UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE 122

DEPARTMENT OF PHYSICS

MAIN EXAMINATION	**:**	**2011/2012**
TITLE OF PAPER	**:**	**ELECTRONICS II**
COURSE NUMBER	**:**	**P312**
TIME ALLOWED	**:**	**THREE HOURS**
INSTRUCTIONS	**:**	**ANSWER ANY FOUR 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) Fig. 1.1 shows a bandpass filter.

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

(ii) Derive an expression for the resonant frequency, f_0 in terms of the inductance and capacitance. (4 marks)

(iii) Calculate the resonant frequency. (2 marks)

(iv) Calculate 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)

(b) Calculate the phase difference between v_{in} and v_{out}, for the high-pass filter shown in Fig. 1.2, when v_{in} has a frequency of 10 kHz. (5 marks)

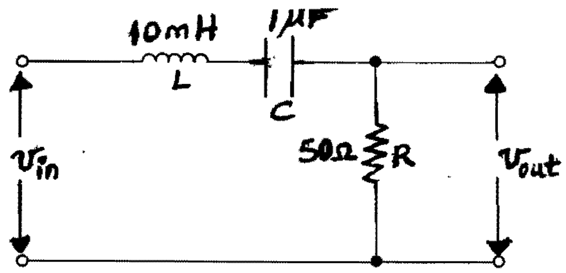

Fig. 1.1

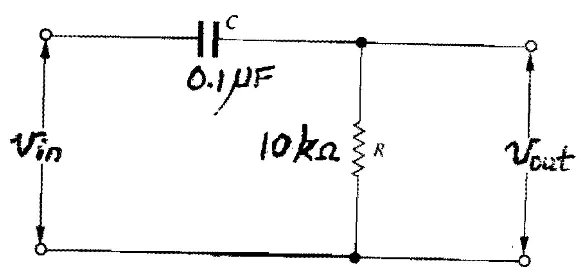

Fig. 1.2

QUESTION 2

(a) (i) Draw the circuit diagram of an astable multivibrator which utilises two bipolar junction transistors, T_1 and T_2 and label it. (3 marks)

(ii) Explain how this multivibrator works. Assume that when the d.c. power supply is turned ON, current rises faster in T_1 in comparison with T_2. (4 marks)

(iii) With the aid of a suitable table, write down the voltages at the base and collector of each of the two transistors. Sketch the waveforms observed at these points and label them. (12 marks)

(b) Fig. 2.1 shows the circuit diagram of a phase-shift oscillator.

(i) Write an expression for the frequency of oscillation of this oscillator. (2 marks)

(ii) Explain why the open-loop gain of the amplifier used in the phase shift oscillator must be greater than or equal to 29. (4 marks)

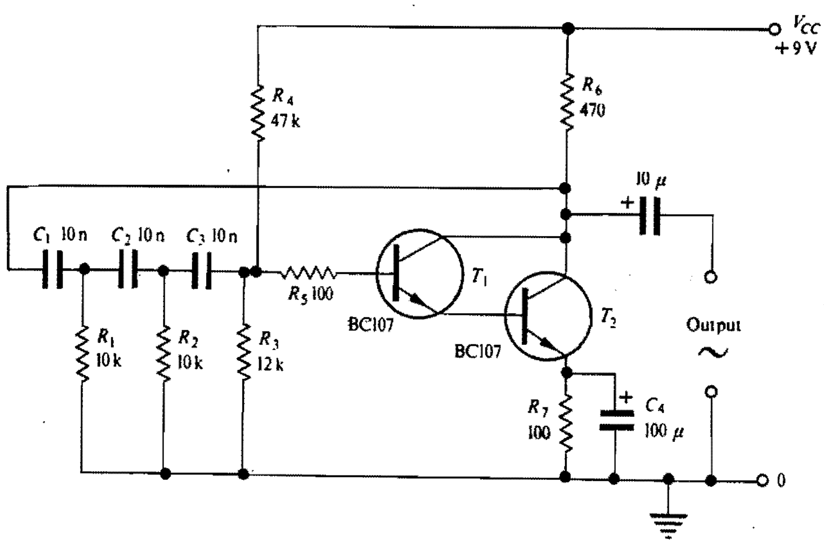

Fig. 2.1

QUESTION 3

(a) What is meant by the following terms:

(i) Barkhausen criterion? (3 marks)

(ii) Degenerative feedback? (3 marks)

(b) Mention three advantages of applying negative feedback to an amplifier. (3 marks)

(c) Consider a voltage amplifier with an open-loop gain of magnitude A. With the aid of a schematic diagram, derive an expression for the overall voltage gain of the amplifier when a fraction B of its output voltage, that is 180° out of phase with the input, is fed back to the input. (5 marks)

(d) An amplifier has an open-loop gain of –300. Negative feedback is applied to the amplifier with a feedback factor of 0.4.

