

Name: _____

USC ID#: _____

I hereby affirm that all the answers below are my own. I have neither searched online nor taken assistance from any external entity.

Student Signature Above

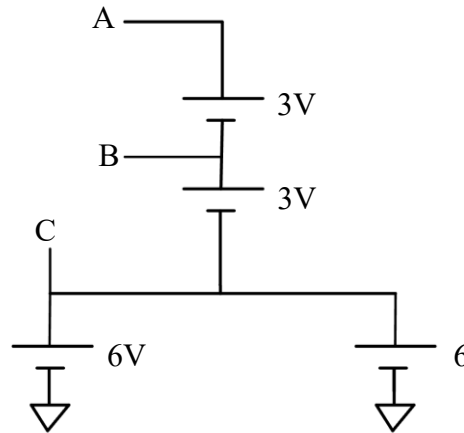
EE105 – Fall 2025 Practice Midterm

Time Limit: 2 hours

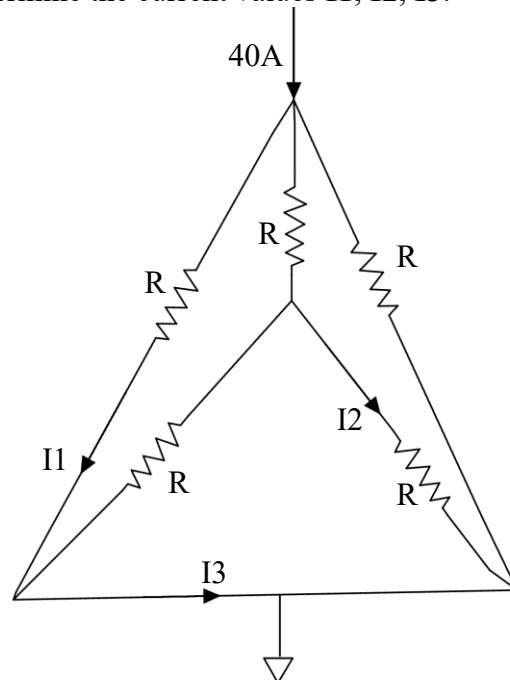
Total number of pages is 6 (including this page). Put your name on every page
where noted

Section A (25 points)**Question 1 (4 points)**

Given the circuit diagram with nodes **A**, **B**, and **C**, each connected to either **3V** or **6V** sources as shown. Determine the voltages V_A , V_B , and V_C at the respective nodes with respect to the ground.

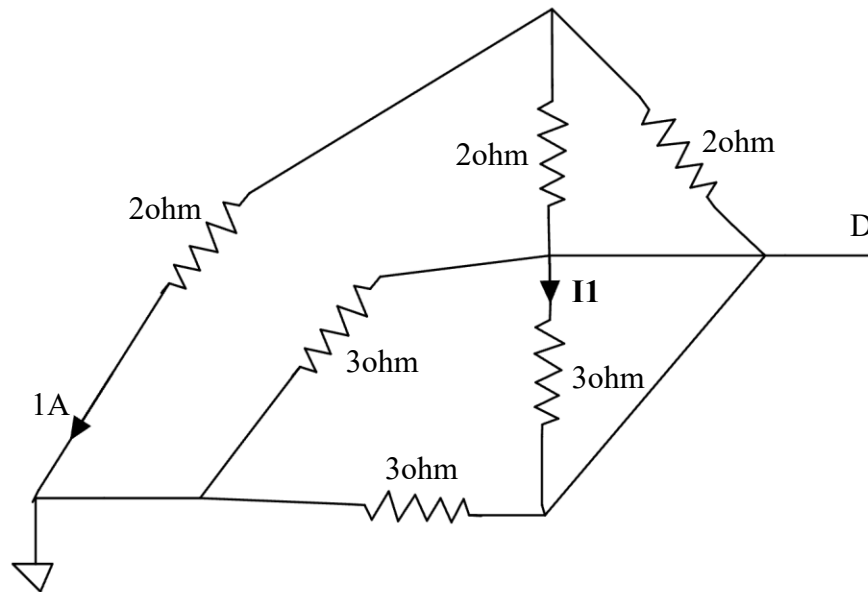
**Question 2 (6 points)**

Given the circuit below, determine the current values **I1**, **I2**, **I3**.

