DUBLIN CITY UNIVERSITY

January 2005

COURSE:	APPLIED PHYSICS PHYSICS with French PHYSICS and ASTRONOMY
YEAR:	2
SEMESTER	1
EXAMINATION:	PS203: Electronics 1
EXAMINER:	Dr B. Lawless (5300)
DURATION:	2 hours
INSTRUCTIONS:	Answer 5 parts of Question 1 (50 %) and 2 other questions (25 % each) Do not turn over this page until instructed to do so.
NUMBER OF PAGES	9 (including this cover page.)

Question 1. Answer five parts of this question.

(a) Calculate the voltages which would be measured, with respect to GND, at each of the nodes, A, B, C, D, E and F in the circuit of Figure 1.
Calculate each of the new voltages which would be measured when the switch is closed.

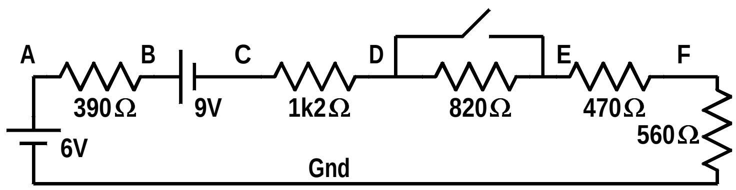

Figure 1: Question 1 (a)

(b) Calculate the complex impedance of the series circuit shown in Figure 2 for a sinusoidal signal at 3.0kHz.
Plot the impedance on the complex impedance diagram.

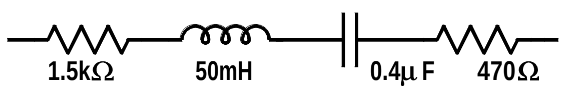

Figure 2: Question 1 (b)

(c) Calculate the corner frequency for the filter circuit shown in Figure 3.
Plot the frequency response of the filter for a frequency range from 10Hz to 10kHz.

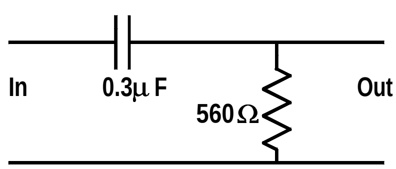

Figure 3: Question 1 (c)

(d) The frequency responses of three individual filters are shown in Figure 4. Plot the frequency response of the filter formed by connecting these three filters in series.

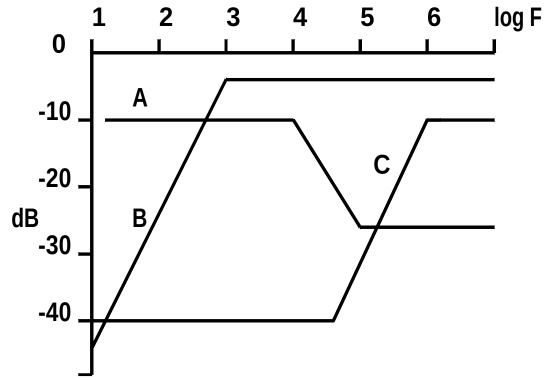

Figure 4: Question 1 (d)

(e) Figure 5 shows the first five Fourier components (in dB relative to 1V) of a particular periodic waveform. Estimate the amplitudes of these components after they have been passed through the filter also shown in Figure 5 and plot the resultant Fourier component amplitudes.

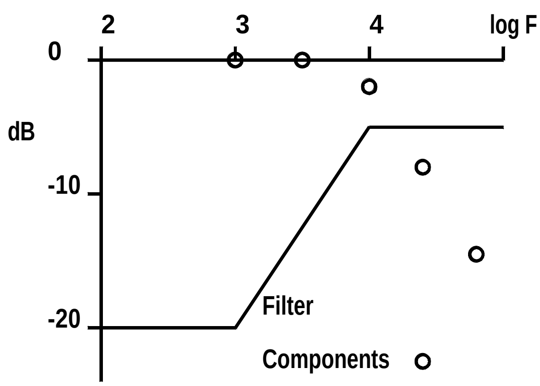

Figure 5: Question 1 (e)

(f) Plot the voltage waveform which you would observe with an oscilloscope connected to the output of the circuit shown in Figure 6.

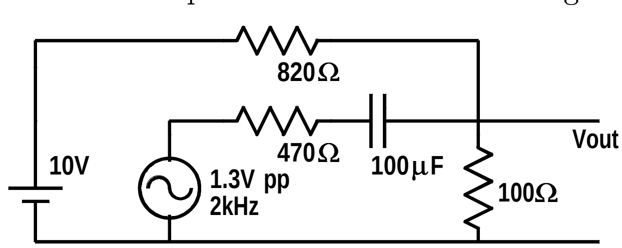

Figure 6: Question 1 (f)

(g) Calculate the current which flows in the 470Ω resistor of the circuit shown in Figure 7.

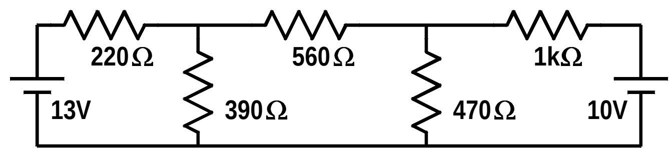

Figure 7: Question 1 (g)

(h) Calculate the voltages at nodes A, B, C, D, and E of the circuit shown in Figure 8

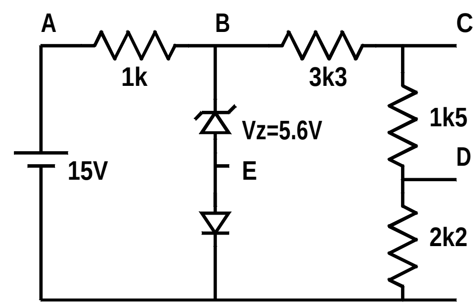

Figure 8: Question 1 (h)

Question 2. Calculate the emitter, base and collector voltages and currents for the amplifier shown in Figure 9.
Calculate the small signal voltage gain of the amplifier.
The current gain of the transistor is $\beta = 250$
Give a scaled sketch of the traces which you would observe on an oscilloscope with Channel A connected to the input and Channel B connected to the output when the input signal is a sinusoidal waveform at $f = 3$kHz and amplitude $V = 10$mV.

