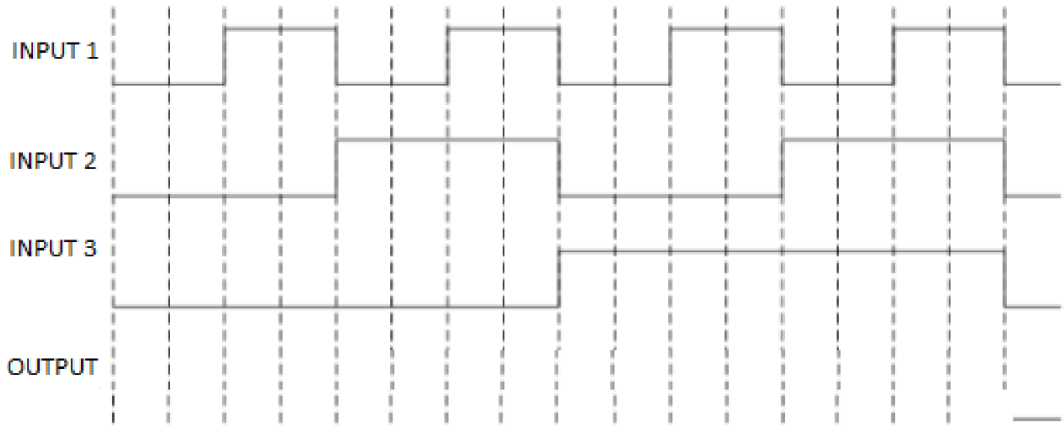

Figure 3 Use with Question 4

[Total Marks 20]

QUESTION 5

A combinational circuit is given below.

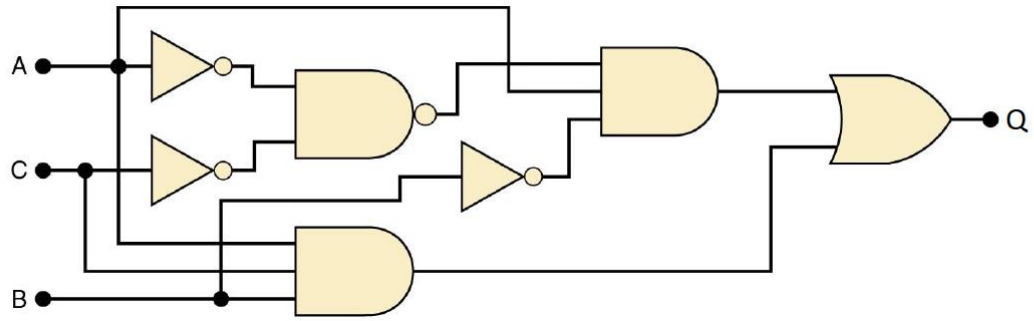

Figure 3 Use with Question 5

Determine the following:

(a) The output expression Q [5 Marks]

(b) Simplify fully the output expression of Q [5 Marks]

(c) Draw a truth table that correspond to the expression in (b) [5 Marks]

(d) Draw the simplified diagram of the combinational circuit as described in (b) [5 Marks]

[Total Marks 20]