THE PNG UNIVERSITY OF TECHNOLOGY

DEPARTMENT OF ELECTRICAL & COMMUNICATIONS ENGINEERING DEPARTMENT

SECOND SEMESTER (2023)

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.**

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 [TOTAL 20 Marks]

(a) Three resistors of resistances 10 Ω, 20 Ω and 15 Ω are connected in parallel across a 50 V supply.

(i) Determine the currents in each resistor and the total current from the supply. [3 Marks]

(ii) If the 20 Ω resistor becomes disconnected, recalculate the currents. Using the results, discuss why the parallel connection is commonly used in electric connections inside a house. [3 Marks]

(iii) With all three resistors connected, a fourth 5 Ω resistor is connected in parallel to the other three resistors. Calculate the currents through the four resistors and the total current from the supply. Using the results, discuss why it is dangerous to connect additional loads to a wired system, for which the system has not been designed to carry. [3 Marks]

[9 Marks]

(b) Given the full wave bridge rectifier circuit shown in Figure Q1(b).

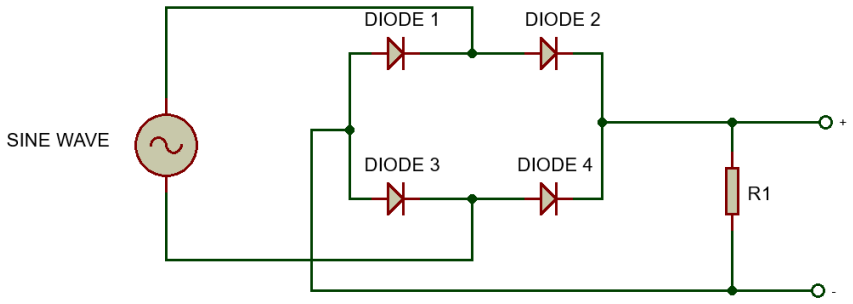

Figure Q1(b)

Describe the operation of the full wave bridge rectifier with suitable input and output waveforms. **[6 Marks]**

(c) Consider the circuit shown in Figure Q1(c), of a transistor used as a switch.

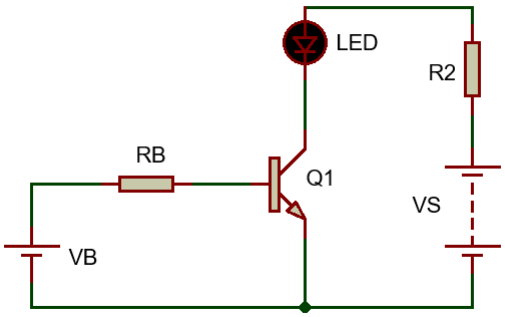

Figure Q1(c)

Given that Vs = 3V, VBE = 0.3V, IC = 9 mA, and R1 = 1kΩ, calculate the base current IB of Q1 using KVL. Find the current gain (β) of the transistor Q1.

[5 Marks]

QUESTION 2 [TOTAL 20 Marks]

(a) Given in Figure Q2(a) is the circuit diagram for a 2 to 4 Binary Decoder. Determine the truth table for the 2 to 4 Decoder.

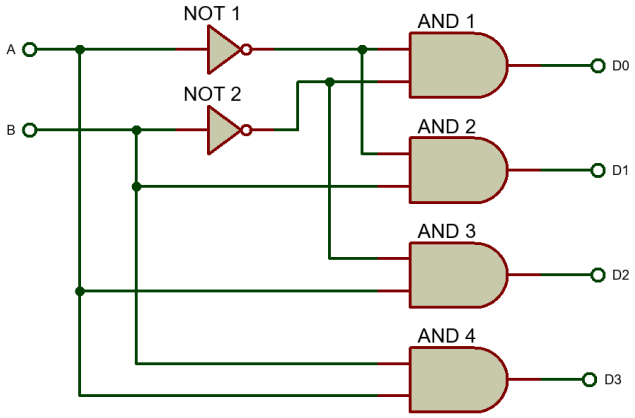

Figure Q2(a)

[4 Marks]

(b) Consider the Darlington transistor pair shown in Figure Q2(b).

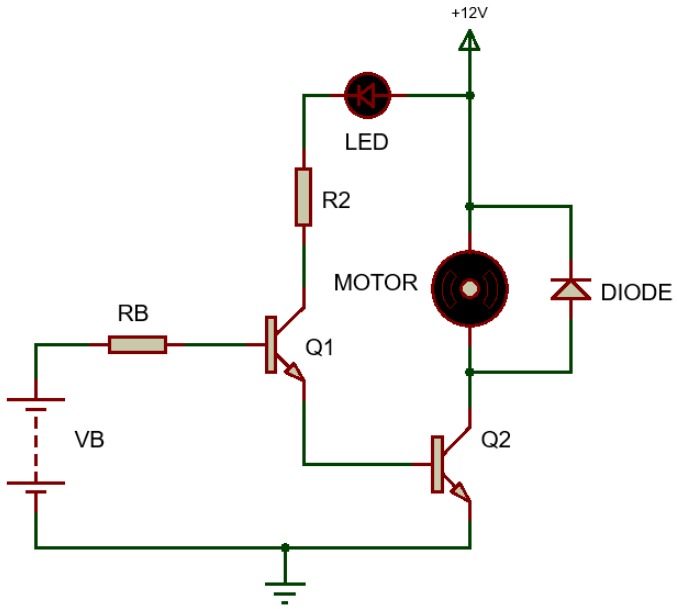

Figure Q2 (b)

The Darlington transistor pair is used to switch two loads, an LED and a DC motor. When the transistors are switched on, the two loads are fully connected. Given the current into the base of transistor Q1, I_{B1} = 4.8 mA, and gain for both transistors is β = 80.

