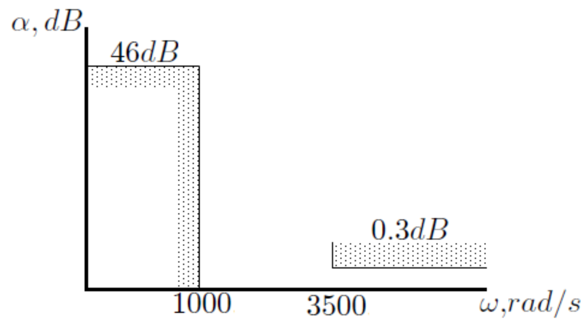
Subject: Shaping Circuits /(EEC 242)(G1)
Examiner : Dr. Mustafa M. Shiple

Term: Sep - Jan 2016
Exam Time:60 min

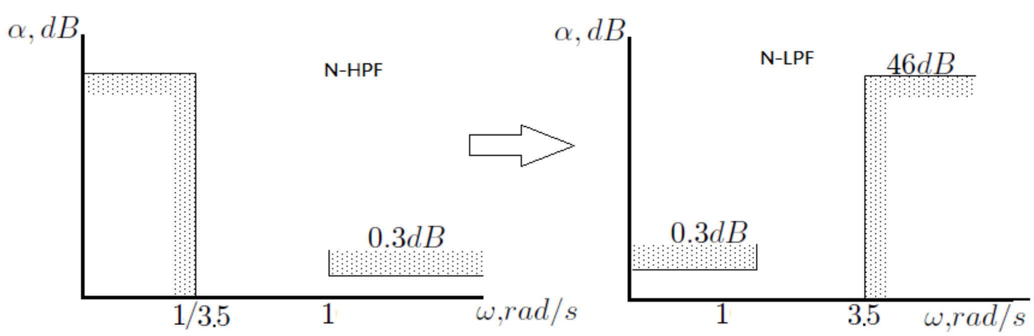
ANSWER THE FOLLOWING QUESTIONS:

1. Design a passive switched capacitor high pass filter with maximum flat response to meet attenuation specification given in next Figure. [10 marks] [B_k, C_o]
   (a) The available capacitor is $10\mu F$.



Order	R_S	C_1 a_1	L_2 a_2	C_3 a_3	L_4 a_4	C_5 a_5	L_6 a_6	C_7 a_7
1	1.0	2.0000						
2	1.0	1.4142	1.4142					
3	1.0	1.0000	2.0000	1.0000				
4	1.0	0.7654	1.8478	1.8478	0.7654			
5	1.0	0.6180	1.6180	2.0000	1.6180	0.6180		
6	1.0	0.5176	1.4142	1.9319	1.9319	1.4142	0.5176	
7	1.0	0.4450	1.2470	1.8019	2.0000	1.8019	1.2470	0.4450

Solution: Q1.(1) Find the normalized LPF



$$n = \frac{\log \frac{10^{0.1\alpha_{min}}-1}{10^{0.1\alpha_{max}}-1}}{2\log \frac{\omega_s}{\omega_p}} = \frac{\log \frac{10^{4.6}-1}{10^{0.03}-1}}{2\log \frac{3.5}{1}} = 5.28 \approx 6$$

(2) Pickup the values of N-LPF from ladder table

[Total Marks is 20]

RS	C1	L2	C3	L4	C5	L6
1	0.5176	1.4142	1.9319	1.9319	1.4142	0.5176

(3) Transform the values of N-LPF to N-HPF by $C = \frac{1}{L}$ and $L = \frac{1}{C}$