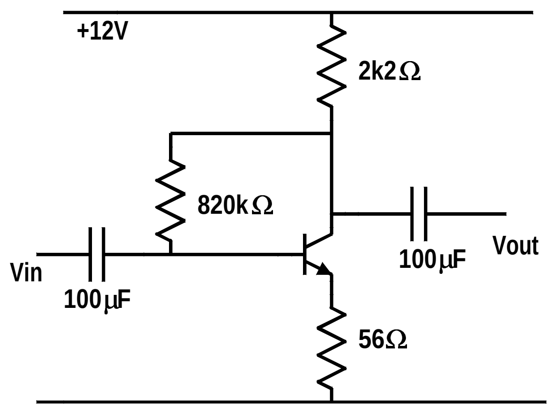

Figure 9: Question 2

Question 3. (a) Describe a procedure which can be used to calculate the component values for a JFET amplifier circuit such as that shown in Figure 10.

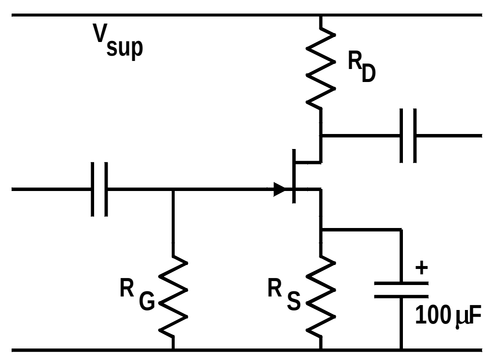

Figure 10: Question 3

(b) Calculate suitable component values for an amplifier having a gain = -4 when a JFET having a $g_m = 2500\mu$S, an $I_{DSS} = 5$mA and a $V_{GS(off)} = -3$V is used. The small signal voltage gain of the amplifier is to be constant for frequencies above 200Hz.

Question 4. (a) Derive the equation for the gain of the inverting amplifier circuit, which uses a 741 op-amp, shown in Figure 11

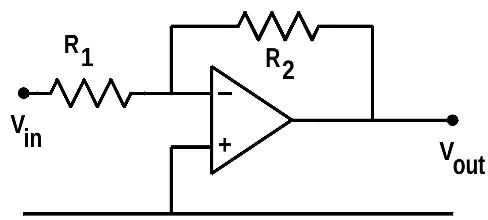

Figure 11: Question 4 (a)

(b) Calculate suitable component values so that this inverting amplifier has a gain of -25.

(c) Give a scaled sketch of the response of the integrating amplifier shown in Figure 12 for a step voltage input of 0V for $t < 0$ and 100mV for $t > 0$. Your sketch should show the response from $t = -10$s to $t = +30$s for a 741 op-amp and a ±15V supply.

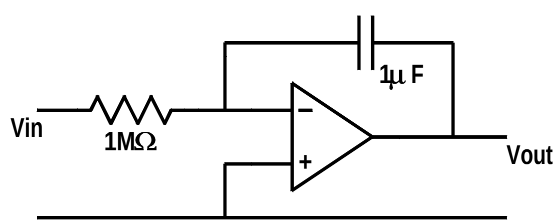

Figure 12: Question 4 (b)

Question 5. (a) Show that the gain of an amplifier employing negative feedback, represented by Figure 13, is given by

$$G = \frac{1}{\beta}$$

where β is the feedback fraction and the open loop gain, A_0, is large.

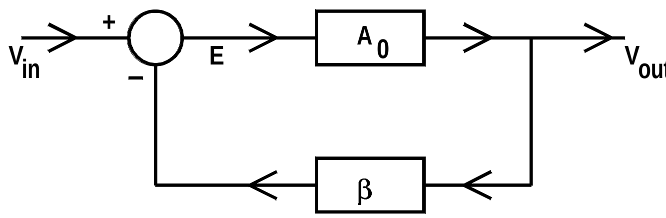

Figure 13: Question 5 (a)

(b) Use this result to show that the gain of a noninverting amplifier such as that shown in Figure 14 is given by

$$G = (\frac{R_1}{R_2} + 1)$$

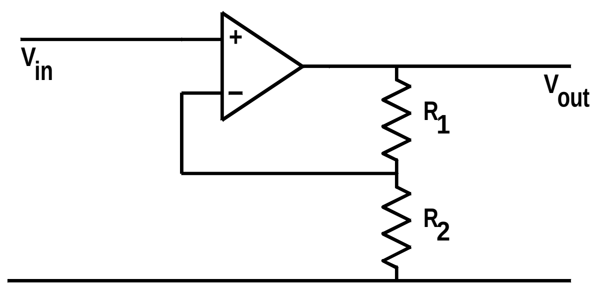

Figure 14: Question 5 (b)

(c) How does the use of negative feedback allow amplifiers having precise, stable gains to be constructed when the open loop gain of op-amp ICs such as the 741 can not be accurately specified?