DUBLIN CITY UNIVERSITY

XX January 1999

COURSE:	APPLIED PHYSICS PHYSICS with a LANGUAGE
YEAR:	2
SEMESTER	1
EXAMINATION:	Electronics 1; PS203
EXAMINER:	Dr B. Lawless
DURATION:	2 hours
INSTRUCTIONS:	Answer 4 parts of Question 1 (50 %) and 2 other questions (25 % each)

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until instructed to do so.

Question 1. Answer four parts of this question.

(a) Calculate the voltage difference between the nodes marked A and B in the circuit in Figure 1.

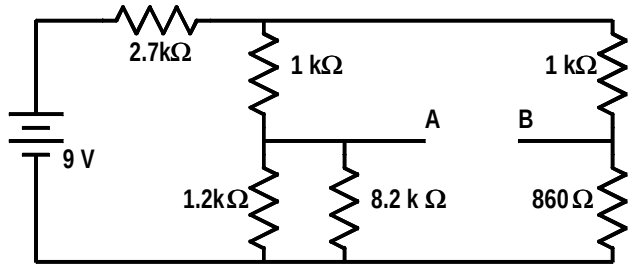

Figure 1: Question 1 (a)

(b) Calculate the corner frequency for the filter circuit shown in Figure 2 and plot the Bode diagram for the filter for the frequency range from 10 Hz to 1 MHz.
Calculate the amplitude of the signal output from the filter when a sinusoidal signal at a frequency of 27 kHz and amplitude 1.5 V is applied at the input. Calculate the phase shift of the output signal.
Plot scaled graphs of the input and output waveforms as a function of time.

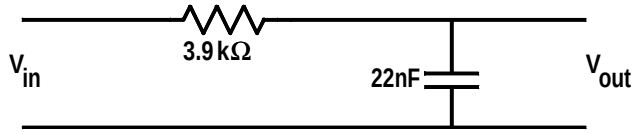

Figure 2: Question 1 (b)

(c) State the Principle of Superposition and explain how it is used in calculation in a circuit when there are voltage and current sources present.
Calculate the current in the 470 Ω resistor in the circuit of Figure 3.

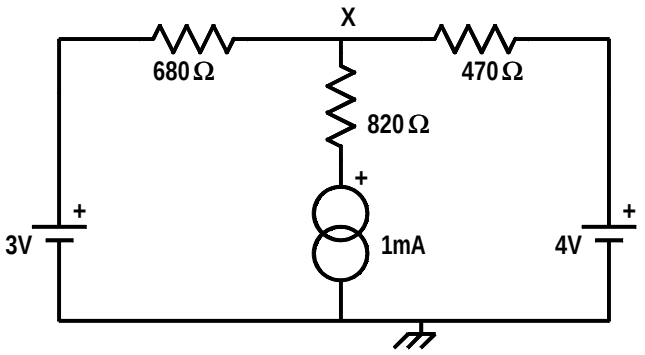

Figure 3: Question 1 (c)

(d) A 1 V, 1 kHz sinusoidal signal is applied as shown to the circuit in Figure 4.
A voltage of +12 V is applied at point B in the circuit.
Calculate the voltage signal which would be observed at the output at point A and give a scaled sketch of the waveform.
How would the output signal change if the DC voltage applied at point B were changed to +5 V?

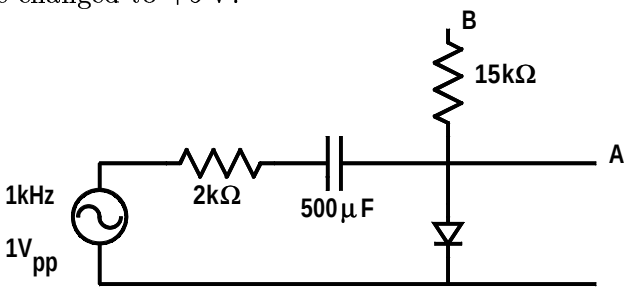

Figure 4: Question 1 (d)

(e) Explain what is meant by "biasing a transistor".
The voltage at the collector of the circuit shown in Figure 5 was measured and was found to be +4.8 V with respect to the ground. Calculate the current gain, β, for the transistor used in the circuit.

