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	EE1618		
Module Title	Devices and Circuits		
Month	January	**Year**	2023
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) Given a 60 V supply with a voltage regulation of 2%:

i) Determine the terminal voltage of the supply under full-load conditions,

ii) If the full-load current is 10 A, determine the internal resistance of the supply,

iii) Sketch the curve of the terminal voltage versus load demand and the equivalent circuit for the supply.

[60%]

b) Determine current I_1 for the network in FIGURE Q1b.

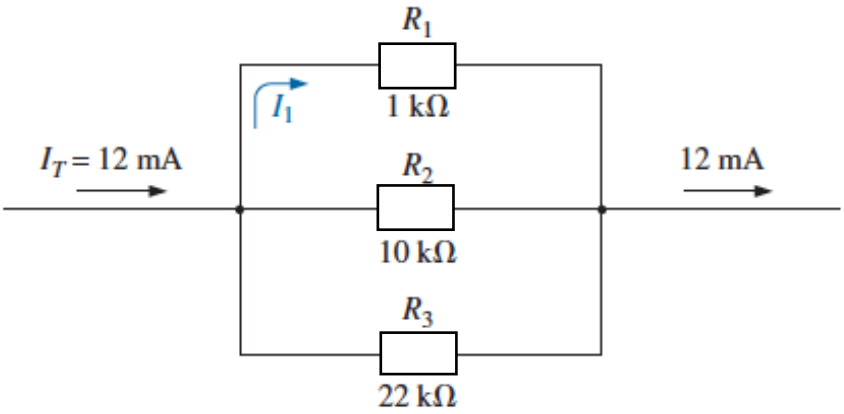

FIGURE Q1b

[40%]

2. a) Using the superposition theorem, find the voltage V_2 for the network in FIGURE Q2a:

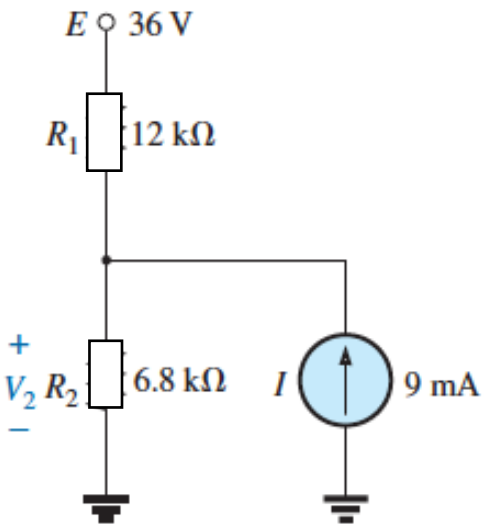

FIGURE Q2a

[60%]

b) Find the Norton equivalent circuit of the networks in FIGURE Q2b external to terminals *a-b*.

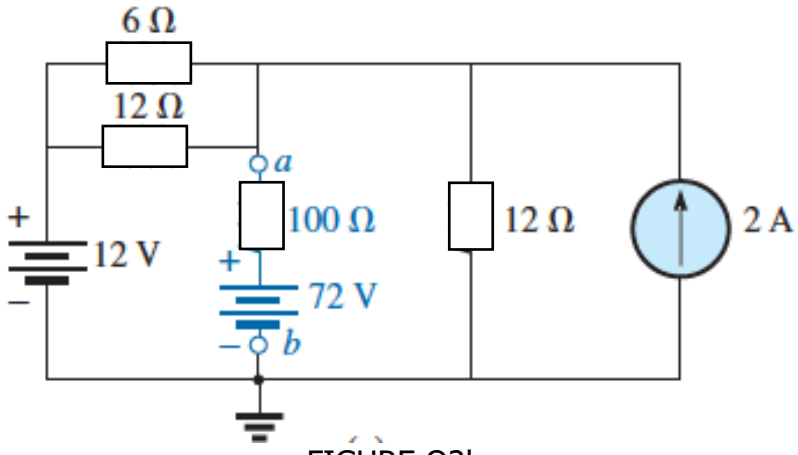

FIGURE Q2b

[40%]

3. a) Using mesh analysis, find the current through each resistor for the network shown in FIGURE Q3a.