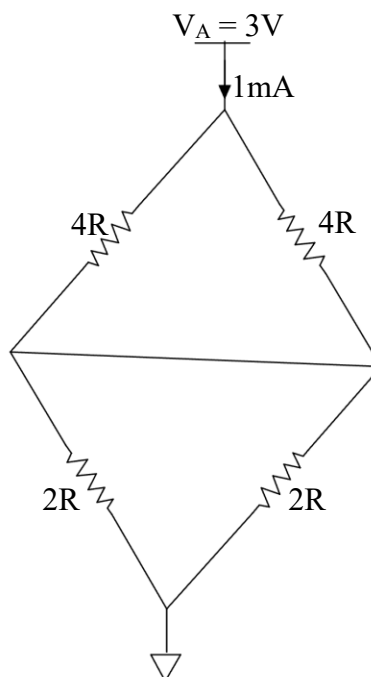


Question 3(6 points)

Given the circuit with six resistors as shown. Find voltage at node D (V_D) and current I_1 .

**Question 4 (6 points)**

The voltage at node A with respect ground is 3V and total current going through the circuit is 1mA. Determine resistance value R.



Question 5 (6 points)

Complete the following python function.

```
import numpy as np

def create_and_print_evens(num_elements, lower_limit, upper_limit):
    """
    Creates a random integer array and then prints its even numbers.

    Args:
        num_elements: The number of integers to create in the array.
        lower_limit: The lowest possible value for the random integers (inclusive).
        upper_limit: The highest possible value for the random integers (inclusive).
    """
    # Step 1: Create a NumPy array with 'num_elements' random integers
    # that are between 'lower_limit' and 'upper_limit'.
    # YOUR CODE HERE

    # Step 2: Now, loop through the random array you just created.
    # If a number is even, print it.
    # YOUR CODE HERE
```

Question 6 (6 points)

Given the three python lists:

```
a = [1, 2, 3]
b = [-1, 1, 2]
c = a + b
```

determine the following values:

```
c =
a[-2:1] =
a[3] =
```

Question 7 (6 points)

Look at the following code has been uploaded to an Arduino.

```
void setup() {  
  pinMode(LED_BUILTIN, OUTPUT);  
}  
  
void loop() {  
  digitalWrite(LED_BUILTIN, HIGH);  
  delay(2000);  
  digitalWrite(LED_BUILTIN, LOW);  
  delay(2000);  
}
```

- How many times does the *void setup()* function run?
- In each cycle, how long does the LED stay ON?
- Explain relationship between delay time and frequency of LED blinking.
- How should you modify the code if the LED blinking frequency needs to be 2Hz?

Question 8 (8 points)

A microcontroller uses a 12-bit ADC with a 5V reference voltage. The ADC outputs digital values in the range 0–4095 (since it is 12-bit).

- What is the range of the raw ADC output?
- Derive the formula for converting the raw ADC output into the corresponding analog voltage.
- Calculate the ADC conversion factor (the multiplier needed to convert the raw ADC value to voltage).
- If the ADC reading is 2175, compute the actual voltage.

Question 9 (6 points)

Draw the CMOS inverter and explain it's operation to fill up the following table

V _{in}	V _{out}
V _{DD}	
0	

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Question 10 (8 points)

Draw the cross section of p-channel and n-channel MOSFETs. Label each layer and terminal. What gate bias will be need to turn on the p-channel and n-channel MOSFETs?

Question 11 (8 points)

Consider an n-channel MOSFET with the following parameters:

- Mobility–oxide product: $\mu C_{ox} = 200 \mu\text{A}/\text{V}^2$
- Width/Length ratio: $W/L = 10$
- Threshold voltage: $V_T = 1.0 \text{ V}$

a) For $V_{GS} = 2.5 \text{ V}$ and $V_{DS} = 1.0 \text{ V}$:

- i) Determine whether the MOSFET operates in the linear or saturation region.
- ii) Calculate the drain current I_D .

b) For $V_{GS} = 4.0 \text{ V}$ and $V_{DS} = 5.0 \text{ V}$:

- i) Check the region of operation.
- ii) Calculate I_D .

c) Compare the results from (1) and (2) and briefly explain why I_D changes with operating region.

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Question 12 (8 points)

Briefly explain what happens at each stage of the following figure. Discuss V_G , V_T relationship, V_{DS} , and I_D values for each of the four stages. Define pinch-off and show how $V_{DS,sat}$ is related to V_{GS} and V_T .

