NAME:_____ STUDENT # _____

University of Toronto
Faculty of Applied Science and Engineering

Final Exam, December 10 2001

ECE 512F - ANALOG FILTERS

Exam Type: A

Examiner - K.A.L. Kozma

ANSWER QUESTIONS ON THESE SHEETS USING BACKS IF NECESSARY

- Grading indicated by [ ]. Maximum #marks=60.
- Attempt all questions since a blank will certainly get zero.
- Closed book.
- Calculator type unrestricted.
- If you feel you are missing any information, make a reasonable assumption and state it **clearly**.
- Good Luck!

1	
2	
3	
4	
5	
TOTAL	

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Question #1 [12 marks]

(a) Find a Butterworth transfer function to realize the following specifications, with no more than 5 dB of excess stopband attenuation.

$\omega_p = 2\pi 10^6$ rad/s

$\omega_s = 20\pi 10^6$ rad/s

$A_{max} = 3$dB

$A_{min} = 45$dB

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(b) Find the system poles and zeros of the transfer function.

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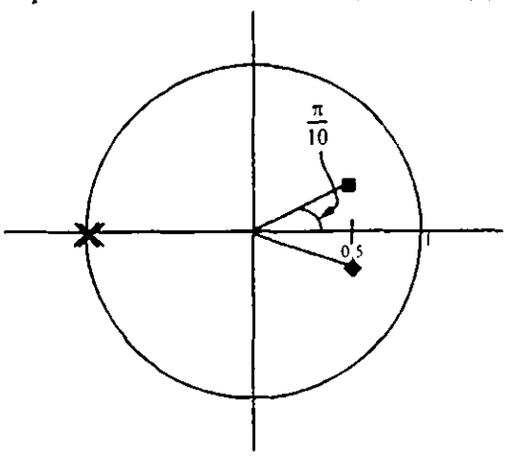
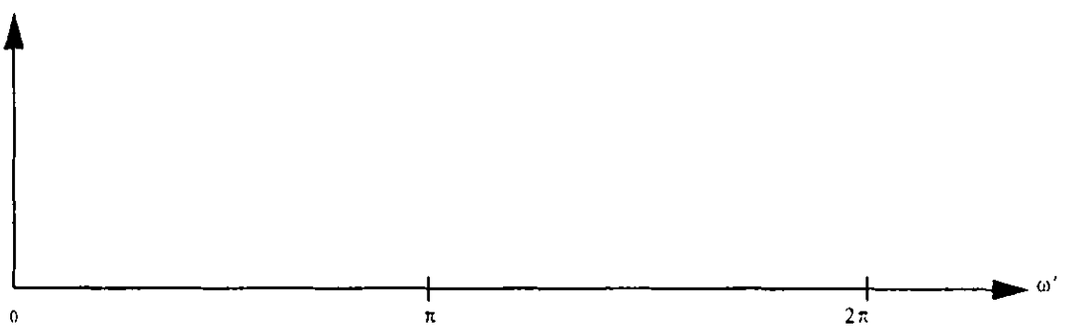
Question #2

(a)[4 marks]

For the pole-zero locations shown, write H(z) if the dc gain is unity.



Sketch the magnitude transfer function on the axes given.



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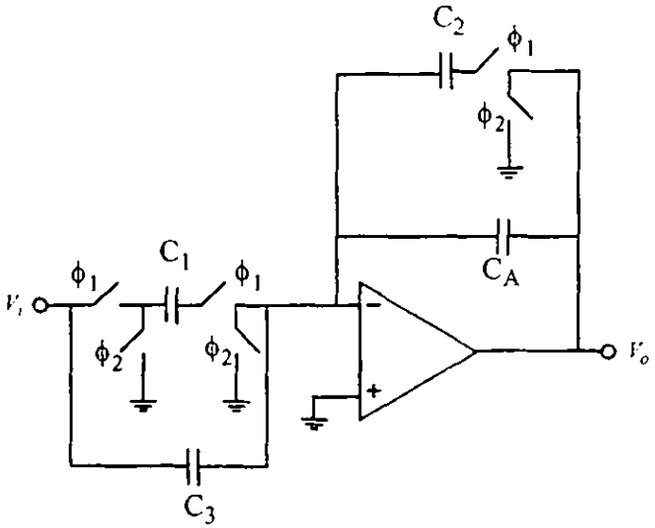
(b)[4marks]
Write the discrete time transfer function for the following circuit.



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(c)[4 marks]

Find $H(z)$ for a first-order lowpass filter with a zero at z=0; a dc gain of unity and the 3 dB frequency at 1/10 the sampling frequency. Sketch $|H(z)|$ on the axes provided.

