Midterm Exam 1

Instructor: Prof. George Anwar

10/14/2024

7 Questions, 25 Hours

Version A

Name: _____

Student ID: _____

Please include units in final answers and box them unless otherwise specified.
No credit is given if no work is shown.

Instructions

- Download the PDF. Show your work either on an electronic device or paper. Submit your work as a PDF on Gradescope.
- Read and sign the statement of academic integrity in Section I.
- **Box your final answer.** If graders cannot identify the final answer, it could be marked incorrect.
- Ensure that you assign problems correctly to the page containing the work and answer on Gradescope.
- Showing correct work is crucial. Even if your final answer is accurate, failure to display correct work will result in a point deduction. Emphasis will be placed more on the process rather than the final answer.
- For series questions, getting the previous answer incorrect will affect the next problem, so take the time to double-check your answer. Incorrect answers will result in point loss.
- **Violation of the honor code will result in the following consequences:**
  - You will receive a zero for the exam.
  - Potential reporting to school authorities.

1 Code of Conduct

Statement of Academic Integrity

- I will adhere to the Berkeley Honor Code: specifically, as a member of the UC Berkeley community, I act with honesty, integrity, and respect for others.

- If I have a question of clarification about what is being asked in any question below, I will e-mail **ellioth00@berkeley.edu** or upload private post on Ed with my question.

- I will complete this assignment entirely on my own, and will not discuss its contents or any related concepts with any fellow ME100 student or other person between 4pm PDT on 10/14/2024 and 5pm PDT on 10/15/2024, other than to ask clarification questions directly of the course staff.

- While I am working on the assignment, I may access materials on the Fall 2024 ME100 bCourses site. I will not post questions from this assignment on forums, including Chegg.

- I understand that my final answers to this assignment must be uploaded to Gradescope and saved by 5pm PDT on 10/15/2024.

- **I will check my email, announcement, and ed post during the exam for any update on the exam.**

- Calculators, including those on computers, are allowed. However, using circuit simulations or other online platforms will be deemed as showing no work. Even when utilizing a calculator, you must detail every step leading to its use. Inefficient or skipped steps can lead to point deductions. Ensure you attempt all questions.

- I hereby acknowledge that I have read and understood the above instructions. I agree that any failure on my part to adhere to these instructions, which may result in a penalty, is solely my responsibility and fault.

Signature: _____ Date: _____

2 Conceptual Questions

15 points

For each of the following statements, mark whether it is True or False. Provide a brief explanation for your answer. Each correct True/False answer will earn one point, while a right explanation will earn two points.

1. **Points: 3**

In a purely resistive AC circuit, the current and voltage are always in phase regardless of frequency or resistance.

True / False Explanation: _____

2. **Points: 3**

Thevenin's theorem can only be applied to circuits that are linear and non-linear in nature.

True / False Explanation: _____

3. **Points: 3**

Parasitic resistance in inductors can be ignored in high-frequency applications as it does not significantly affect circuit behavior. (Hint: Refer Back to Lab 3)

True / False Explanation: _____

4. **Points: 3**

A diode's reverse bias region exhibits no current flow, regardless of the applied reverse voltage, until the breakdown voltage is reached.

True / False Explanation: _____

5. **Points: 3**

The energy stored in an inductor is directly proportional to the square of the current flowing through it.

True / False Explanation: _____

3 Equivalent Resistance

20 points

Consider the following circuit:

