UNIVERSITY OF SWAZILAND

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

MAIN EXAMINATION	:	**MAY 2009**
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.
		PROVIDE A SEMILOG GRAPH PAPER

THIS PAPER HAS 7 PAGES, INCLUDING THE SEMILOG GRAPH PAPER.

DO NOT OPEN THE PAPER UNTIL PERMISSION HAS BEEN GIVEN BY THE INVIGILATOR.

QUESTION 1

(a) What is meant by inverse feedback? (2 marks)

(b) Fig. 1.1 is a schematic representation of an amplifier with negative feedback.

(i) Derive an expression for the closed-loop voltage gain in terms of A_0 and β. (5 marks)

(ii) State three conditions for A and B that influence the closed loop gain. (5 marks)

(c) An amplifier has a voltage gain of -500. Assume that 3/100 of the output voltage is applied as negative feedback.

Calculate the change in the overall gain if the gain without feedback increases by 60%. (10 marks)

(d) Consider an amplifier with negative feedback. The open-loop voltage gain is $A = -100$, and the feedback factor is $\beta = 0.1$. Compute:

(i) the loop gain and (1 mark)

(ii) the closed-loop gain A_{CL} with feedback. (2 marks)

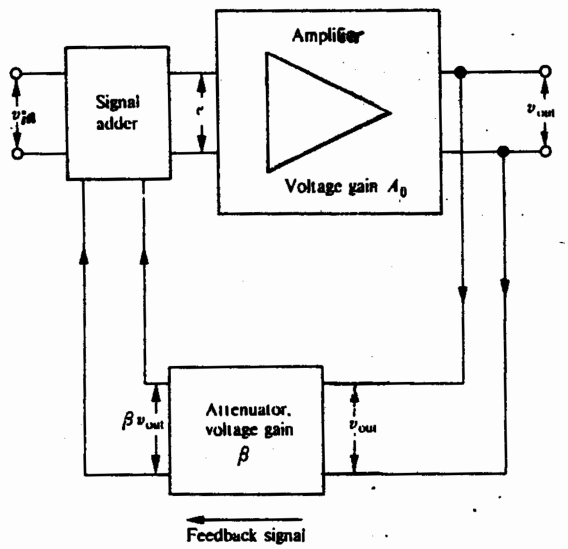

Fig. 1.1

QUESTION 2

(a) Fig. 2.1 shows a Wien bridge oscillator based on an operational amplifier. Explain briefly how the oscillator works. (5 marks)

(b) A certain Wien bridge oscillator is being designed to be tunable from 50 to 500 Hz with a dual potentiometer. Fixed values of 0.1 μF are employed for the two capacitors. Determine the range of resistances required to tune the specified range. (6 marks)

(c) Explain why the amplifier used in a phase shift oscillator which utilises an RC ladder network must have a minimum gain of 29. (4 marks)

(d) (i) Draw the circuit diagram of a bistable multivibrator (3 marks)

(ii) Discuss the principle of operation of the bistable multivibrator. (7 marks)

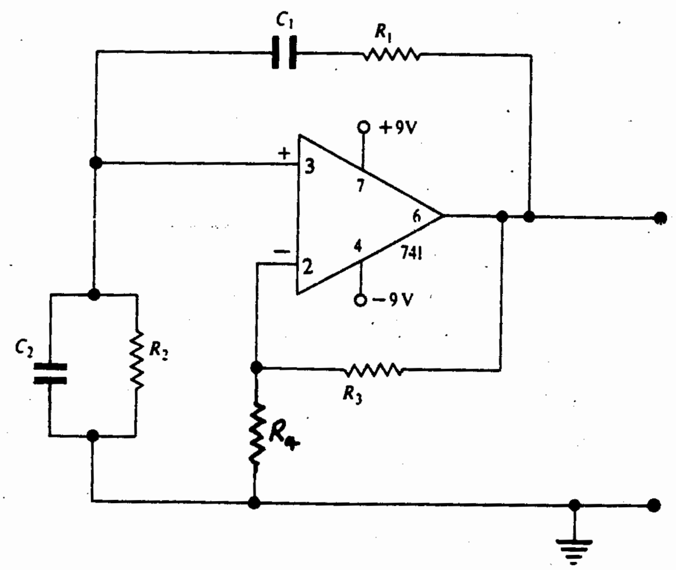

Fig. 2.1

QUESTION 3

(a) (i) Draw the circuit diagram of a logarithmic amplifier and label it. (2 marks)