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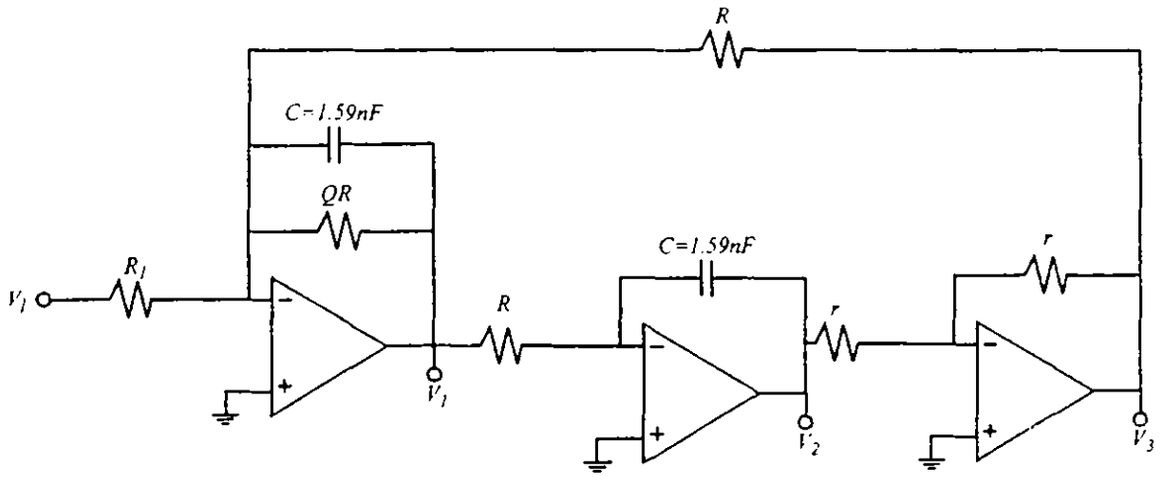
Question #3 [12 marks]

(a) For the Tow Thomas biquad shown find the transfer function $\frac{V_3}{V_I}(s)$.



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(b) Use the circuit to design a bandpass filter with centre frequency of 10 kHz, a quality factor of 20 and unity gain at the centre frequency.

(c) Design a switched capacitor equivalent circuit if a clock frequency of 200 kHz is used.
(hint: you may use the fact that $f_s \gg f_o$)

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Question #4

(a) [4 marks]

Given a sixth order Chebyshev filter with a passband edge of 100 kHz and a passband ripple of 0.5, find A_{max} and the frequencies at which the attenuation is equal to A_{max}.

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(b) [4 marks]
Write K(s) for a third order filter with all attenuation poles at dc and reflection zeros at $s = \pm j\omega_1$ and at ∞. Sketch K(s).

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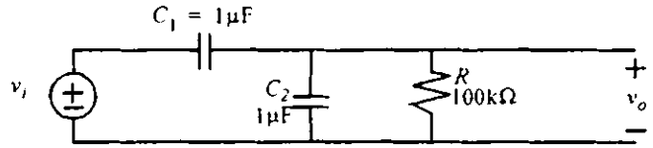
(c) [4 marks]
Write and sketch the voltage transfer function (indicating all important characteristics) for the circuit below. What type of transfer function is it? Realize with an active RC circuit.



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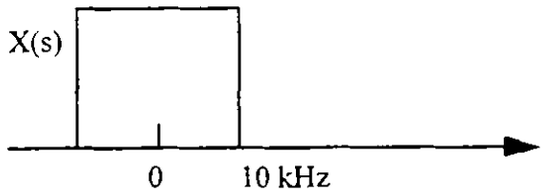
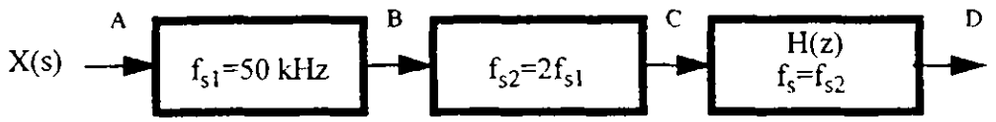
Question #5 [12 marks]
Consider a continuous time signal, X(s), with the following spectrum:



which is fed into the following system:



If the signal that is being sampled at f_{s1} = 50 kHz is upsampled by 2, design a first order digital filter H(z) to remove any aliased signals and the original clock. Let the maximum attenuation of the baseband signal be 3 dB. What is the minimum attenuation achieved for the aliased signal(s)?

