TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Chaitra

Exam.	Regular (New Course)		
Level	BE	Full Marks	60
Programme	BEI	Pass Marks	24
Year / Part	III / I	Time	3 hrs.

Subject: - Filter Design *(ENEX 301)*

- ✓ *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**.*
- ✓ ***Tables are attached herewith.***
- ✓ *Assume suitable data if necessary.*

1. What is filter? Explain its application in the field of communication. Differentiate between ideal and practical response for various filters. [1+1+3]
2. During filter design process, explain the significance of normalization and denormalization. Derive the expression to calculate the new values of elements that will modify the operating frequency of a low pass filter from ω_{old} to ω_{new}. [2+2]
3. What are the characteristics of Butterworth low pass approximation? [3]
4. Derive an expression to calculate the order of Chebyshev low pass filter and use it to find the order of Chebyshev low pass filter having following specifications: α_{max} = 1 dB, α_{min} = 18 dB, ω_p = 1000 rad/sec, ω_s = 1400 rad/sec. Also determine the pole locations and transfer function. [3+3+3]
5. Define frequency transformation and mention its importance in filter design. [3]
6. Synthesize 4th order Butterworth HPF in resistively terminated lossless ladder network. [6]
7. Which of the following is an LC lossless function and why? Pick one of the valid LC lossless functions and realize it using Foster-I and Cauer–I form. [2+6]

$$a)\ Z_1(s) = \frac{s(s^2+4)(s^2+6)}{(s^2+3)(s^2+9)}$$

$$b)\ Z_2(s) = \frac{(s^2+3)(s^2+6)}{s(s^2+4)(s^2+9)}$$

$$c)\ Z_3(s) = \frac{(s^2+4)(s^2+6)}{s(s^2+3)(s^2+9)}$$

$$d)\ Z_4(s) = \frac{(s^2+3)(s^2+6)}{(s^2+4)(s^2+9)}$$

8. Draw the circuit diagram of Tow-Thomas biquad circuit and derive its transfer function. For an ECG machine of a hospital, you are asked to design a low pass filter using Tow-Thomas biquad circuit with poles located at - 450 ± j 893.03 and DC gain of 1.3. Make sure the elements in the final circuit are of practically realizable values. [3+5]
9. How can excess gain be compensated in Sallen-key circuit? Explain with necessary derivations and diagrams. [7]
10. Perform the sensitivity analysis of quality factor in Tow Thomas LPF. [3]
11. What is the significance of using current mode filters in the electronic circuit? With basic block diagram and characteristic equations explain the concepts of first-generation current conveyor (CCI) and second-generation current conveyor (CCII). [1+3]

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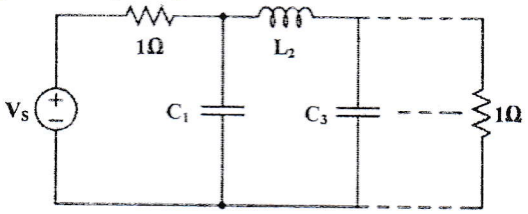
Table 1: Pole location for Butterworth responses

n = 2	n = 3	n = 4	n = 5
- 0.7071068 ± j 0.7071068	-0.5000000 ±j 0.8660254	-0.3826834 ±j0.9238795	-0.8090170 ±j 0.5877852
	-1.0	-0.9238795 ±j 0.3826834	-0.3090170 ±j0.9510565
			-1.0

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



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