EXAM QUESTION PAPER

College/ Institute	Engineering, Design and Physical Sciences		
Department	Electronic and Electrical Engineering		
Exam Author(s)	Dr Chun Sing Lai and Dr Ruiheng Wu		
Module Code	EE1638		
Module Title	Devices and Circuits		
Month	January	**Year**	2024
Exam Type	Full	**Format**	
Duration	Two Hours		
Number of questions	Six		
Question Instructions	Answer 4 questions out of 6. If more than 4 questions are attempted, all attempts will be marked, but only the marks for the highest 4 marked questions will be counted.		
Are calculators permitted	Yes		
Make/Model number of permitted calculators.	Standard		
Can students include drawings/ diagrams?	Yes		
Any permitted reference materials	None		
Required Stationery / Equipment	None		

By continuing beyond this point, you confirm that you have read the information and instructions above, and understand the conditions of this examination.

1. a) Determine the magnitude and direction of the currents I, I_1, I_2, and I_3 for the network in FIGURE Q1a.

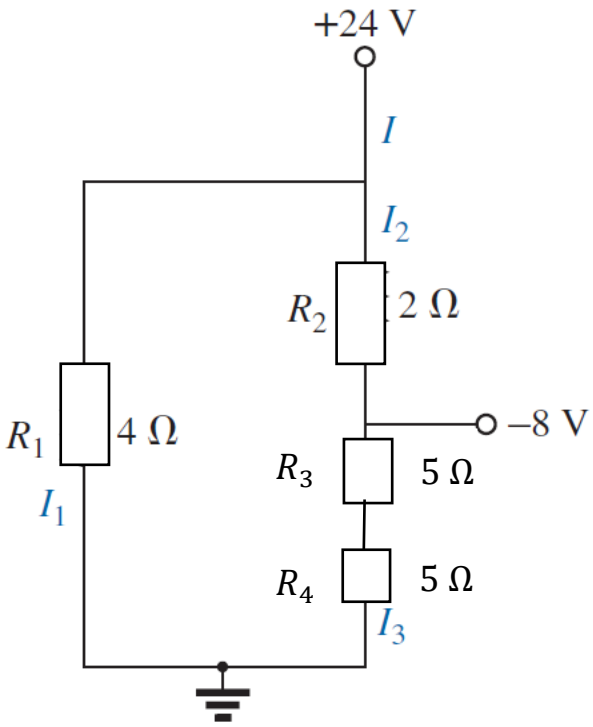

FIGURE Q1a

[40%]

b) Determine the current through the 2 Ω resistor of the network in FIGURE Q1b.

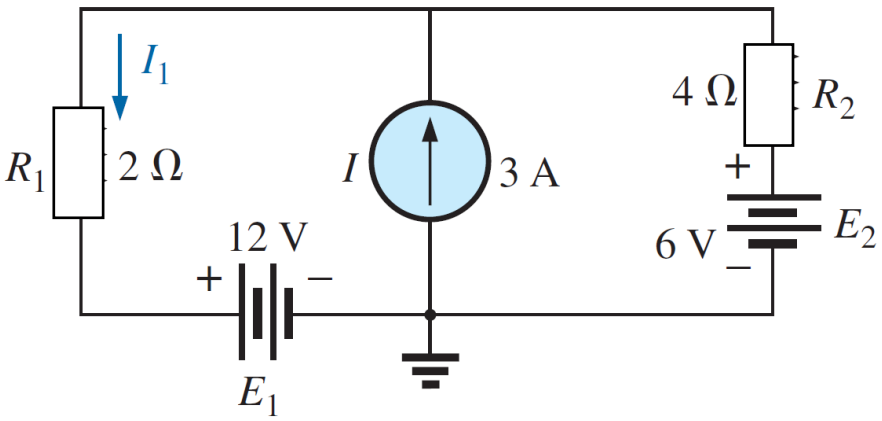

FIGURE Q1b

[60%]

2. a) For the network in FIGURE Q2a:

i) Convert the voltage source to a current source,
ii) Reduce the network to a single current source, and determine the voltage V_1,
iii) Determine V_2 and current I_2.

