TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Filter Design *(EX 606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What is the significance of normalization and denoramlization in filter design? Derive elements scaling equations. [2+5]
2. What are the characteristics of chebyshev magnitude response? Derive an expression to calculate the order (n) of a Chebyshev filter for given lowpass specifications. Determine the minimum order n of chebyshev filter for following specifications.

   α_p =1 dB, α_s= 25 dB and (ωs/ωp) = 1.5, where the symbols have their usual meanings. [3+4+3]
3. What is a constant delay filter? What is its significance? Derive a transfer function of a second order constant delay filter. [1+1+3]
4. What are the applications of frequency transmission in filter design? How can you obtain a high pass filter from a given low pass filter? Explain with a suitable example. [1+4]
5. What are the properties of RC impedance function? Synthesize the given RC impedance in Foster and Cauer form.

   $$Z(s) = 3(s+2)\,(s+4)/(s(s+3))$$ [3+3+3]
6. What is zero shifting by partial removal of a pole? Explain with a suitable example. [5]
7. What is transmission coefficient? What information do we get from it? Derive the expression for reflection coefficient for a resistively terminated LC ladder network. [2+5]
8. Design a second order low pass filter with poles at -10000 ± j 17320.51 and Dc Gain of 2.5 using a Tow Thomas Biquad Circuit. Your final circuit should have capacitors of value 0.001uF. [6]
9. How is the excess gain compensated in Sallen-Key circuit? Explain with necessary derivations and diagrams. [5]
10. What is frequency dependent negative resistar (FDRN) ? How can it be realized? Realize the following passive filter using FDNR, having wo =25000 rad/s and practical element values in your final circuit. [1+3+5]

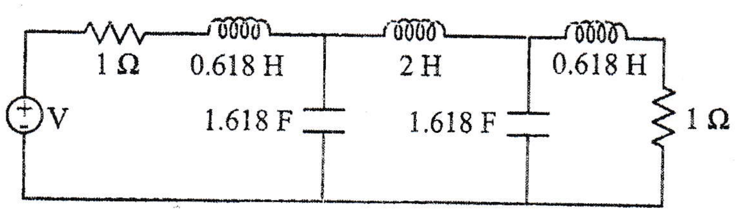

Fig: Butterworth filter at normalized frequency.

11. What is the importance of sensitivity analysis in filter design? Perform the sensitivity analysis of Wo of sallen-key lowpass biquad filter. [2+4]
12. Why do we need switched capacitor to simulate resister in MOS technology? How can you simulate a resister using switched capacitor? Explain with necessary derivations. [2+4]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI	Pass Marks	32
Year / Part	III / I	Time	3 hrs.

Subject: - Filter Design *(EX 606)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ ***Necessary tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. What are the significance of normalization and denormalization in filter design? Derive equation to calculate the new values of resistors, inductors and capacitors that will change the half-power frequency of a low pass filter from ω_0 rad/s to ω_n rad/s. [3+4]

2. What are the characteristics of Butterworth response? Derive an expression to estimate the order (n) of low pass Butterworth filter. Use this formula to estimate the order of Butterworth filter with the following specifications: [3+4+3]

   $\omega_p = 2000$ rad/sec; $\alpha_{max} = 1$ dB
   $\omega_s = 3000$ rad/sec; $\alpha_{min} = 12$ dB

3. What is the importance of all pass filters in delay equalization? Find the transfer function of third order Bessel-Thomson low pass filter. [2+3]

4. What is frequency transformation? Design a band stop filter having center frequency 2000 rad/s and bandwidth 400 rad/s from a third order Butterworth low pass filter. [Refer Table 2] [1+4]

5. What are the properties of LC driving point impedance function? Which of the following function is LC driving point impedance function? Explain with reason. [3+2+3]

$$Z(s) = \frac{8s^3 + 10s}{s^4 + 6s^2 + 5}$$

$$Z(s) = \frac{s^4 + 5s^2 + 4}{s^3 + 9s}$$

6. What are the zeros of transmission? How can they be realized in a network? Explain with suitable examples. [2+4]

7. Define reflection coefficient. Realize the third order Butterworth low pass filter using resistively terminated lossless ladder with $R_1 = 1\ \Omega$ and $R_2 = 4\ \Omega$. [Refer Table 2] [1+5]

8. Realize an active filter using non-inverting op-amp configuration with a zero at s = -4 and a pole at s = -8 having high frequency gain of k = 2. [5]

9. What is Quality factor and center frequency of low pass biquad filter? Explain with suitable diagram. Realize following low pass filter transfer function using Tow Thomas biquad circuit. [3+5]

$$T(s) = \frac{-2000}{s^2 + 500s + 1000000}$$

10. Why is sensitivity analysis important in filter design? Perform the sensitivity analysis of ω_0 in Tow Thomas low pass filter. [1+4]

11. What is Bruton transformation? Design the 4th order Butterworth low pass filter with half power frequency 20,000 rad/s and practically realizable elements using FDNR. [Refer Table 2] [3+5]

12. What is switch capacitor filter? What are its applications? Design a switch capacitor filter from the following Bode plot. [1+1+5]

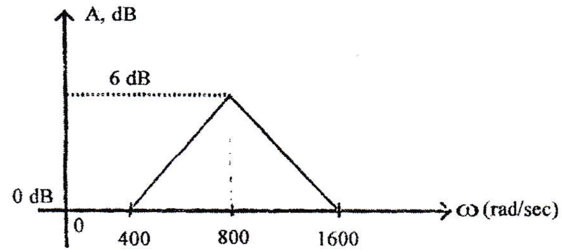

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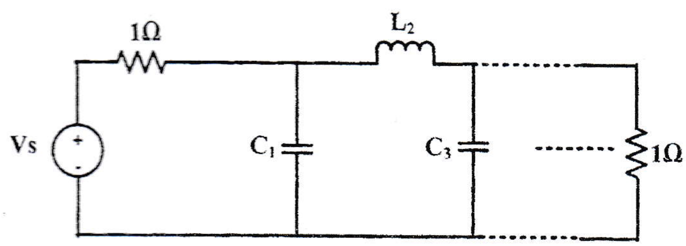
Table 1:

Pole Location for Butterworth Responses

n=2	n=3	n=4	n=5
- 0.7071068 ± j 0.7071068	- 0.50 ± j 0.86603	- 0.3826834 ± j 0.9238795	- 0.809017 ± j 0.5877852
	- 1.0	- 0.9238795 ± j 0. 3826834	- 0.309017 ± j 0. 9510565
			-1.0

Table 2:
Elements values for doubly terminated Butterworth filter normalized to half power frequency of 1 rad/s.



n	C_1	L_2	C_3	L_4	C_5
2	1.414	1.414			
3	1	2	1		
4	0.7654	1.848	1.848	0.7654	
5	0.618	1.618	2	1.618	0.618
n	L_1	C_2	L_3	C_4	L_5