(i) Determine the emitter current I_{B2} for transistor Q1. [4 Marks]

(ii) Calculate the emitter current I_{E2} of transistor Q2 for the Darlington transistor pair. [4 Marks]

(iii) Compare the emitter currents of Q1 and Q2 and discuss how the Darlington pair is useful in driving two different kinds of industrial loads. [4 Marks]

[12 marks]

(c) Consider the half-wave bride rectifier shown in Figure Q2(c).

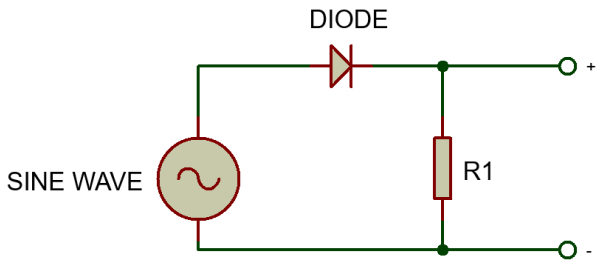

Figure Q2(c)

With suitable input and output waveforms, describe the operation of the circuit shown in Figure Q2(c).

[4 Marks]

QUESTION 3 [Total Marks 20]

(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]

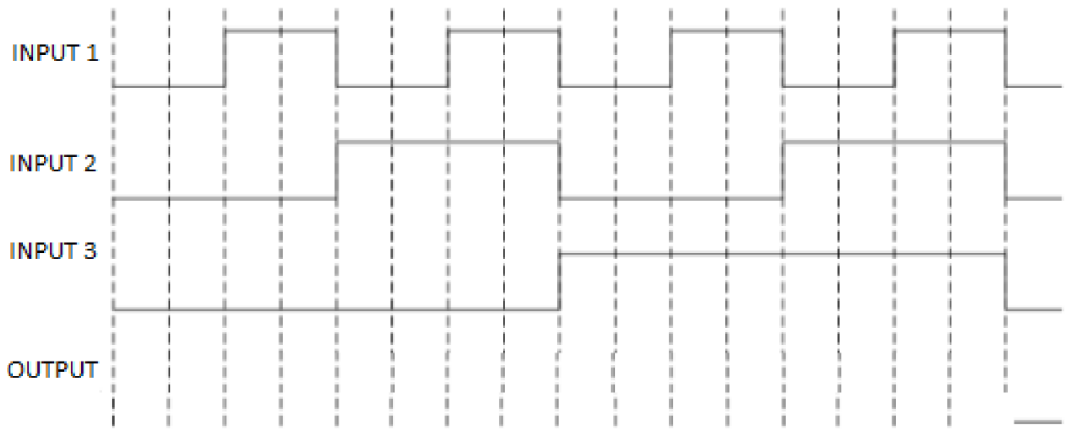

Figure Q3 Use with Question 3

QUESTION 4 [Total Marks 20]

A combinational circuit is given below.

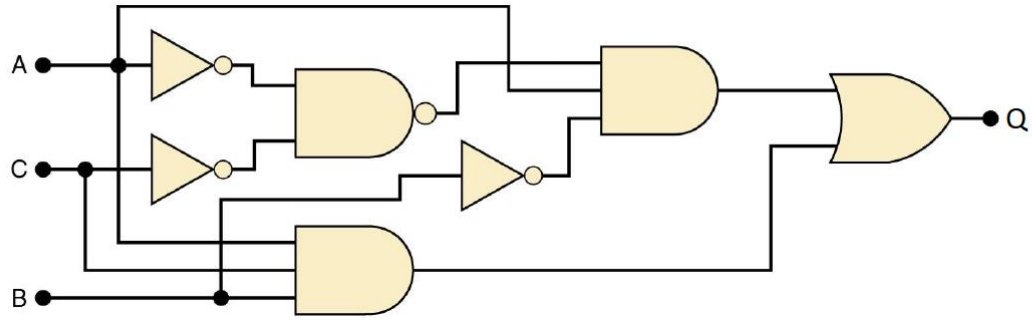

Figure Q4 Use with Question 4

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]

QUESTION 5 [20 Marks]

You are required to design **a** Real-time Motion Based Alarm with Real-time Alert Security System for a College. Write a design proposal, with all necessary technical details, a system designed to meet the following requirements:

(a) Detect motion along perimeter fence at college campus

[4 Marks]

(b) Determine the locations where motion is detected

[4 Marks]

(c) Trigger alarm

[4 Marks]

(d) Send alert and location of alert to the central security base on campus

[4 Marks]

(e) Shot spot beams to be turned on for night time alarms

[4 Marks]