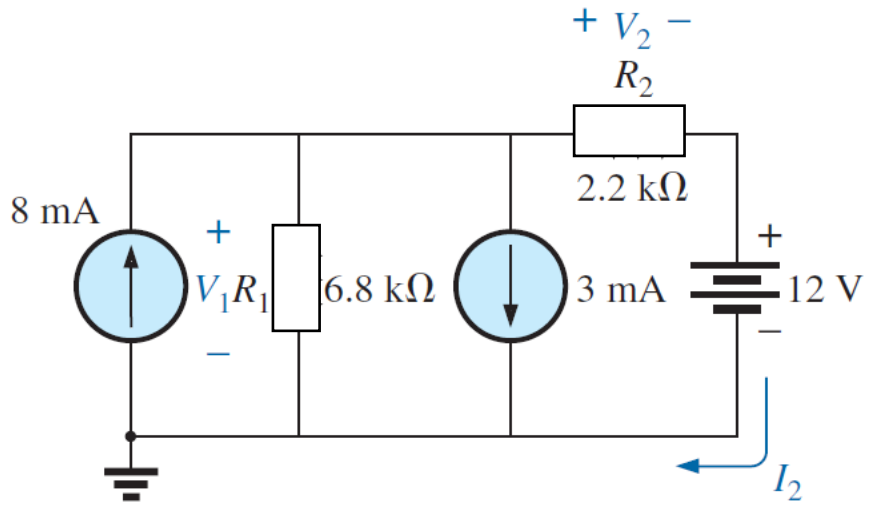

FIGURE Q2a

[60%]

b) Find the current I of the network in FIGURE Q2b.

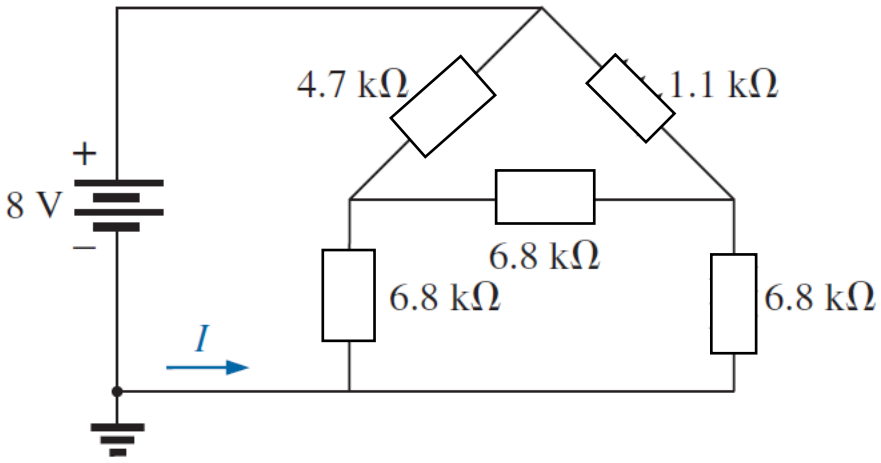

FIGURE Q2b [40%]

3. a) Discuss what is a capacitor. Derive the equations for the energy stored in a capacitor. Sketch the power, voltage, current, and energy stored in a

capacitor with respect to time.

[50%]

b) Find the Norton equivalent circuit for the network external to the 9 Ω resistor in FIGURE Q3b.

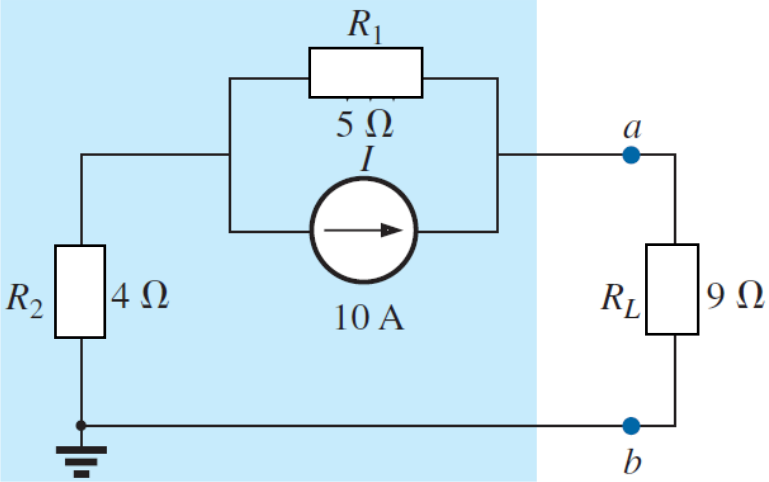

FIGURE Q3b

[50%]

4. a) Figure 4(a) shows a circuit for charging a 12 V battery. Assuming the diode is ideal, if v_s is a sinusoid with 20 V peak amplitude, determine the peak value of the diode current and the maximum reverse-bias voltage that appears across the diode.

[24%]

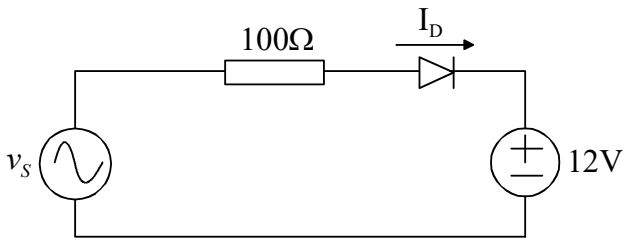

Figure Q4(a)

b) Figure Q4(b) shows the operation of a Silicon-Controlled Rectifier (SCR). Explain how a positive feedback can be formed using the circuit in the figure.