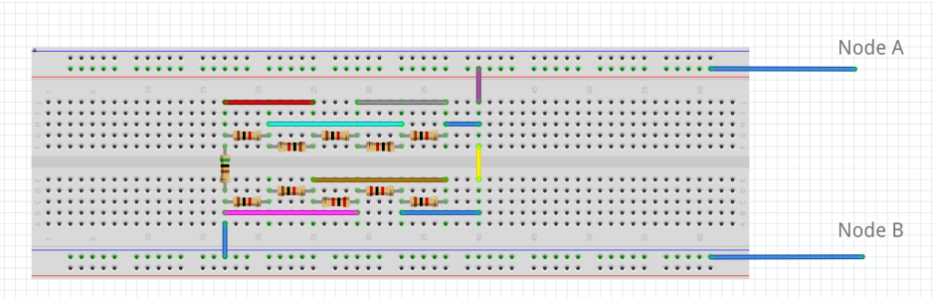


Figure 1: Circuit to find the equivalent resistance

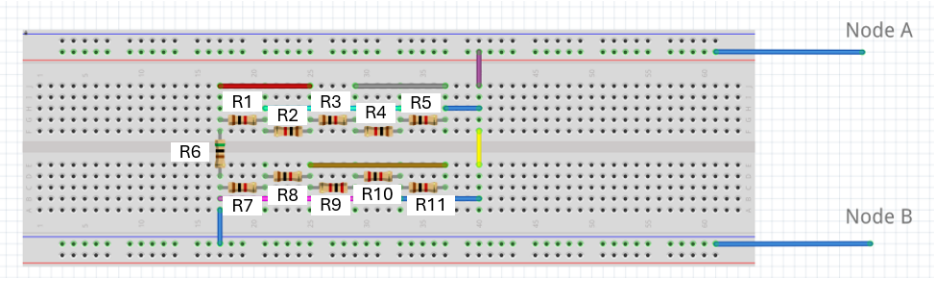
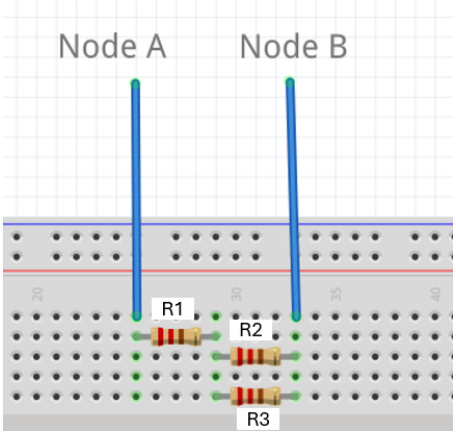
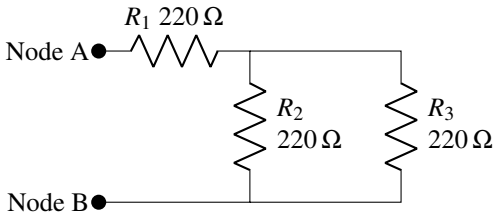


Figure 2: Circuit with label

Here we have a example circuit. The following is how we want you to write your answers. Use the chart at the end of the problem (page 6) to figure out the resistance value of the resistor.



This is an example problem!!!



Circuit diagram for the circuit on the left.
Make sure you label the resistors and their resistance

3.1

6 points
Consider **Figure 1** above, the circuit with resistors. Draw the circuit diagram, labeling all resistors and their respective resistance values. Refer to the example given on the previous page for detailed steps.

3.2

10 points
Write an equation to find the equivalent resistance value using R1 to R11, based on the circuit diagram above.
The example circuit given can be written as $R_{eq} = R1 + (R2 \,||\, R3)$. Make sure you use brackets to indicate which operation happens first.

3.3

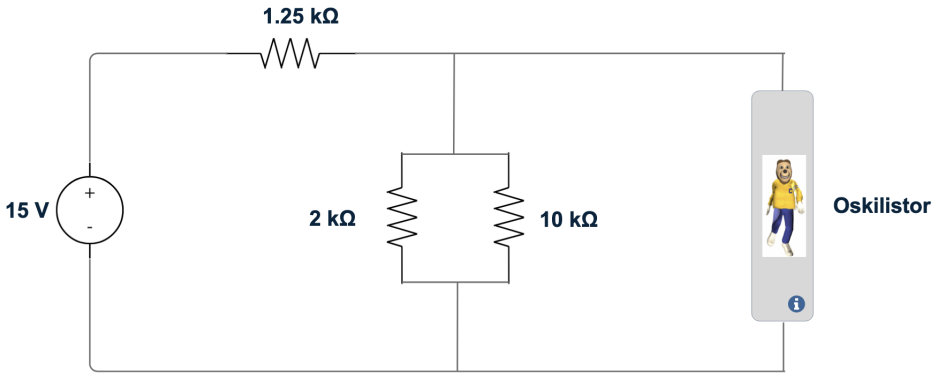
4 points
Using your equation from above, compute the equivalent resistance value.