RS	L1	C2	L3	C4	L5	C6
1	1.931994	0.707114	0.517625	0.517625	0.707114	1.931994

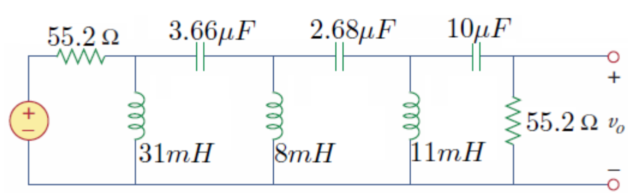
(4) Available $C = 10\mu F$, $k_f = 3500$ and $C = \frac{c_n}{k_m k_f} \Rightarrow k_m = \frac{c_n}{ck_f} = \frac{c_n}{10\mu \times 3500}$

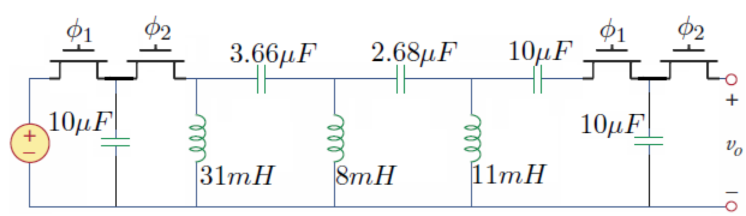
RS	L1	C2	L3	C4	L5	C6
1	1.931994	0.707114	0.517625	0.517625	0.707114	1.931994
k_m		20.20324		14.78929		55.19982

(5)Select $k_m = 55.2$

RS=RL	L1	C2	L3	C4	L5	C6
1	1.931993818	0.707114	0.517625	0.517625	0.707114	1.931994
55.2	$31mH$	$3.66\mu F$	$8mH$	$2.68\mu F \phi_1 \phi_2$	$11mH$	$10\mu F$

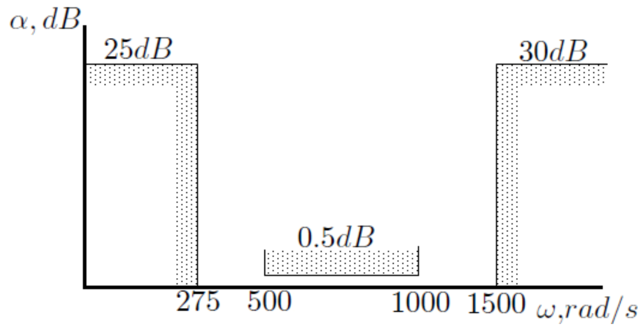
(5)Switched Capacitor $f_c = \frac{1}{RC} \Rightarrow f_c = \frac{1}{55.2 \times 10\mu} = 1811.6Hz$. we need non-overlap clock signals with frequency = 1811.6 Hz



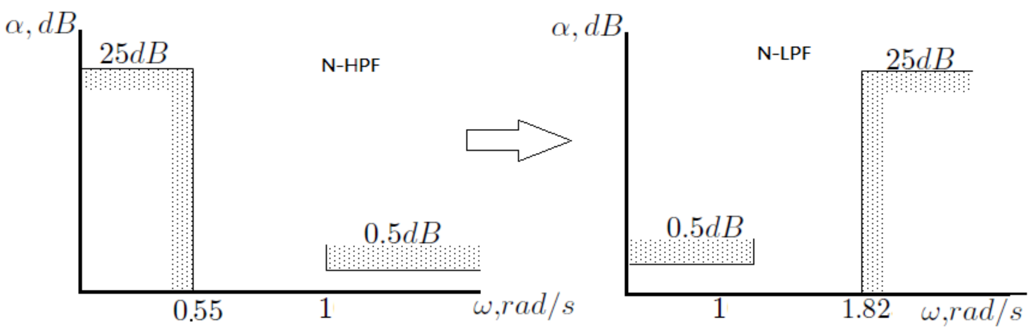


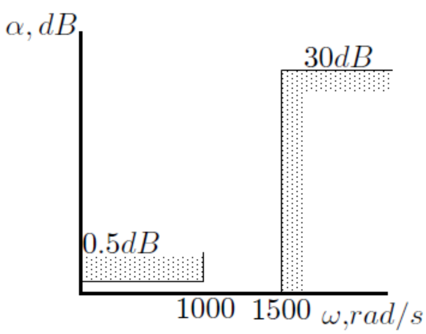
2. Design a band pass filter with maximum flat response to meet attenuation specification given in next Figure. [10 marks] [C_o, A_m]

   (a) The available capacitor is $0.1\mu F$.