(ii) Derive an expression to show the relationship between the output and input voltages of the logarithmic amplifier. (4 marks)

(iii) State the function of a logarithmic amplifier in computation. (2 marks)

(b) A inverting operational amplifier has a voltage gain $A = -20$. Determine the output signal voltage v_o for each of the following input signal voltages: $v_i = 0$; $v_i = 0.5$ V and $v_i = -0.2$ V. (4 marks)

(c) The gain of a certain amplifier is to be determined from an oscilloscope measurement using a sine-wave output. The input and output waveforms are shown in Fig. 3.1. The vertical sensitivities of the two channels are indicated. The time base reference is established in channel 1. Determine the gain. (3 marks)

(d) Use one or more operational amplifiers to design a circuit which corresponds to the following (ideal) relationship between the output, v_{out}, and the input voltages v_1, v_2 and v_3:

$$v_{out} = -50\, v_1 - 3\, v_2 + 15\, v_3$$

Choose suitable and realistic component values of resistors as part of your design. (10 marks)

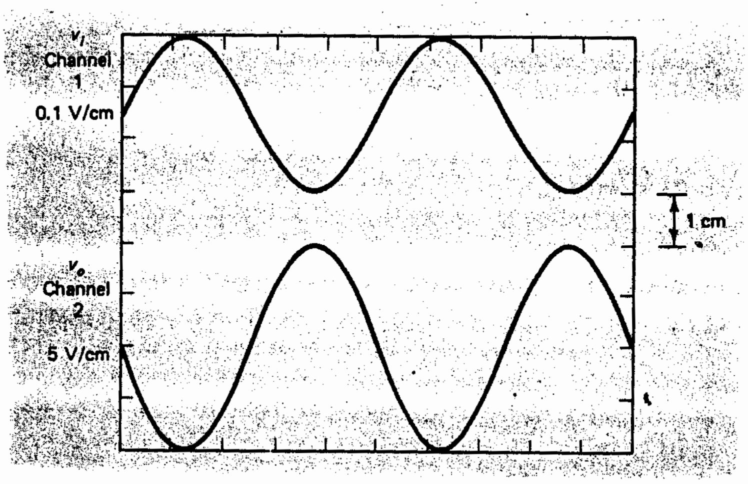

Fig. 3.1

QUESTION 4

(a) An RLC bandpass filter has a centre frequency of 2 MHz and a 3-dB bandwidth of 200 kHz. The inductance is 50 μH. The load resistance is 10 kΩ. Determine

(i) the capacitance of the capacitor, C and (3 marks)
(ii) the quality factor, Q. (2 marks)

(b) Consider an RC high-pass filter consisting of a resistor and capacitor with values R = 20 kΩ and C = 1.0 nF, respectively.

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

(ii) Show the frequency response of the filter by sketching the transfer function (in decibels) versus frequency on a semilog graph paper. (4 marks)

(c) An RC low-pass filter is to be designed to create a 60° phase lag in a 2.5 kHz signal. If the filter capacitance is 0.2 μF, what value of resistance should be used? (4 marks)

(d) (i) Find the inductance of the high-pass filter circuit shown in Fig. 4.1, if $|T(s)| =$ 0.50 at a frequency of 50 MHz. (7 marks)

(ii) What is the phase difference between V_i and V_o at this frequency? (3 marks)

