# ECE 110 Cramming Carnival Review

Author: Members of HKN

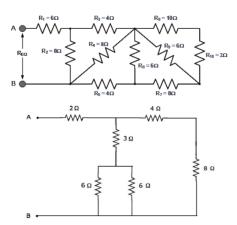
Fall 2024

### Introduction

This worksheet does not cover content in lectures after November 25th and is not meant to be a replacement for any practice exams or section reviews. Use this worksheet as a quick refresher for various topics throughout the semester and for slightly different questions than the homeworks.

#### Formulas not on the help sheet

**Note:** All formulas required for the questions are assumed to be known, as they are not provided in this sheet.



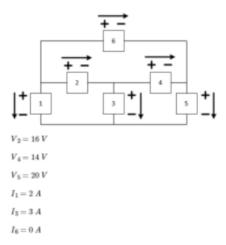
### Power Efficiency & Capacitors

Question 1: Consider a car that has 400 kJ of energy at a specific speed. The car's regenerative brakes are 40% efficient at converting kinetic energy to energy stored in a battery. What is the energy added when the car brakes to half speed?

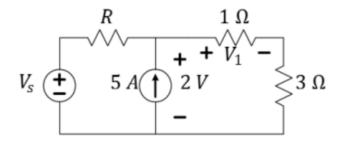
Question 2: If a 15 kWh battery has to be recharged using a 60% efficient generator with peak power of 500 W, how long does the generator need to run to fully charge the battery?

**Question 3:** What is the energy stored in a 4 nF capacitor charged to 9V? **Question 4:** What voltage is needed to charge the capacitor from the above question enough to lift a 2-gram mass 15 cm?

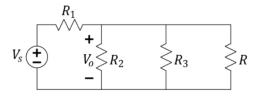
#### Kirchoff's Laws/Dividers



**Question 5:** Given the above circuit and information, find V1, V3, V6, I2, I4, and I5.



Question 6: Find V1 in the above circuit.



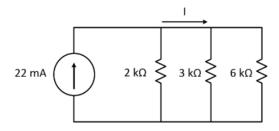
 $R_1=9~\Omega$ 

 $R_2=10\;\Omega$ 

 $R_3=15~\Omega$ 

 $V_S=4~V$ 

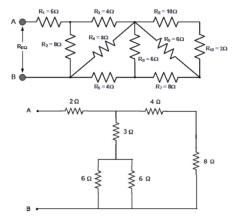
**Question 7:** What value of R will result in Vo = 1V?



Question 8: Find I in the above circuit.

## Equivalent Resistance / Power

Question 9: Find equivalent resistance for the circuits below.



**Question 10:** If the voltage between nodes A and B in the second circuit is 9V...

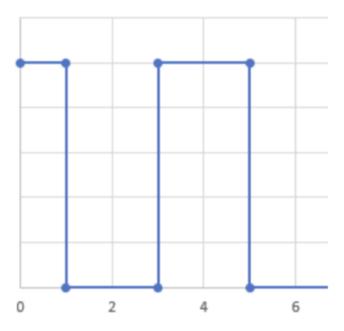
- 1. What is the current through the 3 ohm resistor?
- 2. What is the power through the 3 ohm resistor?
- 3. What is the power through the 8 ohm resistor?
- 4. What resistor has the highest power output?

### PWM

**Question 11:** Imagine a square wave that outputs 15W from 0 to 12 seconds and 5W from 12 to 20 seconds. This square wave corresponds to a 10 ohm resistor.

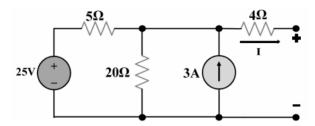
- 1. What is the Average Power of this waveform?
- 2. What is the RMS Voltage of this waveform?

Question 12: Given a limited portion of this graphed waveform, what is its duty cycle?



