DUBLIN CITY UNIVERSITY

January 2004

COURSE:	APPLIED PHYSICS PHYSICS with French PHYSICS with German Applied Physics Exchange
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	8 (including this cover page.)

Question 1. Answer five parts of this question.

(a) Calculate the voltage which would be indicated by the voltmeter in the circuit of Figure 1.

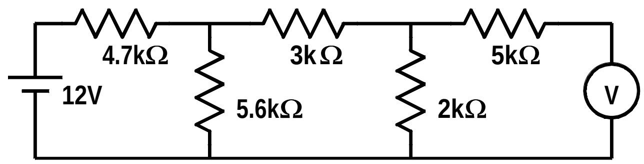

Figure 1: Question 1 (a)

(b) Calculate the current which would be indicated by the milliammeter in the circuit of Figure 2.

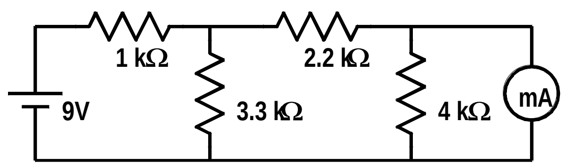

Figure 2: Question 1 (b)

(c) Calculate the voltage at each of the nodes A, B, C and D in the circuit of Figure 3.

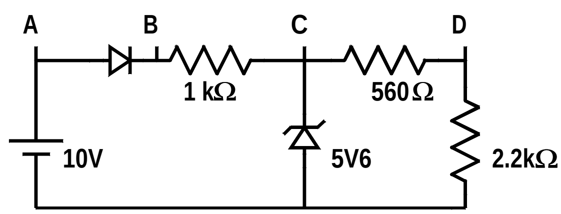

Figure 3: Question 1 (c)

(d) Plot the complex impedance vector for the series circuit shown in Figure 4 onto the complex impedance diagram for a frequency of 2kHz. Plot the path taken by the tip of the complex impedance vector as the frequency is varied from 100Hz to 10kHz.

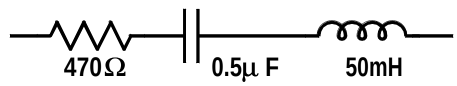

Figure 4: Question 1 (d)

(e) Plot the frequency response (dB versus log F) for the filter circuit shown in Figure 5.
Calculate the exact attenuation for a frequency of 1kHz.

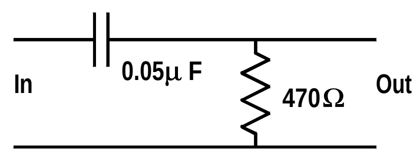

Figure 5: Question 1 (e)

(f) Calculate the Th´evenin equivalent of the circuit shown in Figure 6.

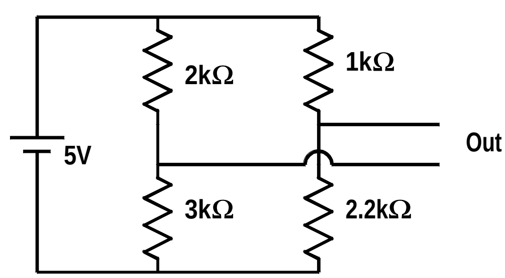

Figure 6: Question 1 (f)

(g) The input voltage to the circuit shown in Figure 7 is varied from 0V to +5V causing the output voltage to vary. Sketch a graph of the output voltage as a function of the input voltage.

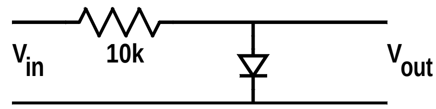

Figure 7: Question 1 (g)

(h) Using the Principle of Superposition (or any other suitable method) calculate the current which flows in the 1kΩ resistor in the circuit shown in Figure 8.

