UNIVERSITY OF KWAZULU NATAL
School of Engineering

MAIN EXAMINATIONS:2025

Course and Code: Electronic Engineering: ENEL2ECH2

Duration: 2 hours **Paper 1of 1** **Maximum Marks: 70**

Examiners: **Dr. N. Sibanda (Internal)**

Prof T. Quazi (Internal moderator)

Instructions:

A. **Answer all questions**
B. **Show adequate work in your solutions.**
C. **No notes of any form are allowed in the examination.**
D. **Programmable calculators may be used, provided text and formulae are removed from memory prior to the start of the examination.**
E. **Label all sketches and plots**
F. **Question paper consists of 7 Questions in 5 pages including the cover page.**

Question 1: [10 Marks]

1. In Figure 1 below, calculate the values of ***I*** and ***V***, assuming that the diodes are ideal. You can do that by.
   a. Using the intelligent guess/assumption method, stating which diode is on and which diode is off with valid/confirmed reasoning **[2]**
   b. Clearly outlining your calculation steps to get ***I*** and ***V***, including drawing the equivalent circuit after your assumption in (Q1a). **[3]**

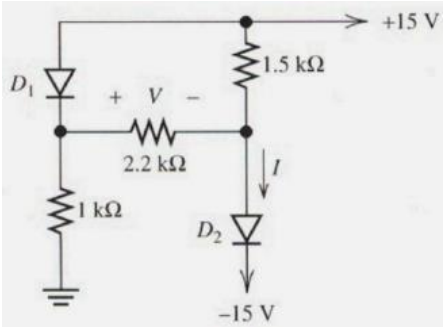


Figure 1.

   c. Convert $112{,}75_{10}$ to octal. **[3]**
   d. Perform the following subtraction using 2's complement:
   $1011_2 - 10010_2$. Show all your steps in the calculation. **[2]**

Question 2: [10 Marks]

2. A student testing the dc bias circuit in Figure 2, measures the dc emitter voltage V_E as +2,2 V.
   a. Redraw this circuit showing all BJT voltages and current directions.
   You can do that by assuming that $V_{BE} = 0{,}7$ V and then determine the following dc currents, voltages and BJT parameters: $I_E, V_B, I_B, I_C, V_C, \beta, \alpha.$ [All node voltages measured with respect to ground.] **[4]**
   b. Given that for active mode operation $V_{CE} = 0{,}5V$, determine if this BJT is operating in active mode. **[1]**

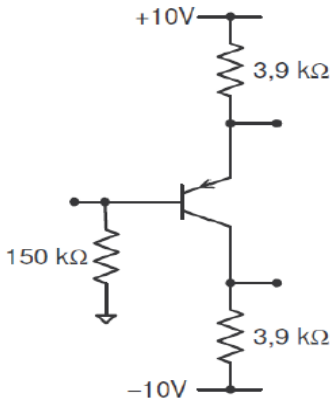


Figure 2.

c. Identify the transistor amplifier configuration in the circuit in Figure 3. Hence design/give the dc bias circuit to determine the BJT node voltages, V_{CE}, currents I_E and I_C. ***Hint:*** Draw the equivalent Thevenin circuit, assuming the BJT is in active mode with $V_{BE} = 0{,}7\ \text{V}, \beta = 150$ and $V_A = \infty$. Show all design calculations. **[5]**

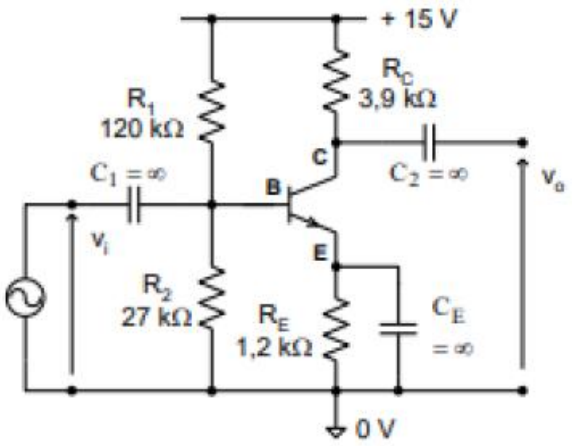


Figure 3.

Question 3: [10 Marks]

