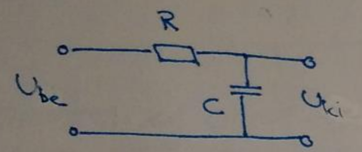
Elektronika kiemelt fejezetek

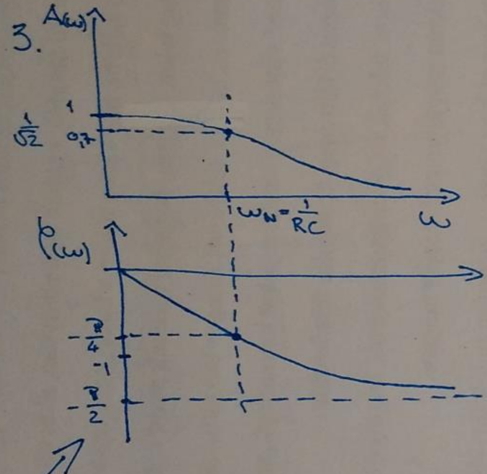
Szűrők

Készítette: Bajusz Péter és Nagy A.

1.



3.



$$A(\omega) = \frac{1}{\sqrt{1+\omega^2 \cdot R^2 \cdot C^2}}$$

$$\varphi(\omega) = -\operatorname{arctg}(\omega \cdot R \cdot C)$$

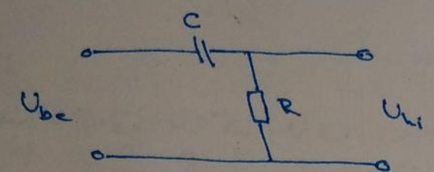
5.

7. $X_C = R \qquad |X_C| = \frac{1}{\omega C} = R$

$$A(\omega) = \frac{1}{\sqrt{1+\omega^2 \cdot R^2 \cdot C^2}}$$

$$A(\omega) = \frac{1}{\sqrt{1+\cancel{R^2} \cdot \frac{1}{\cancel{R^2}}}} = \frac{1}{\sqrt{2}} \overset{-3dB}{=} 0{,}7$$

2.



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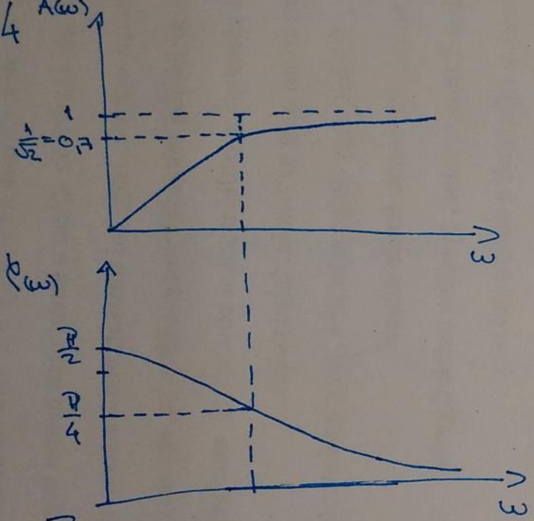


$$A(\omega) = \frac{\omega \cdot R \cdot C}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}}$$

$$\varphi(\omega) = \operatorname{arctg}\left(\frac{1}{\omega R C}\right)$$

6.

8. $X_C = R$ $\quad |X_C| = \frac{1}{\omega C} = R$

$$A_\omega = \frac{\omega \cdot R \cdot C}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}} \qquad A(\omega) = \frac{\frac{1}{\cancel{R}} \cdot \cancel{R}}{\sqrt{1 + \cancel{R^2}\,\frac{1}{\cancel{R^2}}}} = \frac{1}{\sqrt{2}} \approx 0{,}7$$

-3dB

9. $X_C = R$ $|X_C| = \frac{1}{\omega C} = R$

$$\varphi(\omega) = -\operatorname{arctg}(\omega \cdot R \cdot C)$$

$$\varphi(\omega) = -\operatorname{arctg}\left(\frac{1}{R} \cdot R\right)$$

$$\varphi(\omega) = -\operatorname{arctg}(1)$$

$$\varphi(\omega) = -45^\circ \Rightarrow -0{,}78 \text{ rad} \Rightarrow -\frac{\pi}{4}$$

