R221/308

DUBLIN INSTITUTE OF TECHNOLOGY
KEVIN STREET, DUBLIN 8

Diploma in Electronic Engineering

YEAR 3

AUTUMN EXAMINATIONS 1999

ELECTRIC CIRCUITS AND SIGNAL PROCESSING

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DATE:

Attempt three questions

Smith chart
Laplace tables
Butterworth and Chebychev tables

1.(a)Obtain a transfer function for a 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)Show how the transfer function, for the second stage of the Sallen and Key, high-pass filter shown in figure 1, is:

$$\frac{E_3}{E_2} = \frac{s^2}{s^2 + s\dfrac{2}{CR_2} + \dfrac{1}{C^2 R_1 R_2}}$$

[8 marks]

Hence calculate component values for this circuit, which could implement the transfer function obtained in part (a).

R = 20 kΩ.

[7 marks]

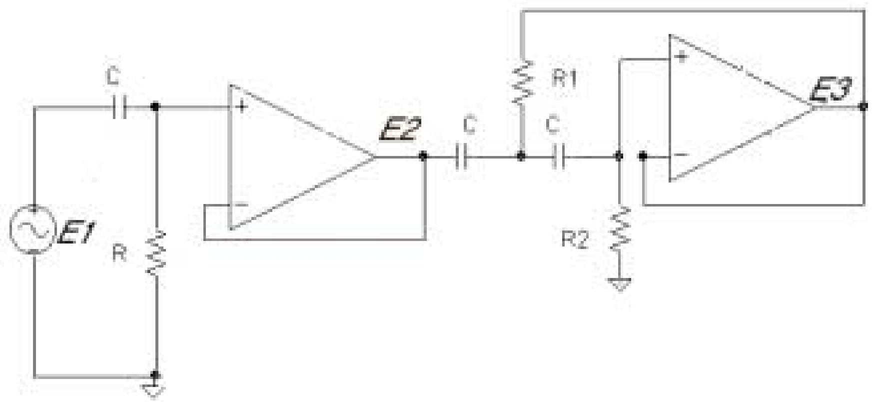

Figure 1

2.(a)It is desired to produce a 1 kHz sinusoidal signal from a 1 kHz squarewave. Obtain the transfer function for a low-pass filter, which will produce a maximum attenuation of the fundamental signal 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]

(b) Identify the circuit shown in figure 2. State one possible application for this circuit. Obtain the high-pass transfer function, assuming equal value resistances.

[13 marks]

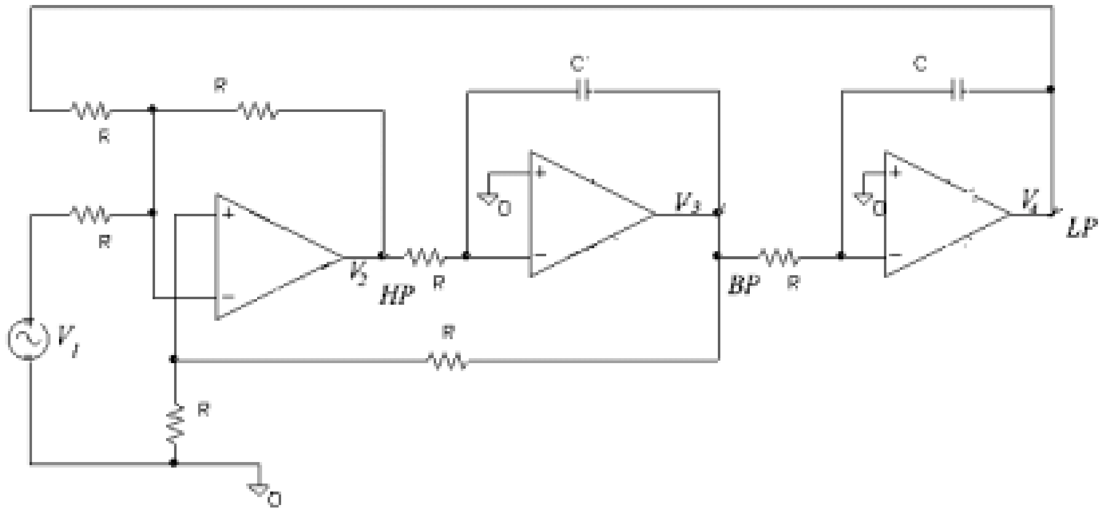

Figure 2

3 (a) A 10 km length of screened telephone cable, operating at a frequency of 10 kHz, has the following, primary transmission line parameters:

L = 700 mH per km,

C = 0.05 μF per km,

R = 28 Ω per km, and

G = 1 μS per km

Determine the phase and attenuation constants for this cable and hence calculate the characteristic impedance.

[8 marks]

(b) An expression for the input impedance of a transmission line, terminated in a resistance $Z_{R,}$ = 35 Ω is:

$$Z_{in} = Z_o \left[\frac{\dfrac{Z_R}{tan\beta\ell} + jZ_o}{\dfrac{Z_o}{tan\beta\ell} + jZ_R} \right]$$

Where β is the phase change coefficient and Z_o is the characteristic impedance equal to 75 Ω. Determine the input impedance of a section of line whose length is $\lambda/4$ metres.

[7 marks]

(c) Describe one graphical technique for matching a transmission line to a load. Illustrate your answer using a Smith chart.

[10 marks]