Solution: Q1.(1) Find the normalized LPF for HPF





$$n_{NLPF} = \frac{\log \frac{10^{0.1\alpha_{min}-1}}{10^{0.1\alpha_{max}-1}}}{2\log \frac{\omega_s}{\omega_p}} = \frac{\log \frac{10^{2.5}-1}{10^{0.05}-1}}{2\log \frac{3.51.82}{1}} = 6.56 \approx 7$$

$$n_{LPF} = \frac{\log \frac{10^{0.1\alpha_{min}-1}}{10^{0.1\alpha_{max}-1}}}{2\log \frac{\omega_s}{\omega_p}} = \frac{\log \frac{10^{3}-1}{10^{0.05}-1}}{2\log \frac{1500}{1000}} = 11.11 \approx 12$$

(2) Analysis of (N-LPF) $\psi = \frac{180}{7} = 25.71$

$$\omega_B = \varepsilon^{\frac{-1}{n}} \omega_p = 1.17 rad/sec$$

$$R_1 = R_2 = \frac{1}{\omega_B C} = 0.85\Omega \qquad \text{assume } c = 1F$$

#	ϕ	location	$\frac{1}{Q}$	Q	$k = 3 - \frac{1}{Q}$	$R_F = (k-1)R$
pole 2,3	25.71	$-0.901 \pm j0.434$	1.802	0.55	1.198	0.15
pole 4,5	51.43	$-0.624 \pm j0.782$	1.248	0.8	1.752	0.56
pole 6,7	77.14	$-0.223 \pm j0.975$	0.446	2.24	2.554	1.15

(3) Transform the values of N-LPF to HPF. Available $C = 0.1\mu F$, $k_f = 500$ $\therefore C = \frac{c_n}{k_m k_f} \Rightarrow k_m = \frac{c_n}{c k_f} = \frac{c_n}{0.1\mu \times 500} = 20000$

$$C = 0.1\mu F \quad R = 0.85 * 20000 = 17K\Omega \quad R_{F1} = 0.15 k_m = 3K\Omega$$

$$R_{F2} = 0.56 k_m = 11.2K\Omega \quad R_{F3} = 1.15 k_m = 23K\Omega$$

	non-Normalized (assume C=0.1uF)	Normalized (assume C= 1F)
ω_B	430.189	0.8604
R_n		1.1623
k_m		20000.00
R	23245.5967	23246

(2) Analysis of (LPF) $\psi = \frac{180}{12} = 15$

$$\omega_B = \varepsilon^{\frac{-1}{n}} \omega_p = 1091.68 rad/sec$$

$$R_1 = R_2 = \frac{1}{\omega_B C} = 9160.14\Omega \qquad \text{assume } c = 0.1\mu F$$

#	ϕ	location	$\frac{1}{Q}$	Q	$k = 3 - \frac{1}{Q}$	$R_F = (k-1)R$
pole 1,2	7.50	$-0.991 \pm j0.13$	1.98	0.50	1.02	156.6
pole 3,4	22.50	$-0.924 \pm j0.382$	1.85	0.54	1.15	1393.15
pole 5,6	37.50	$-0.794 \pm j0.608$	1.59	0.63	1.41	3782.12
pole 7,8	52.50	$-0.609 \pm j0.793$	1.22	0.82	1.78	7160.85
pole 9,10	67.50	$-0.383 \pm j0.924$	0.77	1.30	2.23	11299.30
pole 11,12	82.50	$-0.131 \pm j0.991$	0.26	3.81	2.74	15915.75