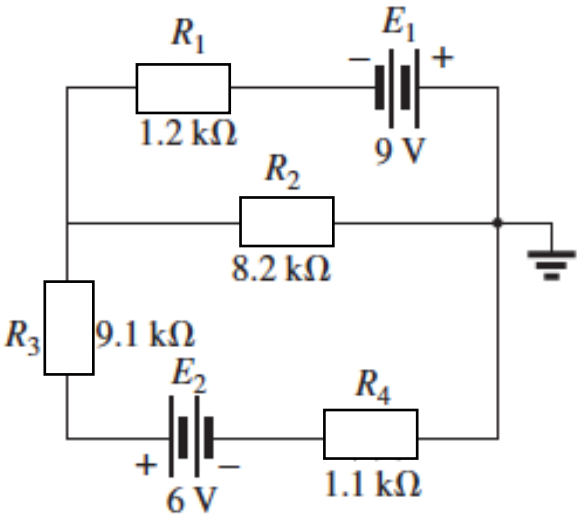

FIGURE Q3a

[40%]

b) For the *R-L* circuit shown in FIGURE Q3b:

i) Determine the frequency at which $X_L = R$.,
ii) Find the total impedance at $f = 40$ kHz,
iii) Plot the curve of V_L versus frequency,
iv) Find the phase angle of the total impedance at $f = 40$ kHz. Can the circuit be considered inductive at this frequency? Why?

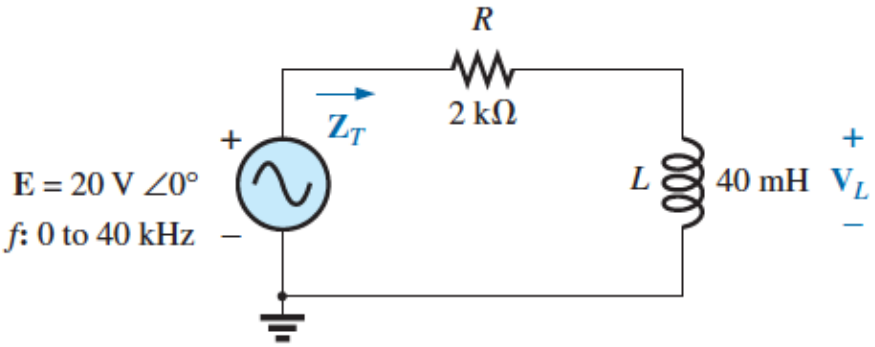

FIGURE Q3b [60%]

4. a) Assuming the diodes to be ideal, describe the transfer characteristic for the circuit shown in Figure Q4a.

[40%]

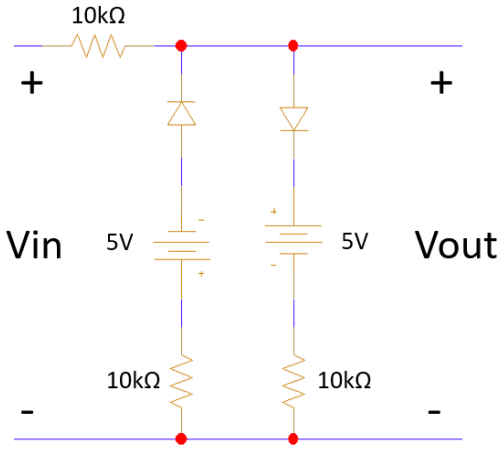

Figure Q4a

b) A sawtooth generator using Shockley diode is shown in Figure Q4b. Explain its operation.

[20%]

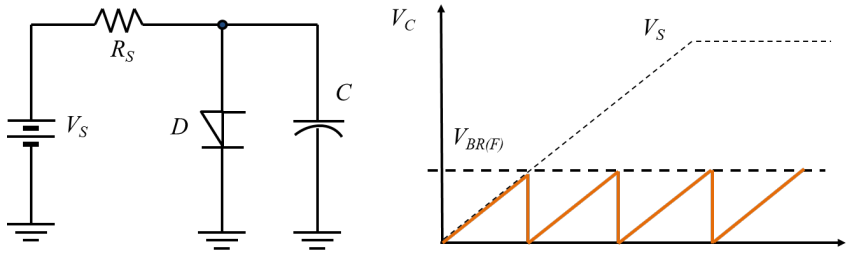

Figure Q4b

c) Consider an amplifier operating from ±10 V power supplies. It is fed with a sinusoidal voltage having 1 V peak and delivers a sinusoidal voltage output of 9 V peak to a 1 kΩ load. The amplifier draws a current of 9.5 mA from each of its two power supplies. The input current of the amplifier is found to be sinusoidal with 0.1 mA peak. Find the voltage gain and the current gain.

