UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE & ENGINEERING

DEPARTMENT OF PHYSICS

SUPPLEMENTARY EXAMINATION 2012/2013

TITLE OF PAPER	:	ELECTRONICS II
COURSE NUMBER	:	P312
TIME ALLOWED	:	THREE HOURS
INSTRUCTIONS	:	ANSWER <u>ANY FOUR</u> OUT OF FIVE QUESTIONS
		EACH QUESTION CARRIES 25 MARKS
		MARKS FOR DIFFERENT SECTIONS ARE SHOWN IN THE RIGHT-HAND MARGIN.

THIS PAPER HAS 6 PAGES, INCLUDING THIS PAGE.

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QUESTION 1

(a) Explain how the input resistance of a device, such as an amplifier, can be measured. Use a schematic diagram and appropriate equations to illustrate your point. (5 marks)

(b) Fig. 1 shows a low-pass filter circuit. The amplitude of the input voltage, v_i is 10 V.

(i) Determine the cut-off frequency of this filter (in Hertz). (2 marks)

(ii) Calculate the magnitudes of v_o when v_i has a frequency 500 Hz, 1 kHz, and 2 kHz. (7 marks)

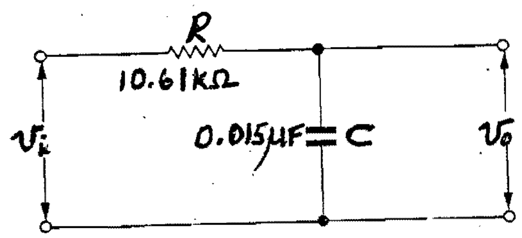

Fig. 1

(c) (i) Calculate v_{out} as a function of time for the circuit shown in Fig. 2 when $v_{in} = A\sin\omega t$, A = 500 mV and ω = 100 rad.s^{-1}. (5 marks)

(ii) Sketch and label graphs of v_{out} and v_{in} against time. Sketch them on the same axis. (6 marks)

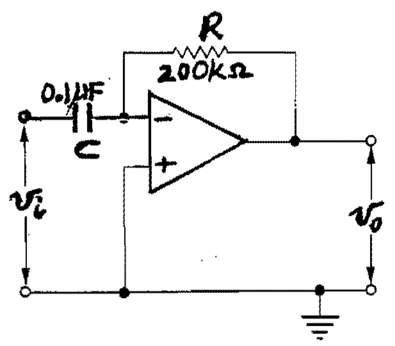

Fig. 2

QUESTION 2

(a) Fig. 3 represents a free-running multivibrator.

(i) Explain how this multivibrator works. Assume that the a.c. current gain of transistor T_1 is higher than that of transistor T_2. (4 marks)

(ii) With the aid of a table, sketch the waveforms observed at points P, Q, R and S. Label them. (12 marks)

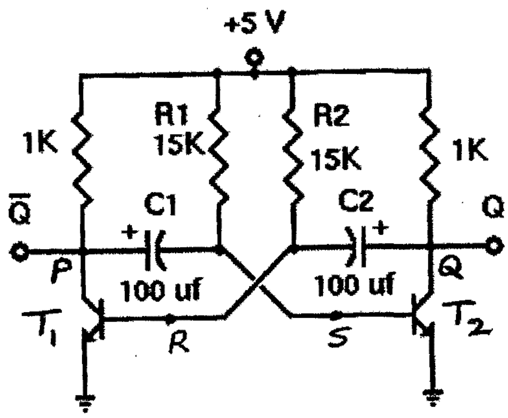

Fig. 3

(b) (i) Write an expression for the frequency of oscillation of a phase shift oscillator which is made up of a BJT amplifier and an RC ladder network. The ladder network consists of equal resistors and equal capacitors. (2 marks)

(ii) Consider each of the capacitors to be of capacitance C = 0.01 μF whilst each of the resistances of the resistors can be varied between 2 kΩ and 200 kΩ.