[40%]

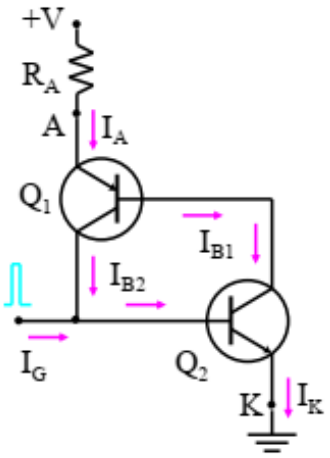

FIGURE Q4(b)

c) An amplifier fed by a sine-wave signal of 10 mV peak delivers a sine-wave output of 1 V peak to a load resistance of 2 kΩ. The input current of the amplifier is found to be a sine wave of 10 μA peak. Calculate the voltage gain, current gain, and power gain as ratios and decibels.

[36%]

5. a) A negative-feedback amplifier has a closed-loop gain $A_f = 100$, and an open-loop gain $A = 10^4$.

i) What is the feedback factor B?

[8%]

ii) If a manufacturing error results in a reduction of A to 10^3, what closed -loop gain results?

[12%]

b) The parameters for the inverting amplifier shown in Figure Q5(a) are R_1 = 10 kΩ, R_2 = 100 kΩ, R_L = 2.5 kΩ, v_i = 0.5 sinωt (V), determine:

i) The voltage gain.

[16%]

ii) The input resistance.

[16%]

iii) The peak value of the output voltage.

[16%]

iv) The maximum load current.

[16%]

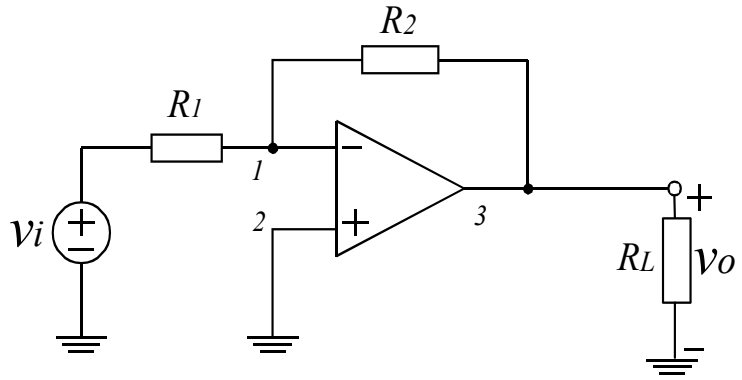

Figure Q5(a)

(Continued on the next page)

c) Give the name and the gain of the amplifier circuits shown in Figure Q5(b).

[16%]

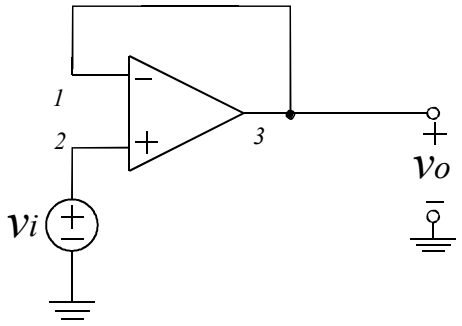

Figure Q5(b)

6. a) It is required to connect a 10 V source with a source resistance of 100 kΩ to a 1 kΩ load. Find the voltage that will appear across the load if

i) The source is connected directly to the load.

[10%]

ii) A unity-gain Op-Amp buffer is inserted between the source and the load.

[30%]

In each case find the load current and the current supplied by the source.

b) In Figure Q6(b): R_1=100kΩ, R_2=100kΩ, R_E=5kΩ, R_C=5kΩ, V_{CC}=15V. Determine its V_B, V_C, V_E, I_B, I_C and I_E (β=100). What is the operation mode of transistor? Why?

[60%]

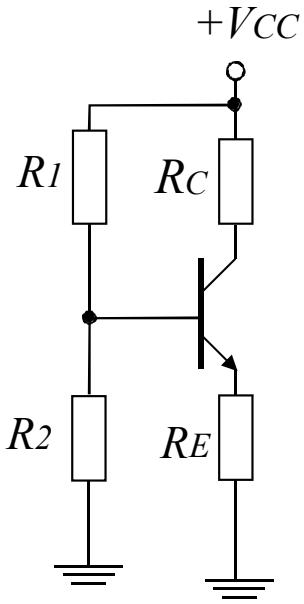

Figure Q6(b)