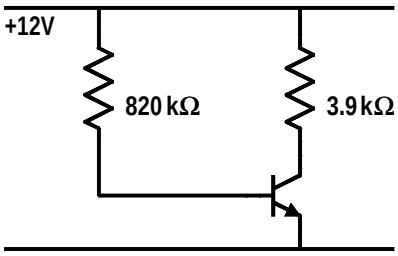

Figure 5: Question 1 (e)

(f) Justify the two rules used for op-amp linear circuit design.
Design a noninverting amplifier, uing a 741 op-amp, which has a DC gain of +12.6. Justify your choice of resistor values.

Question 2. Give an account of the photolithographic process used in the fabrication of transistors and integrated circuits.
Give sketches of the constructional details of an NPN transistor and explain why the dopant concentrations and dimensions of the various regions determine the performance of the device.
Sketch the current voltage characteristics of an NPN transistor.

Question 3. Explain the operation of a transistor amplifier with particular reference to the amplification of small signals. Use circuit diagrams and sketches of the voltage waveforms present at various points in the circuit to illustrate your answer.
You have available a transistor which has a current gain, $\beta = 240$ and a full selection of resistors and capacitors. Design a transistor amplifier which has a gain of -80 at a signal frequency of 1 kHz. What is the significance of the - sign in the gain of -80? What tests would you carry ont on the circuit to verify that it is operating to speciications?

Question 4. Explain what is meant by negative feedback. Derive an equation for the gain of a noninverting amplifier in terms of the feedback fraction.
Calculate resistor values such that the output from the circuit shown in Figure 6 is given by

$$V_{\text{out}} = -2.3V_1 - 4.6V_2 - 3.9V_3$$

Derive an expression for the output of the circuit shown in Figure 7.

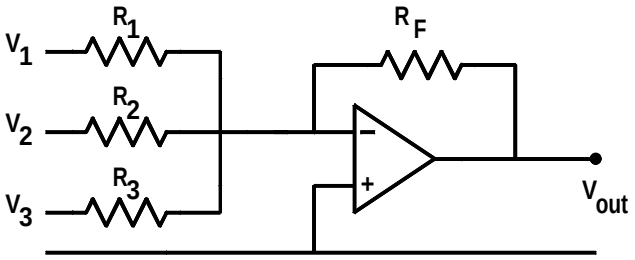

Figure 6: Question 4

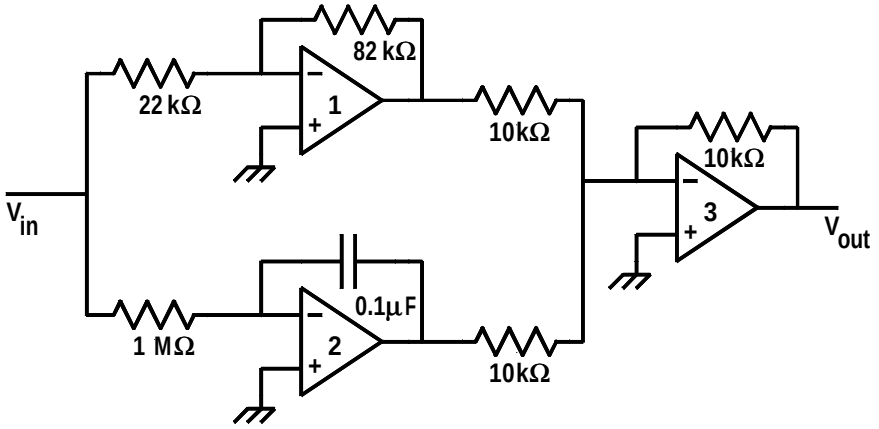

Figure 7: Question 4