DUBLIN INSTITUTE OF TECHNOLOGY
KEVIN STREET, DUBLIN 8

Diploma in Electronic Engineering

YEAR 3

Winter EXAMINATION 2000

ELECTRIC CIRCUITS AND SIGNAL PROCESSING

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DATE:

Attempt three questions

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

1. (a) A low-pass filter is required to meet the filter specification:
The maximum passband loss A_{max} = 0.5 dB
The minimum stopband loss A_{min} = 12 dB
The passband edge frequency ω_p = 100 rs^{-1}
The stopband edge frequency ω_s = 400 rs^{-1}

Determine the filter order n using the relationship

$$n = \frac{\log_{10}\left[\frac{10^{0.1A_{min}} - 1}{10^{0.1A_{max}} - 1}\right]}{2\log_{10}(\frac{\omega_s}{\omega_p})}.$$

Sketch the pole-zero diagram using the relationship between n and the angle θ_k, between the poles

$$\theta_k = \frac{360^0}{2n}$$

Hence obtain a transfer function, which meets the specification.
Note: Butterworth tables are not supplied.

[15 marks]

(b) Obtain circuit values for a Sallen and Key VCVS circuit configuration that would meet the specification in part (a).

[10 marks]

2.(a) State one advantage and one disadvantage of using Chebychev polynomials in approximation loss function analysis.

[5 marks]

(b) A bandpass filter is required for a particular application, which will tolerate ripple in the passband equal to 0.5 dB. The specification for the bandpass filter is:
ω_{bs1} = the lower stopband edge frequency = 688 rs^{-1}
ω_{bs2} = the upper stopband edge frequency = 1930 rs^{-1}
ω_{bp1} = the lower passband edge frequency = 970 rs^{-1}
ω_{bp2} = the upper passband edge frequency = 1370 rs^{-1}
The maximum passband attenuation A_{max} = 0.5 dB.
The minimum stopband attenuation A_{min} = 15 dB.

Obtain the bandpass transfer function, which will meet this specification. (Use the available Chebychev tables).

[20 marks]

3.(a) Define the following transmission line terms: Voltage standing wave ratio and voltage reflection coefficient.

[5 marks]

(b) A transmission line, whose characteristic impedance Z_o = 300 + j0 Ω, has an antenna of impedance 225 - j175 Ω connected as a load. Matching by means of a single stub connected, at a distance d metres from the load, is used. Estimate the length in metres of the stub and the distance d if the operating frequency f = 500 MHz. Assume that the stub is formed from a section of the same air-spaced transmission line.

[12 marks]

(c) Calculate the characteristic impedance, phase coefficient and attenuation constant for a 10 km length of telephone cable, operating at a frequency of 10 kHz, if the cable has the following, primary transmission line parameters:

L = 700 mH per km, C = 0.05 μF per km, R = 28 Ω per km, G = 1 μS per km

[8 marks]