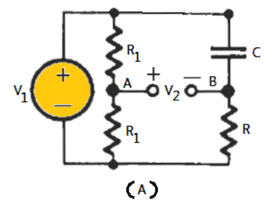
Subject: Shaping Circuits /(EEC 242)(G1)
Examiner : Dr. Mustafa M. Shiple

Term: June - August 2015
Exam Time:60 min

ANSWER THE FOLLOWING QUESTIONS:

1. Draw the wiring diagram of all pass filter. [10 marks] [B_k, C_o]
   (a) Drive an expression for $|T(S)|$ and $\angle T(S)$.
   (b) Modify the circuit to be make the output lead the input.

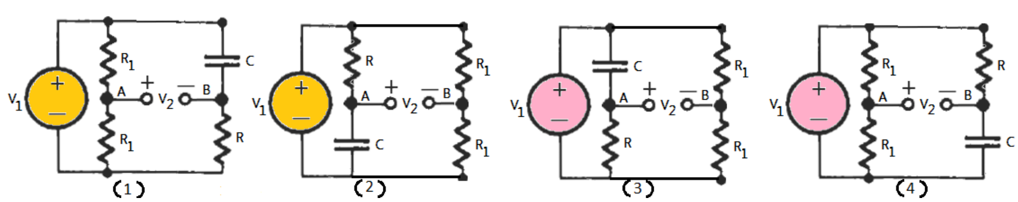
Solution: Q1.



- A)

$$V_A = V_1 \frac{R_1}{2R_1} = \frac{1}{2}$$
$$V_B = V_1 \frac{SCR}{SCR+1}$$
$$V_2 = V_A - V_B = v_1 \left(\frac{1}{2} - \frac{SCR}{SCR+1}\right)$$
$$\omega_c = \frac{1}{RC}$$
$$H(S) = \frac{1}{2} \times \frac{1-SCR}{1+SCR}$$
$$|H(S)| = \frac{1}{2} \times \left(\sqrt{1+(\omega CR)^2} - \sqrt{1+(\omega CR)^2}\right) = \frac{1}{2}$$
$$\angle H(S) = -\tan^{-1}(\omega CR) - \tan^{-1}(\omega CR) = -2\tan^{-1}(\omega CR).$$

- B)



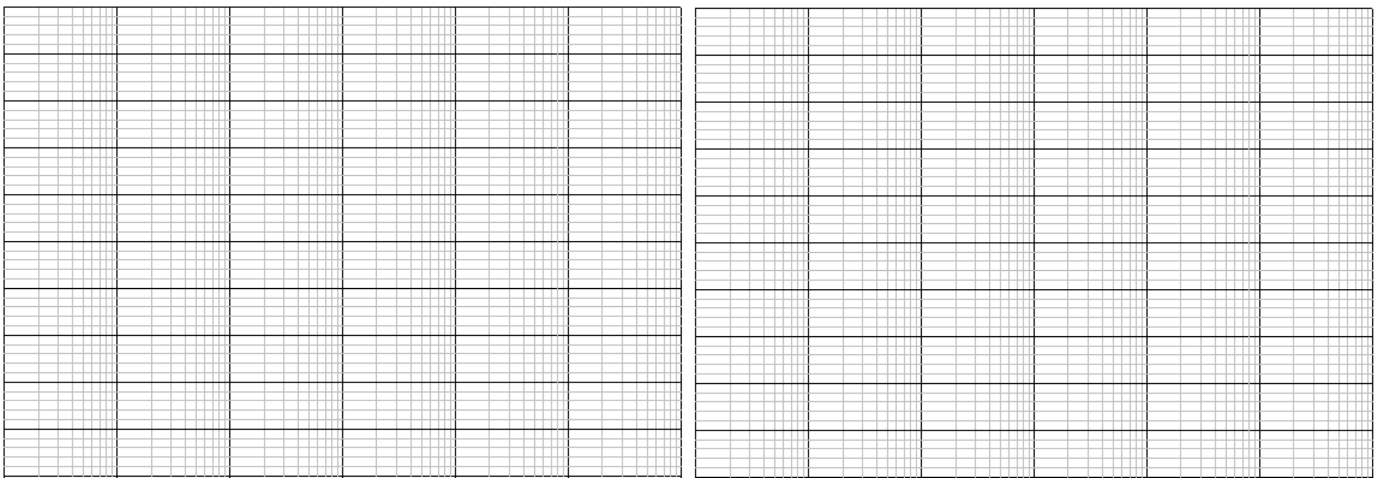
$$(1) \text{ and } (2) - H(S) = \frac{1}{2} \times \frac{1-SCR}{1+SCR}$$
$$(3) \text{ and } (4) - H(S) = \frac{1}{2} \times \frac{SCR-1}{1+SCR}$$
$$1 - \angle H(S) = -\tan^{-1}(\omega CR) - \tan^{-1}(\omega CR) = -2\tan^{-1}(\omega CR).$$
$$2 - \angle H(S) = \tan^{-1}\left(\frac{\omega CR}{-1}\right) - \tan^{-1}(\omega CR) = 180 - \tan^{-1}(\omega CR).$$