	1st Digit	2nd Digit	Multiplier	Tolerance
Black	0	0	x 1	
Brown	1	1	x10	±1%
Red	2	2	$x10^{2}$	±2%
Orange	3	3	$x10^{3}$	±3%
Yellow	4	4	$x10^{4}$	±4%
Green	5	5	$x10^{5}$	±0.5%
Blue	6	6	$x10^{6}$	±0.25%
Violet	7	7	$x10^{7}$	±0.1%
Grey	8	8	$x10^{8}$	±0.05%
White	9	9	$x10^{9}$	
Gold			$x10^{-1}$	±5%
Silver			$x10^{-2}$	±10%

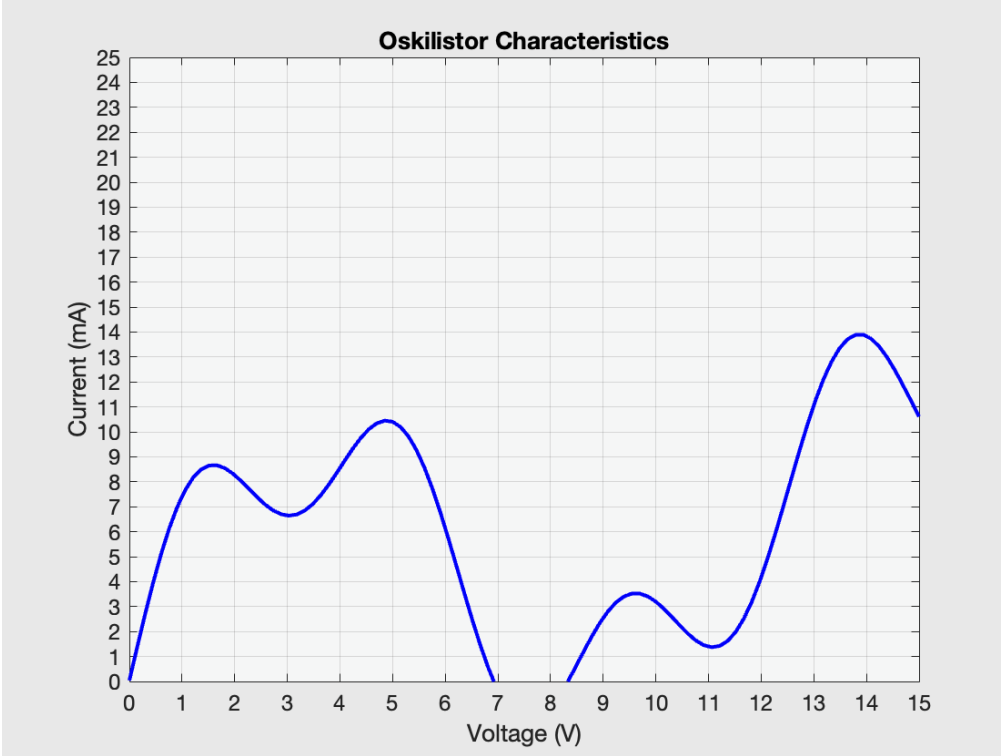
4 Load Line Analysis

20 points

Consider the following circuit:



Where the **Oskilistor** is a non-linear device with a characteristic curve shown below.