(i) Calculate the loop gain. (2 marks)

(ii) Calculate the voltage gain when negative feedback is applied (to three decimal places). (2 marks)

(iii) Calculate the percentage increase in gain with feedback when the open-loop gain of the amplifier increases by 10% as a result of replacing a faulty transistor. (7 marks)

QUESTION 4

(a) Fig. 4.1 shows an operational integrator.

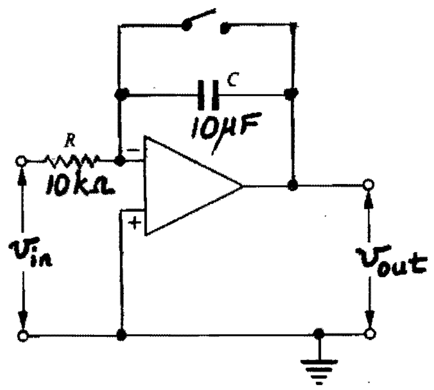

Fig. 4.1

(i) State the relationship between v_{in} and v_{out} for an operational integrator. (1 mark)

(ii) Determine an expression for v_{out} as a function of time when v_{in} = 15 mV. Sketch graphs of v_{in} and v_{out} against time, on the same axes. Label the graphs. (5 marks)

(iii) If v_{in} is a sinusoidal waveform with a frequency of 200 Hz and a peak value of 5 V, determine an expression for v_{out} in terms of time. Sketch graphs of v_{in} and v_{out} against time, on the same axes, and label them. (9 marks)

(b) Use operational amplifiers and other appropriate components to design a circuit which corresponds to the following (ideal) relationship between the input and output voltage, v_I and v_0, respectively:

$$v_0 = -(v_I - 4\times10^{-3}\int v_I dt)$$ (10 marks)

QUESTION 5

(a) (i) Calculate v_{out} as a function of time for the circuit shown in Fig. 5.1, given that $v_{in} = A\cos\omega t$, $\omega = 200$ rad.s^{-1} and $A = 0.2$ V. (4 marks)

(ii) Sketch graphs of v_{in} and v_{out} as a function of time, on the same axes, and label them. (4 marks)

(b) Use appropriate circuit diagrams and equations to explain how you would measure the input resistance of a device, such as a voltage amplifier. (5 marks)

(c) Given the low-pass filter shown in Fig. 5.2,

(i) Calculate the cut-off frequency of the filter. (2 marks)

(ii) Find the magnitude of v_{out} when v_{in} has a frequency of 4 kHz. (3 marks)

(d) Fig. 5.3 shows a circuit consisting of a voltage source. The source has an internal resistance, R_s and generates a voltage V_s. It is connected to an emitter follower which acts as an impedance buffer. The output of the follower is, in turn, connected to a sink with an input resistance, R_i.

With the aid of a detailed circuit diagram of the emitter follower, and mathematical analysis, derive an expression to show the relationship between V_s and V_i. (7 marks)

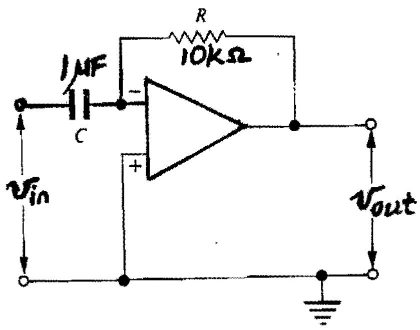

Fig. 5.1

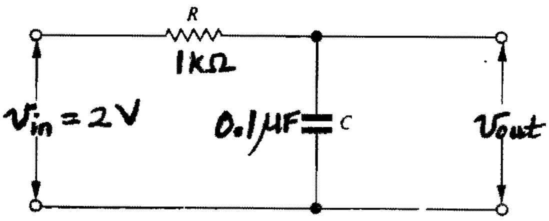

Fig. 5.2

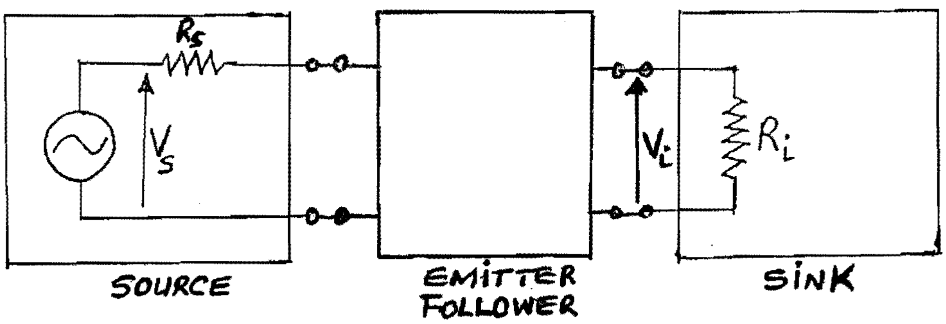

Fig. 53