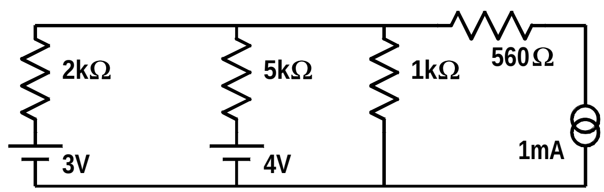

Figure 8: Question 1 (h)

Question 2. Give an account of the operation of a junction diode.
Explain the meanings of the terms:

(a) semiconductor material

(b) diode characteristic

(c) knee voltage

Derive the approximate expression for the the current in a junction diode:

$$I = I_0 \exp\left(\frac{V}{25\,\mathrm{mV}}\right)$$

and explain each of the terms in the equation.
Give a scaled sketch of the characteristic curve for a 1N4004 silicon diode which passes 1.0A for a forward voltage of 1.1V.
A current of 10mA is passing through a 1N4148 silicon diode. Calculate the increase in the current through the diode which results when the voltage across the diode is increased by 0.2mV.

Question 3. Sketch and explain the characteristic curves for a Junction Field Effect Transistor (JFET).
What is meant by the terms:

(a) pinch-off voltage V_P

(b) Gate to Source off voltage $V_{GS(off)}$

(c) Drain saturation voltage I_{DSS}

(d) mutual conductance g_m

A circuit for a JFET amplifier is shown in Figure 9. The JFET has $g_m = 2000\mu$S, $I_{DSS} = 6$mA and $V_{GS(off)} = -3$V. Calculate suitable values for the resistances in the circuit so that the amplifier has a small signal gain of -4.

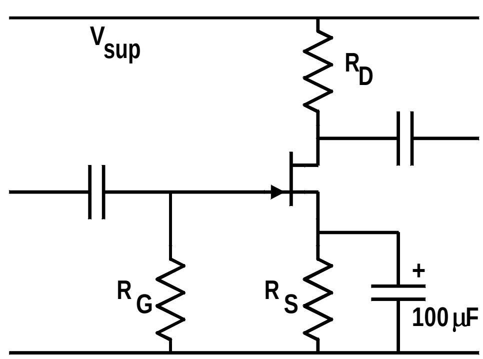

Figure 9: Question 3

Question 4. Calculate the emitter, base and collector voltages and currents for the amplifier circuit shown in Figure 10. The β for the transistor in 280. Calculate the small signal voltage gain of the amplifier. Give a scaled sketch of the voltage waveform which you would observe with an oscilloscope with V_{in} connected to Channel A and V_{out} connected to Channel B. The input signal is 10mV_{pp} at 1kHz.

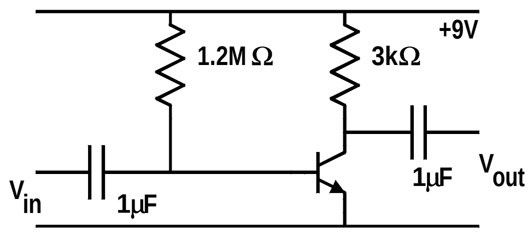

Figure 10: Question 4 (a)

Question 5. Justify the two rules for the operation of op-amps which are being operated in the linear region:

(a) There is no voltage difference between the non-inverting and inverting inputs to an op-amp

(b) No current flows into the input terminals of an op-amp.

Use these rules to obtain an equation which describes the operation of the inverting adder circuit shown in Figure 11.
If $R_1 = R_2 = R_3 = R_F = 10\text{k}\Omega$, calculate and sketch the output voltage waveform when

(a) $V_1 = +1.2\text{V}$,

(b) $V_2 = 3.0 \sin(300t)$ and

(c) $V_3 = 4.0 \sin(600t)$

where t is the time.

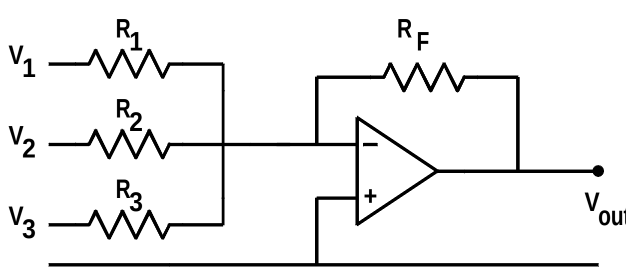

Figure 11: Question 5