4.1

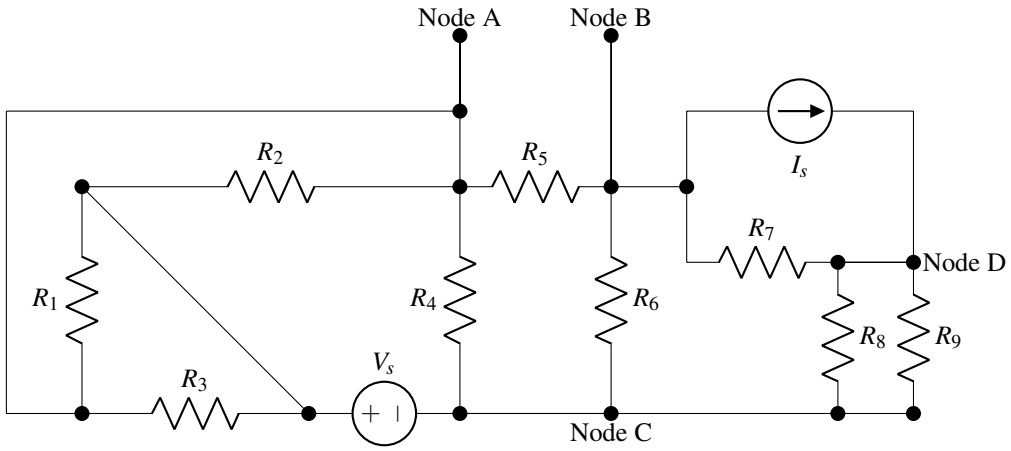
10 points
Determine all possible voltages and currents across the **Oskilistor** in the circuit with a 15 V source.

4.2

10 Points
Instead of 1.25 $k\Omega$ Find a ideal resistance such that the **Oskilistor** only operates at **one** point.

5 Thevenin and Norton equivalent

10 points



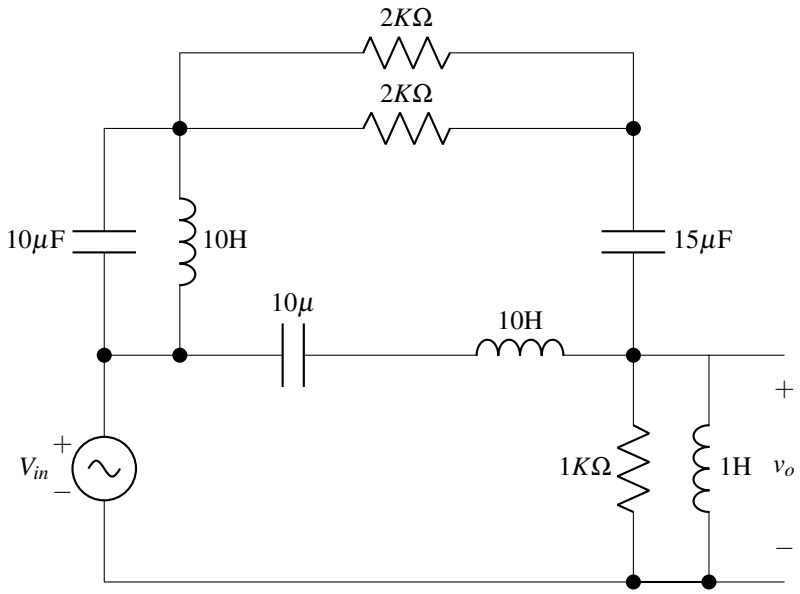
In this problem, we will find the Thevenin and Norton equivalent circuit. Black dot refers to junctions.

Using the given resistance values given as $R_1 = 9\ \Omega$, $R_2 = 9\ \Omega$, $R_3 = 9\ \Omega$, $R_4 = 6\ \Omega$, $R_5 = 4\ \Omega$, $R_6 = 12\ \Omega$, $R_7 = 10\ \Omega$, $R_8 = 3\ \Omega$, $R_9 = 6\ \Omega$, $V_s = 12$ V, $I_s = 2$ A.

