UNIVERSITY OF SWAZILAND
FACULTY OF SCIENCE AND ENGINEERING
DEPARTMENT OF PHYSICS

SUPPLEMENTARY EXAMINATION, 2017/2018

TITLE OF PAPER	:	ELECTRONICS II
COURSE NUMBER	:	PHY 312
TIME ALLOWED	:	THREE HOURS
INSTRUCTIONS	:	Answer **FOUR** (4) questions only.
	:	Each Question carries **25 Marks**
	:	Marks for different Sections are shown in far Right margin.

THIS PAPER HAS 6 PAGES, INCLUDING THIS ONE.

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1. (a) Design a filter with the transfer function of

$$H(j\omega) = \frac{-3}{1 + j\omega/5000}$$

and a minimum input impedance of 50 kΩ [7

(b) Consider the RLC bandpass filter shown in Figure 1.

i. Derive an expression for $|H(j\omega)|$ of this filter. [3]

ii. Derive the expression for the resonant frequency. [2]

iii. Calculate the value of the resonant frequency? [2]

iv. What is the Q-factor? [2]

v. Find the cut-off frequencies, f_1 and f_2. [8]

vi. Find the bandwidth. [1]

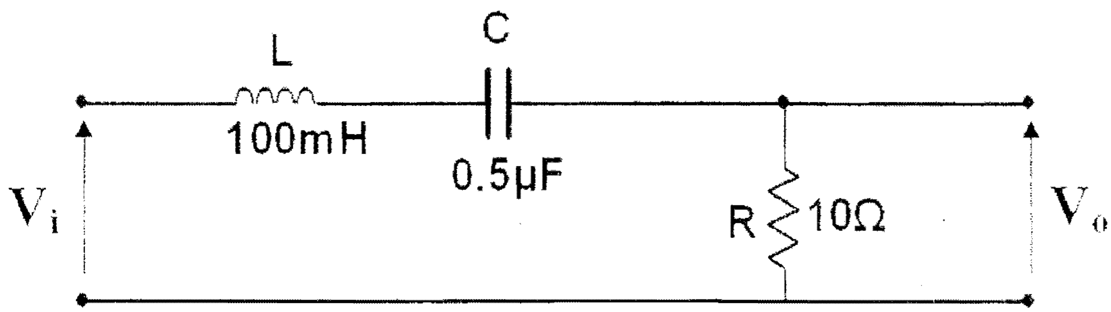

Figure 1: RLC band pass filter

2. (a) With the aid of a circuit diagram and appropriate equations, explain how you would measure the input resistance of an amplifier. [5]

(b) Consider an RC low-pass filter with component values $R = 10.61$ kΩ and $C = 0.015$ μF.

i. Find the cut-off frequency of the filter, in Hertz. [2]

ii. Find v_o when v_i has a frequency 500 Hz, 1 kHz, and 2 kHz. [7]

iii. Using the values of v_o calculated in (ii), sketch v_o versus frequency. [3]

(c) i. Calculate V_{out} as a function of time for the circuit shown in Figure 2, given that $V_{in} = A \sin \omega t$. $A = 500$ mV and $\omega = 100$ rad.s^{-1} . [4]

ii. Sketch graphs of V_{out} and v_{in} against time. [4]

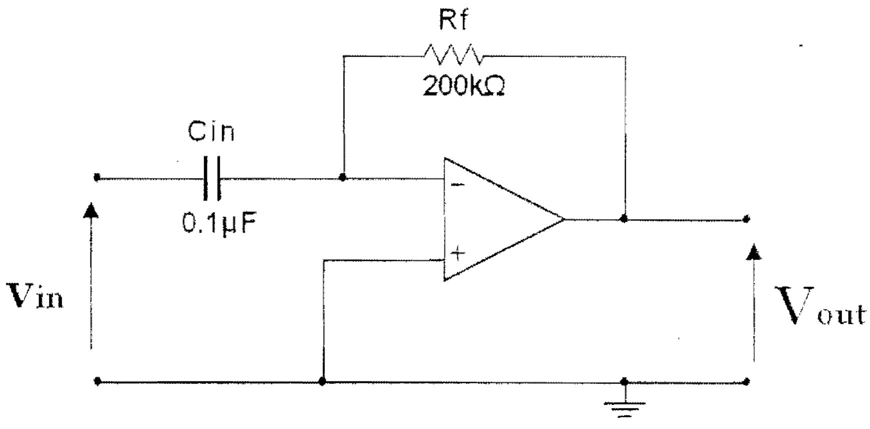

Figure 2: Differentiator Amplifier

3. (a) What is a multivibrator? [2]

(b) Draw the circuit diagram of an astable Multivibrator. [2]

(c) Explain how the astable multivibrator works and assume that when the d.c. power supply is switched on, current rises faster in transistor T_1 in relation to transistor T_2. The d.c. supply voltage is 9 V. [11]

(d) Sketch the waveforms observed at the base and collector of transistor T_1 to show how the voltage varies with time. [2]

(e) i. Write an expression for the frequency of oscillation of a phase shift oscillator that is designed using a BJT amplifier and a phase-shift ladder network. The ladder network is made up of equal resistors and equal capacitors. [2]

ii. Consider each of the capacitors to have a fixed capacitance $C = 0.01\ \mu F$ whilst each of the resistances can be varied from 2 kΩ to 200 kΩ. Calculate the minimum and maximum frequencies which can be generated by the oscillator. [3]

iii. Explain why the open-loop gain of the amplifier used in the phase shift oscillator must be of magnitude ≥ 29. [3]

4. (a) i. What is meant by negative feedback? [2]

ii. State the Barkhausen condition necessary for oscillation to occur. [2]

(b) State the advantages of negative feedback for an amplifier. [5]

(c) An amplifier has an open-loop gain of magnitude A_o. A fraction β of its output voltage signal is fed back to the input of the amplifier so as to subtract from the input. Using a suitable diagram, derive an expression for the overall voltage gain A_f with feedback. [6]

(d) An amplifier has an open-loop gain of -500 and a feedback factor of 0.2.

i. What is the loop gain? [1]

ii. Find the voltage gain with feedback. [2]

iii. Determine the percentage fall in the gain with feedback if the open-loop gain of the amplifier falls by 20%. [7]

5. (a) i. Sketch the circuit diagram of a an operational integrator. [3]

ii. Derive equation below which describes the relationship between the input and output voltages, V_{in} and V_{out} of the integrator. [6]

$$V_{out} = -\frac{1}{RC}\int V_{in}dt$$

(b) Use operational amplifiers and appropriate components to design a circuit which corresponds to the following ideal relationship between the output voltage, v_{out} and the input voltages, v_i, v_1 and v_2 (Assume same value of resistance in your design, $R = 10\text{k}\Omega$): [16]

$$v_{out}(t) = 3\text{x}10^{-4}\frac{dv_i}{dt} - \int (v_1 - v_2)dt$$

END