3. Figure 4 shows a circuit based on an ideal operational amplifier and a signal used as input to the circuit.

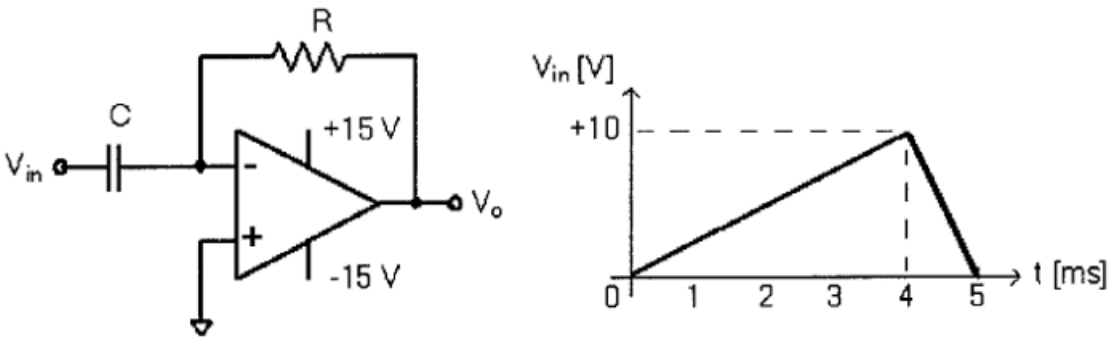


Figure 4

a. State three ideal operational amplifier characteristics. **[3]**

b. Identify the circuit in Figure 4 and from first principles solve for the output voltage in terms of the input voltage.
[3]

c. Given $R = 5K\Omega, C = 200nF$, draw the output voltage waveform for the same period as the input signal showing necessary calculations. **[4]**

Question 4: [10 Marks]

4. For this question,

   a. Draw the waveforms of the outputs A_0 through A_2 for the circuit shown in Figure 5, ***for four clock cycles***. Assume all flipflops are initially reset. **[7]**

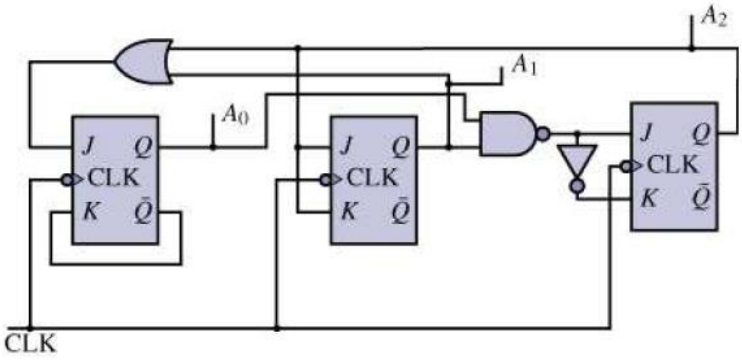


Figure 5.

   b. Using a diagram, show how you would use a T flipflop to make a D flipflop. Assume any logic gate is available to you. **[3]**

Question 5: [10 Marks]

5.

   a. A four-bit binary number is represented as $A_3A_2A_1A_0$, where $A_0$is the LSB. Design a minimal logic circuit that will produce a HIGH output whenever the binary number is great than 0010 and less than 1000. You can do that by
      I. Giving the Truth table solution **[3]**
      II. Giving the Boolean expression of the output solution from the truth table in 5a(I) and minimising it using Boolean algebra rules. **[2]**
      III. Finally draw the logic circuit expressed by the Boolean expression in 5a(II). **[2]**

   b. Given that, a 5-bit DAC has a current output of 10 mA for a binary input of 10100_2, determine the current output for a digital input of 10110? **[3]**

Question 6: [10 Marks]

6. A complementary Metal Oxide Semiconductor (CMOS) shown in Figure 6 is used to implement a particular logic function.
    a. Given A and B as the input and Out as the Output, draw the circuit truth table. Include in your table the states (ON or OFF) of transistors Q1 to Q4.

       [8]
    b. State what logic function this circuit performs.
       [2]

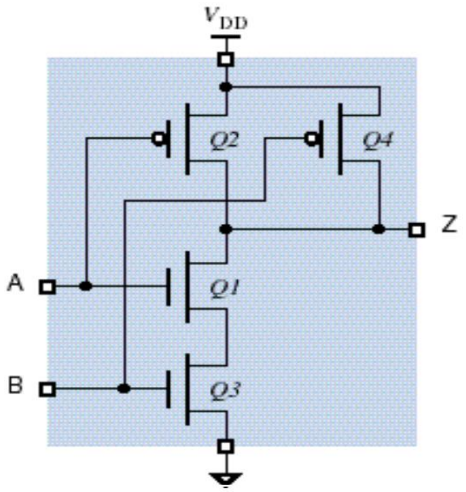


Figure 6.

Question 7: [10 Marks]

7. Figure 7 shows a low pass filter circuit. Suppose the input signal to the circuit is given as $V_{in}(t) = 5\cos(20\pi t) + 5\cos(200\pi t) + 5\cos(2000\pi t)$. Prove that this is a low pass filter, by

    a. Finding and computing the expression for the output of the first three components in the time domain.
       [10]

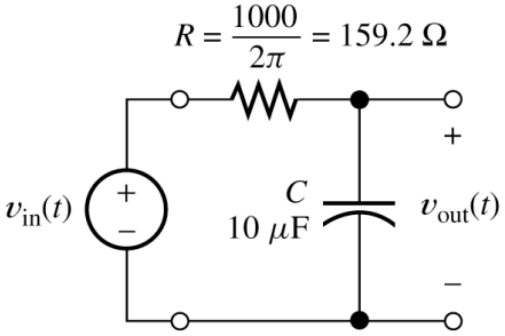


Figure 7.

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