Calculate the minimum and maximum frequencies which can be generated by the oscillator. (4 marks)

(iii) Explain why the open-loop gain of the amplifier used in the phase shift oscillator must be of magnitude greater than or equal to 29. (3 marks)

QUESTION 3

(a) Consider the RLC bandpass filter shown in Fig. 4.

(i) Derive an expression for the magnitude of the transfer function of this filter. (5 marks)

(ii) Derive the expression for the resonant frequency. (4 marks)

(iii) What is the value of the resonant frequency? (2 marks)

(iv) Determine the Q-factor. (2 marks)

(v) Calculate the cut-off frequencies, f_1 and f_2. (6 marks)

(vi) Calculate the bandwidth of the filter. (1 mark)

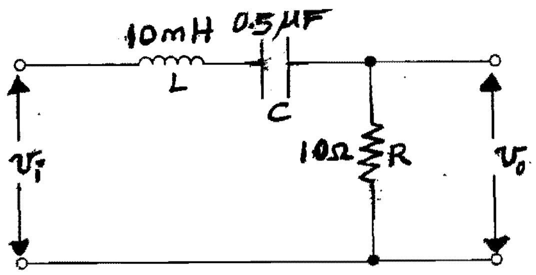

Fig. 4

(b) Calculate the phase difference between v_o and v_i, for the high-pass filter shown in Fig. 5, when v_i has a frequency of 20 kHz. (5 marks)

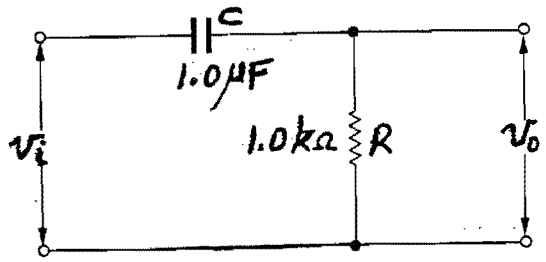

Fig. 5

QUESTION 4

(a) (i) What is meant by degenerative feedback in amplifiers? (3 marks)

(ii) Explain what is meant by the Barkhausen criterion? (3 marks)

(b) State two distinct advantages of inverse feedback to an amplifier. (3 marks)

(c) An amplifier has an open-loop gain of magnitude A. A fraction B of its output signal voltage is fed back to the input so as to reduce the signal at the input.

Derive an expression for the gain with feedback. (5 marks)

(d) An amplifier has the following properties:

Open-loop gain = –500
Feedback is applied with a feedback factor of 0.2

(i) What is the loop gain? (2 marks)

(ii) Find the voltage gain with feedback. (2 marks)

(iii) Determine the percentage fall in gain with feedback if the open-loop gain of the amplifier falls by 20 per cent. (7 marks)

QUESTION 5

(a) Fig. 6 shows an operational integrator.

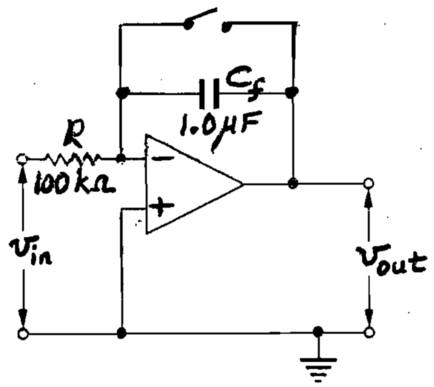

Fig. 6

(i) Write down the relationship between v_{out} and v_{in} for a circuit shown in Fig. 6. (1 mark)

(ii) Calculate v_{out} as a function of time when v_{in} = -10 mV. Sketch graphs of v_{out} and v_{in} with respect to time and label them. (5 marks)

(iii) Calculate v_{out} as a function of time when v_{in} is a voltage that varies sinusoidally with time. The voltage signal has an amplitude of 10 V and a frequency of 100 Hz. Sketch graphs of v_{out} and v_{in} as a function of time and label them (9 marks)

(b) The equation below represents an ideal relationship between the output voltage, v_o and the input voltage, v_i of a circuit. Use operational amplifiers to design this circuit and label it.

$$v_o = -(v_i - 2 \times 10^{-4} \int v_i dt)$$ (10 marks)