[Total Marks is 20]

From all the previous, its clear that all circuits can not provide lead phase except the second configuration.

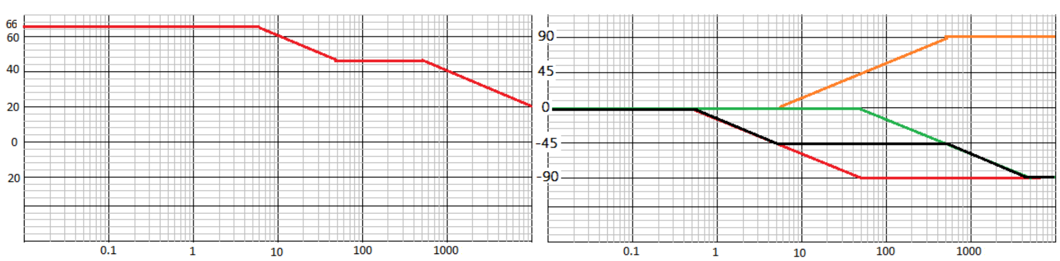
2. For the Transfer Function given, sketch the Bode diagram which shows how the phase and magnitude of the system is affected by changing input frequency. [5 marks] $[A_d, A_q]$

$$|T(S)| = \frac{5 \times 10^4(2S + 100)}{S^2 + 505S + 2500}$$



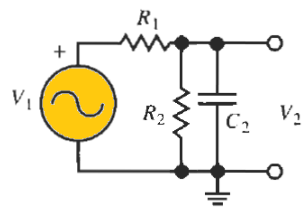
Solution: Q2.

$$|T(S)| = \frac{5 \times 10^4(2S + 100)}{S^2 + 505S + 2500} = \frac{500 \times 10^4}{5 \times 500} \frac{(\frac{S}{50} + 1)}{(\frac{S}{500} + 1)(\frac{S}{5} + 1)} = 2000 \frac{(\frac{S}{50} + 1)}{(\frac{S}{500} + 1)(\frac{S}{5} + 1)}$$



3. Design a passive first order low-pass filter with T(0)=0.9 and 3db frequency = 1.2 khz. [5 marks] $[C_o, A_m]$

Solution: Q3. (Hint: Question 3.6, pp.118) the gain $\neq 1$. Consequently, shut resistor will be attached to capacitor.



$$T(S) = \frac{\frac{R_2}{SCR_2+1}}{\frac{R_2}{SCR_2+1} + R_1} = \frac{R_2}{R_2 + R_1(SCR_2+1)} = \frac{R_2}{SCR_1R_2 + R_2 + R_1}$$

$$= \frac{R_2}{R_2+R_1}\frac{1}{\left(\frac{SCR_1R_2}{R_2+R_1}+1\right)}$$

$$\therefore \text{ The gain } = \frac{R_2}{R_2+R_1} = 0.9 \Rightarrow R_2 - 0.9R_2 = 0.9R_1 \Rightarrow R_2 = 9R_1$$

$$\therefore \text{ The pole frequency } = \frac{R_2+R_1}{2\pi CR_1R_2} = 1.2K \Rightarrow \frac{10}{18\pi CR_1}$$

$$R_1C = \frac{10}{18\pi 1.2K} = 1.47 \times 10^{-4}$$

Assume $C = 10 \times 10^{-9}$

$$\Rightarrow R_1 = 14.7K\Omega \Rightarrow R_2 = 132.3K\omega$$