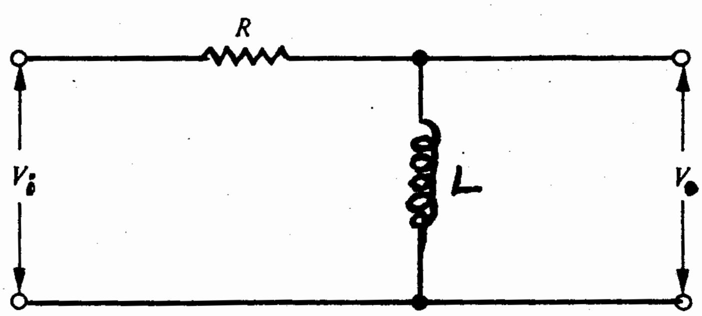

Fig. 4.1

QUESTION 5

(a) The circuit in Fig. 5.1 shows an emitter follower.

(i) Explain why it is called an emitter follower. (2 marks)

(ii) Draw the equivalent circuit of the follower and label it. (4 marks)

(iii) Use the equivalent circuit to derive expressions for the voltage gain and input resistance of the follower. Comment on the magnitude of each of them. (11 marks)

(b) The amplifier given in Fig. 5.2 (a) has the following parameters: $A = 90$, $R_{in} = 6$ kΩ, and $R_{out} = 1.2$ kΩ. The equivalent circuit of the amplifier with source and load connected is shown in Fig. 5.2 (b). The amplifier is driven from a signal source with an internal resistance $R_g = 2$ kΩ, and a load $R_L = 2.4$ kΩ is connected across the output.

Calculate v_o/v_g. (8 marks)

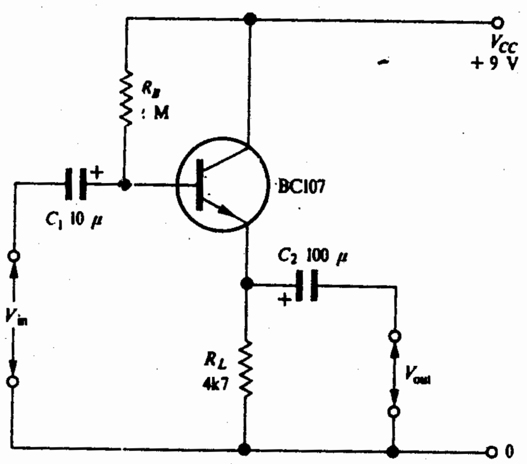

Fig. 5.1

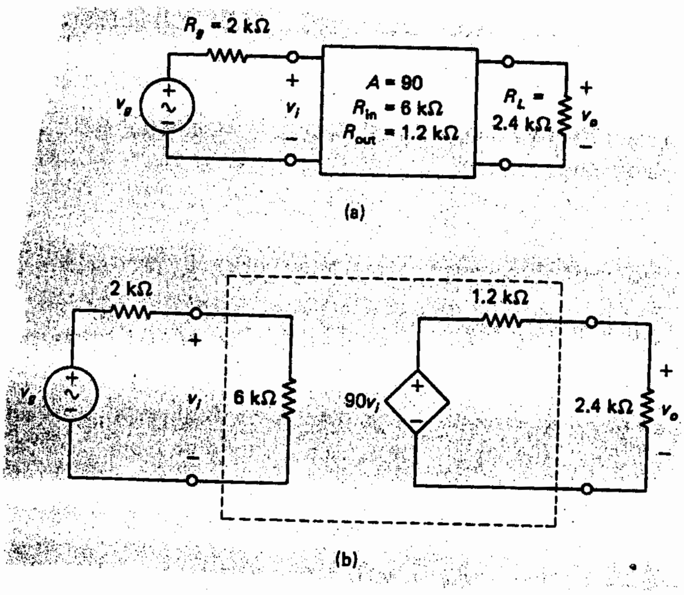

Fig. 5.2

WELL Graph Data Ref. 5541 Log 4 Cycles x , ½ and 1 cm

1
9
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