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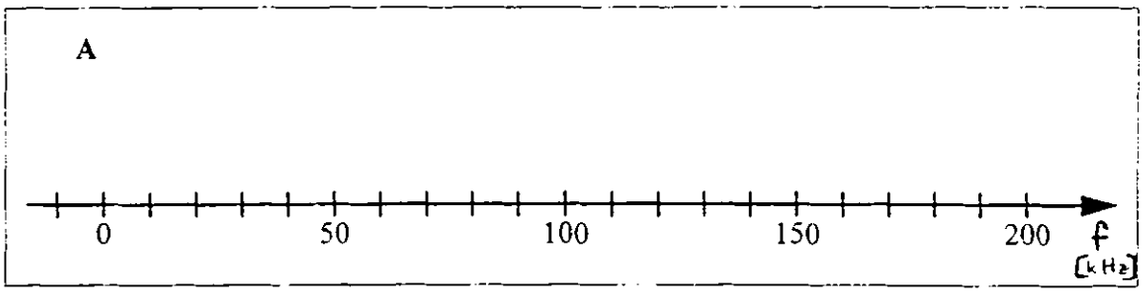
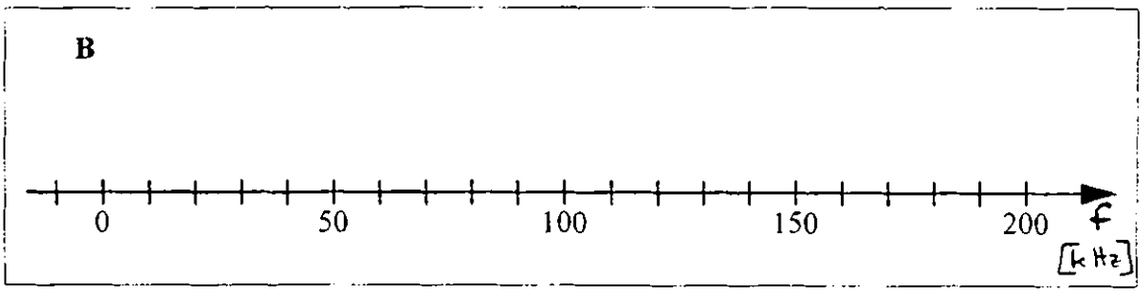
Draw the spectrum at points A, B, C, D on the axes provided.

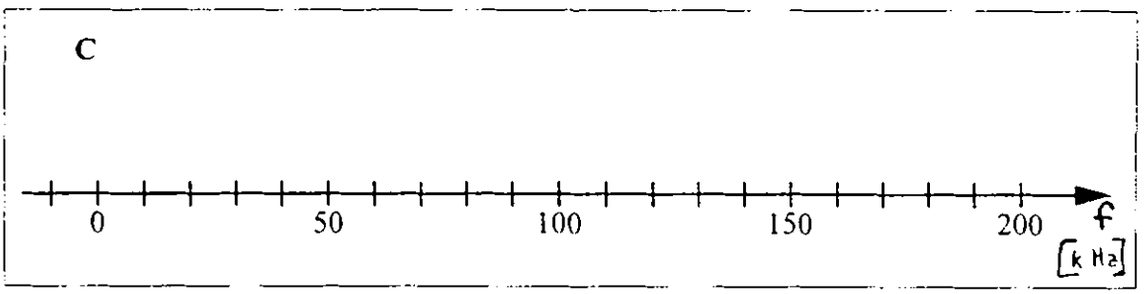
A



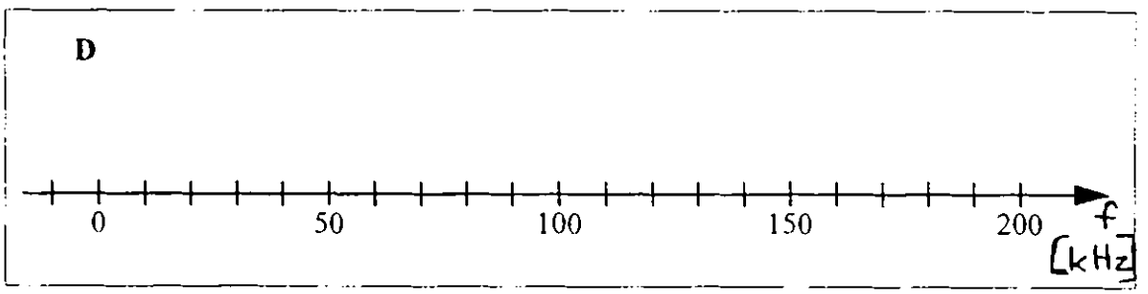
B



C



D



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