**Analog/IC Filter Design (ELEC 441/6081)**

**Mid-Term Test#1 (Winter 2009-2010)**

Electrical and Computer Engineering Department

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Instructor: Dr. R. Raut **Student id#** **Time: 60 minutes**

Answer **All** questions

**Q.1**: The circuit below is a low-pass filter with AP =0.25 dB and ωp =1 rad/sec. Based on this prototype, design

(a) A low-pass filter with pass-band edge frequency at 10 kHz., and a load resistance of 75 ohms,

and (b) A high pass filter with the stop-band edge frequency of 400 Hz and a load resistance of 100 ohms.



Figure 1

**Q.2**: A low-pass filter of order 5 with maximally flat magnitude approximation has a loss of 1 dB at the pass-band edge frequency of 1 kHz. The normalized transfer function is given by:



Where *ωn* is the frequency normalized with respect to the pass-band edge frequency.

(a) What will be attenuation produced by this filter at 10 kHz?

(b) What will be the order of the filter if we require a loss of 40 dB at 40 kHz?

**Q.3**: Find the transfer function of a high pass filter which has

 a) an equiripple pass-band for f> 15kHz with Ap = 0.5dB.

and b) a monotonic stop-band for f<7.8 kHz with Aa= 35dB.

**Q.4**: The circuit in Fig.4 presents a SAB filter with infinite gain voltage amplifier. The voltage transfer function is given by:





Figure 4

The transfer function *E2/E1* can be alternatively expressed as:



Design the components of the filter so that G=5, b1=1.2, and bo=1.

Filter Function Tables

**A.1:** Coefficients of denominator polynomial, in the form , for Butterworth filter function of order *n* , with pass-band from 0 to 1 rad/sec[[1]](#footnote-1)+.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |
| 2 | 1.4142 |  |  |  |  |  |
| 3 | 2.0000 | 2.0000 |  |  |  |  |
| 4 | 2.6131 | 3.4142 | 2.6131 |  |  |  |
| 5 | 3.2361 | 5.2361 | 5.2361 | 3.2361 |  |  |
| 6 | 3.8637 | 7.4641 | 9.1416 | 7.4641 | 3.8637 |  |
| 7 | 4.4940 | 10.0978 | 14.5918 | 14.5918 | 10.0978 | 4.4940 |

**A.2:** Coefficients of denominator polynomial, in the form , for Chebyshev filter function of order *n*, with pass-band from 0 to 1 rad/sec+.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Pass-bandripple *Ap* | *n* | a1 | a2 | a3 | a4 | a5 | a6 |
|  | 1 | 2.863 |  |  |  |  |  |
|  | 2 | 1.425 | 1.516 |  |  |  |  |
| 0.5 dB | 3 | 1.253 | 1.535 | 0.716 |  |  |  |
| ε=0.3493 | 4 | 1.197 | 1.717 | 1.025 | 0.379 |  |  |
|  | 5 | 1.1725 | 1.9374 | 1.3096 | 0.7525 | 0.1789 |  |
|  | 6 | 1.1592 | 2.1718 | 1.5898 | 1.1719 | 0.4324 | 0.0948 |

1. + R. Schaumann et al, “Design of Analog Filters- Passive, Active RC, and Switched Capacitor”, Prentice-Hall Inc., © 1990

 [↑](#footnote-ref-1)