DUBLIN INSTITUTE OF TECHNOLOGY
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Diploma in Electronic Engineering

YEAR 3

AUTUMN EXAMINATION 2000

ELECTRIC CIRCUITS AND SIGNAL PROCESSING

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DATE:

Attempt three questions

Smith chart
Laplace tables
Butterworth and Chebychev tables
$c = 3.10^8$ m/s

1. (a) Obtain a transfer function for a third-order high-pass filter, which uses a Butterworth loss function, and which meets the following specification:
The maximum passband loss A_{max} = 3 dB
The minimum stopband loss A_{min} = 28 dB
The passband edge frequency ω_p = 6000 rs^{-1}
The stopband edge frequency ω_s = 2000 rs^{-1}

[10 marks]

(b) A second-order IGMF bandpass active filter is shown in Figure 1. Show, by means of nodal analysis, how the transfer function is:

$$-\frac{s\frac{1}{R_1C}}{s^2+s\frac{2}{CR_2}+\frac{1}{C^2R_1R_2}}=\frac{V_{out}}{V_{in}}$$

[8 marks]

Calculate a value for the centre frequency ω_0, the -3 dB bandwidth and the passband gain for the circuit values given.
R_1 = 1 kΩ, R_2 = 100 kΩ, C =15 nF.

[7 marks]

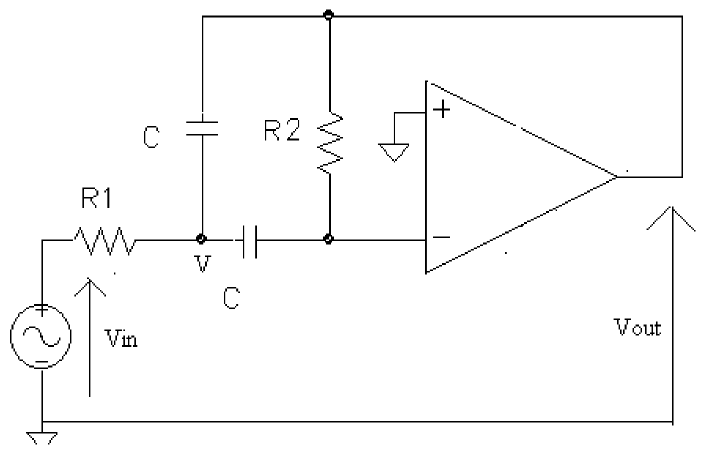

Figure 1

2.(a) (a) Discuss the effect, component tolerance, has on the performance of active filters.

[5 marks]

(b) The frequency spectrum of a 1 kHz squarewave is shown in figure 2. It is desired to extract, from this squarewave, a 1 kHz sinusoidal signal. Obtain a transfer function for a low-pass filter, which will produce a maximum attenuation of the fundamental component of 1 dB. The third harmonic (3 kHz) should be attenuated by 12 dB (Butterworth loss functions tables are available for use in your analysis).

[12 marks]

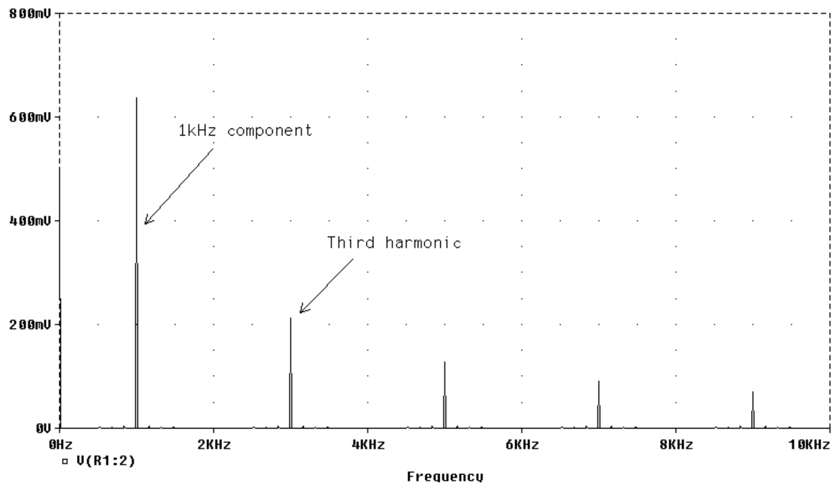

Figure 2

(c) Show how you could implement the transfer function obtained in part (a) using a Sallen and Key VCVS active filter.

[8 marks]

3 (a) Define the term voltage reflection coefficient. Use the solution for the voltage along a transmission line $V = V_1\, e^{-(\alpha + j\beta)\, z} + V_2\, e^{(\alpha + j\beta)\, z}$ in your answer.

[7 marks]

(b)A transmission line with characteristic impedance Z_o equal to 75 Ω, is terminated in an impedance $Z_L = 40 + j20\ \Omega$. Calculate

(i) The reflection coefficient,
(ii) The voltage standing ratio, and
(iii) The input impedance.

[6 marks]

(c) Hence use a Smith chart to verify approximately, the three values calculated in (i) to (iii).

[12 marks]