Find the Thevenin voltage and Norton current across terminal A and B. Use either 1) KVL and KCL, 2) Superposition, 3) Node voltage analysis, or 4) Mesh analysis. Clearly state what method/methods you used and write all necessary equations to set up your problem.

6 RLC circuit

20 points



Black dots are junctions.

6.1

5 points
For the circuit above find the value of the $\frac{V_o}{V_{in}}$ as $\omega \to 0\ rad/sec$

6.2

5 points
For the circuit above find the value of the $\frac{V_o}{V_{in}}$ as $\omega \to \infty\ rad/sec$

6.3

10 points
For the circuit above find the value of the $\frac{V_o}{V_{in}}$ as $\omega \to 100\ rad/sec$

7 Debugging circuit

15 points

Elliot is building a circuit for his final project, following the schematic provided in **Figure 3**. However, the breadboard circuit he assembled (shown in **Figure 4**) is not working due to several mistakes he made. Help Elliot troubleshoot the breadboard by **identifying at least three issues**. Clearly mark where the errors are located in **Figure 4**, and explain why each is a problem and how Elliot can fix it. (Note: The breadboard image is available on bCourses, and all pin connections to the ESP32 are correct, even if the numbers are not visible. Only if there is a dot means it is a junction without dot it means two wires are not connected. Same nodes are represented with same color. led polarity is written on the figure)