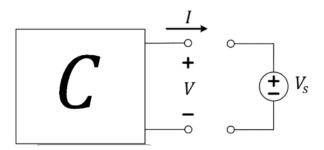
### **I-V** Equations

**Question 13:** What is the short circuit current and the open circuit voltage for the circuit below?



**Question 14:** If this circuit were to be placed in series with another circuit with an IV equation of I = 0.005V - 0.025, assuming the same polarities given above, what would be the operating current and voltage?

Question 15: If the open circuit voltage of a circuit containing ideal sources and resistors is measured at Voc = 8 V, while the current through the short circuit across the circuit is Isc = 200 mA, what would be the power in watts absorbed by an ideal voltage source, Vs = 4, placed across the terminals?

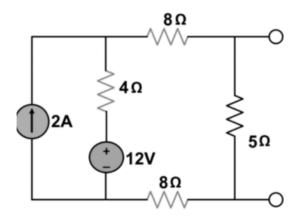


#### Norton and Thevenin

**Question 16:** Give Norton and Thevenin Forms for the subcircuit shown on the previous page.

**Question 17:** What is the Norton resistance of the circuit below? What is the Thevenin Resistance?

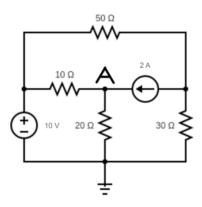
Question 18: Draw the Thevenin and Norton Equivalents.



# Nodal Analysis

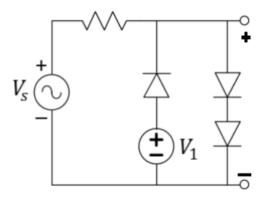
Question 19: Find the voltage at node A for this circuit.

Question 20: Find the voltage drop across the 10, 30, and 50 ohm resistors.

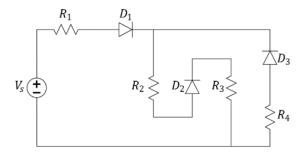


## Diodes

**Question 21:** Assume an ideal-offset model and Von = 1 volt. If  $Vs = 5 \cos(\omega t)$  volts and V1 = 2 volts, what are the maximum and minimum voltages across the open nodes?

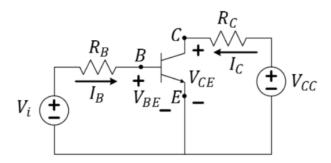


**Question 22:** In the circuit below, which diodes are on? Furthermore, if Vs = 10 V, all the diodes have Von = 2V under the offset ideal model, and the voltage drop over R1 is also 2V, what is the voltage drop across the other resistors, assuming they have an equal resistance?



### BJTs

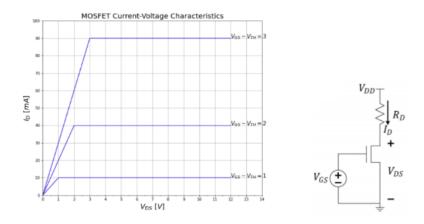
Question 23: The properties of the transistor are that VBE on is 1V,  $\beta$  is 120, and VCE sat is 0.2 V. In this circuit, VCC is 9V, RC is 150 $\Omega$ , and RB is 30000 $\Omega$ . What are the maximum and minimum values for VCE if Vi's output is variable between 0V and 9V?



Question 24: If Vi was set to 5V, what would VCE be?

### MOSFETs/cMOS logic

**Question 25:** An IC dissipates 110W. If the IC has a 5% activity factor  $\alpha$ , frequency of 10GHz, and 1nF gate capacitance, what is the maximum number of transistors that can be in the IC if it can operate at up to 9V?



**Question 26:** The given circuit with a MOSFET in series with a voltage source of 6V and a resistor with a resistance of  $120\Omega$  Find the transistor parameter k and a value for VDS that results in I = 30 mA, given that VGS - VTH = 2.

# **Bonus Questions**

Question 27: Give the IV equation, Norton equivalent, and Thevenin Equivalent for the circuit below.