[30%]

(Continued on the next page)

d) For the 3-stage amplifier shown in FIGURE Q4c, determine the overall voltage gain for the amplifier. Show all your calculations in detail.

i) if $A_1 = 5$, $A_2 = -10$, $A_3 = -2$

[5%]

ii) if $A_1 = 15$ dB, $A_2 = 10$ dB, $A_3 = 2$ dB

[5%]

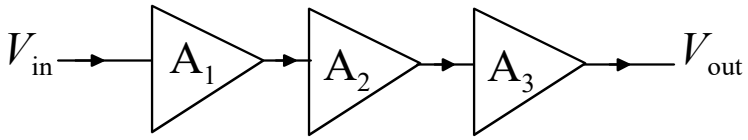

FIGURE Q4c

5.

a) A negative-feedback amplifier has closed-loop gain A_f = 100, and an open-loop gain $A = 10^6$.

i) What is the feedback factor B?

[12%]

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

[12%]

b) Draw the circuit diagram of an inverting amplifier using a single operational amplifier which has an input resistance of 5 kΩ and a gain of -10.

[24%]

c) In a noninverting amplifier shown in FIGURE Q5a, $R_1 = 10$ kΩ, $R_2 = 40$ kΩ, $R_L = 10$kΩ, $v_i = 2\sin\omega t$, determine

i) the closed-loop gain.

[12%]

ii) the peak value of the output voltage.

[20%]

iii) the maximum output current of the amplifier.

[20%]

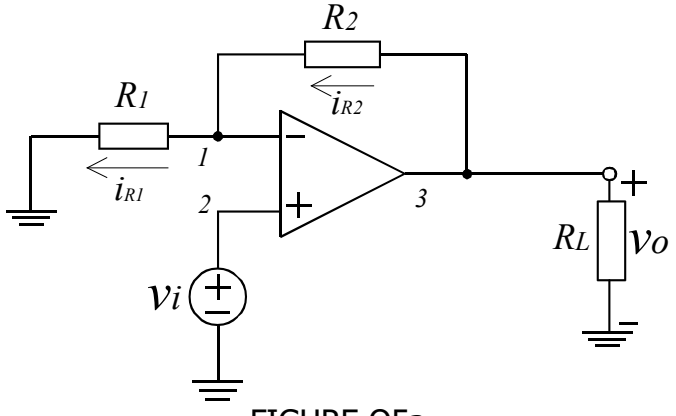

FIGURE Q5a

6. a) What is the role of the Zener diode in the DC power supply shown in FIGURE Q6a?

[12%]

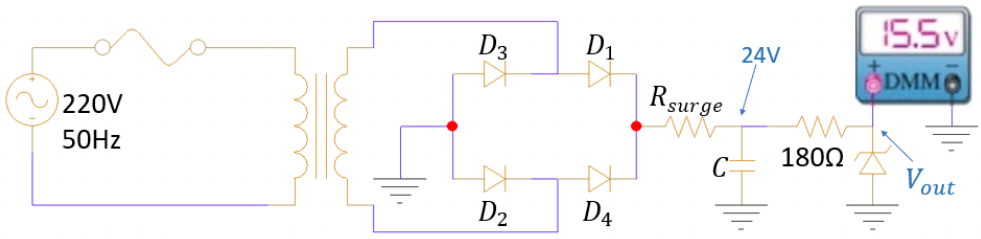

FIGURE Q6a

b) The transistor in the circuit of FIGURE Q6b has $\beta = 100$ and exhibits a V_{BE} of 0.7 V. Design the circuit so that a current of 1 mA flows through the collector and a voltage of +10 V appears at the collector.

[36%]

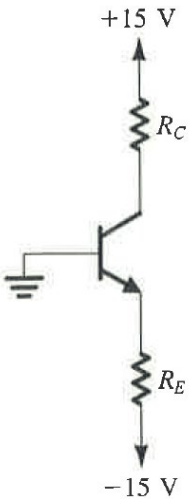

FIGURE Q6b

(Continued on the next page)

c) For the circuit shown in FIGURE Q6c, determine its V_B, V_C, V_E, I_B, I_C and I_E ($\beta = 100$). What is the operation mode of transistor Q_1? Why?

[52%]

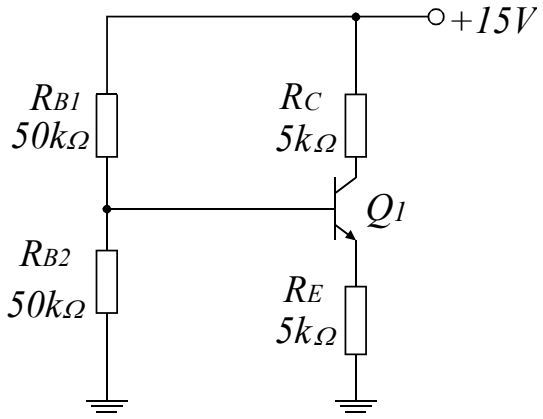

FIGURE Q6c