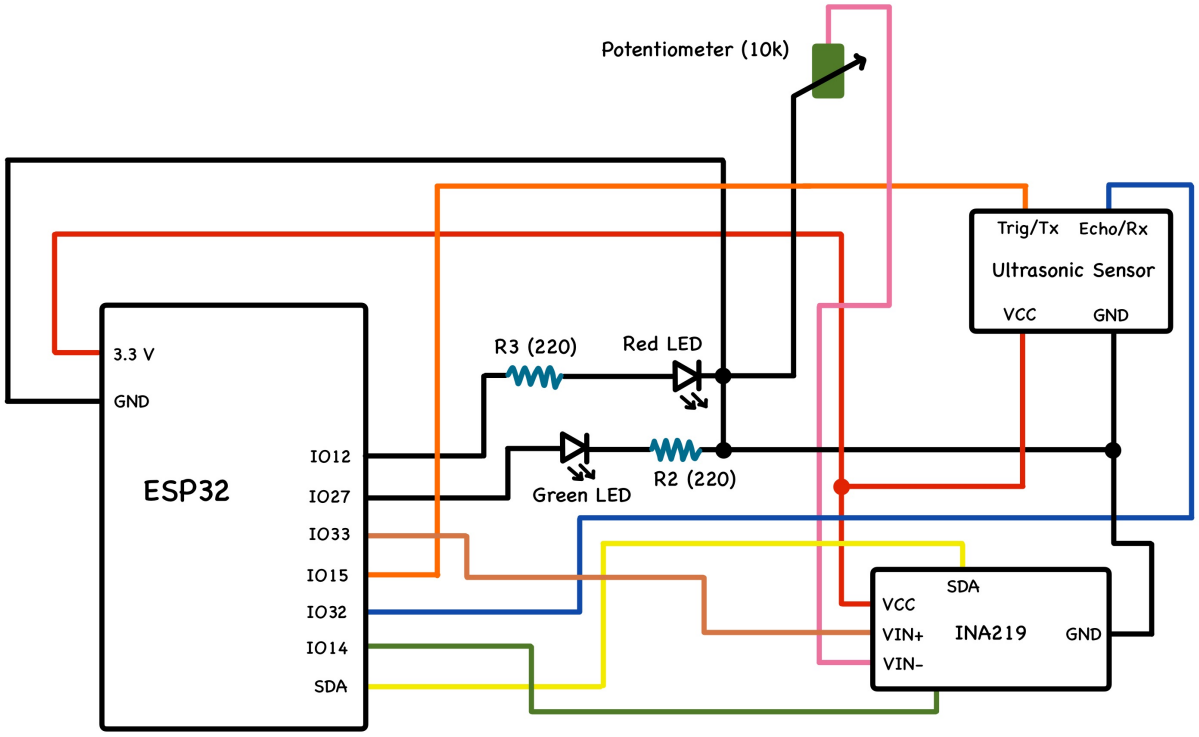


Figure 3: Schematic of correct circuit that Elliot followed

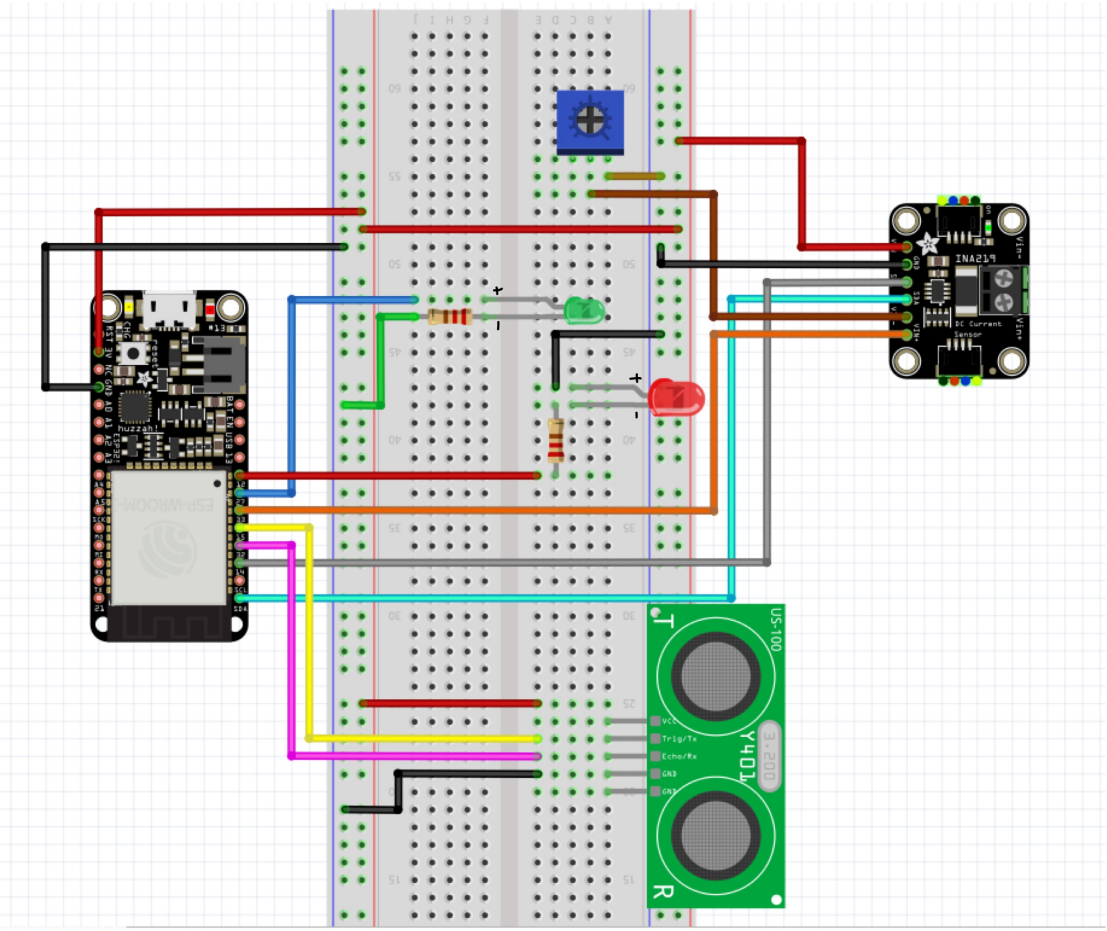


Figure 4: Elliot's breadboard circuit that has to be fixed