10. $X_c = R \quad |X_c| = \frac{1}{\omega c} = R$

$$\varphi_{(\omega)} = \operatorname{arctg}\left(\frac{1}{\omega R C}\right)$$

$$\varphi_{(\omega)} = \operatorname{arctg}\left(\frac{1}{R \cdot \frac{1}{R}}\right)$$

$$\varphi_{(\omega)} = \operatorname{arctg}(1)$$

$$\varphi_{(\omega)} = 45^\circ \Rightarrow 0{,}78 \text{ rad} \Rightarrow \frac{\pi}{4}$$

11. $X_C = R \quad |X_C| = \frac{1}{\omega C} = R$

$$A(\omega) = \frac{1}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}}$$

$$A(e) = A(\omega) \cdot A(\omega)$$

$$A(e) = \frac{1}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}} \cdot \frac{1}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}}$$

$$A(e) = \frac{1}{\sqrt{1 + R^2 \cdot \frac{1}{R^2}}} \cdot \frac{1}{\sqrt{1 + R^2 \cdot \frac{1}{R^2}}}$$

$$A(e) = \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}}$$

$$A(e) = \frac{1}{2} \Rightarrow -6\,dB$$

12. $X_c = R \qquad |X_c| = \frac{1}{\omega C} = R$

$$A(\omega) = \frac{\omega \cdot R \cdot C}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}}$$

$$A(e) = A(\omega) \cdot A(\omega)$$

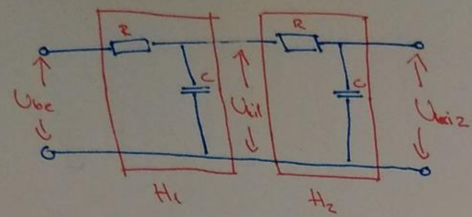
$$A(e) = \frac{\omega \cdot R \cdot C}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}} \cdot \frac{\omega \cdot R \cdot C}{\sqrt{1 + \omega^2 \cdot R^2 \cdot C^2}}$$

$$A(e) = \frac{\frac{1}{R} \cdot R}{\sqrt{1 + R^2 \cdot \frac{1}{R^2}}} \cdot \frac{\frac{1}{R} \cdot R}{\sqrt{1 + R^2 \cdot \frac{1}{R^2}}}$$

$$A(e) = \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}}$$

$$A(e) = \frac{1}{2} \Rightarrow -6\,dB$$

11.13.



$$H_1(j\omega) = H_2(j\omega)$$

$$U_{ki1} = H_1(j\omega) \cdot U_{be} \qquad U_{ki} = H_2(j\omega) \cdot U_{ki1}$$

$$U_{ki2} = H_2(j\omega) \cdot H_1(j\omega) \cdot U_{be}$$

$$H_e(j\omega) = H_2(j\omega) \cdot H_1(j\omega)$$

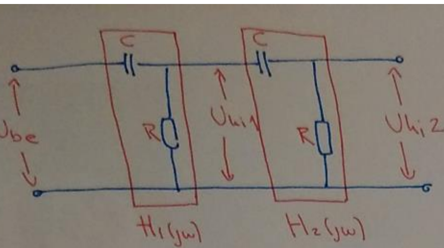
$$H_e(j\omega) = A_1(\omega) \cdot e^{j\varphi_1(\omega)} \cdot A_2(\omega) \cdot e^{j\varphi_2(\omega)}$$

$$H_e(j\omega) = A_1(\omega) \cdot A_2(\omega) \cdot e^{j(\varphi_1(\omega) + \varphi_2(\omega))}$$

$$A_e(\omega) = A_1(\omega) \cdot A_2(\omega) = \frac{1}{\sqrt{1+\omega^2R^2C^2}} \cdot \frac{1}{\sqrt{1+\omega^2R^2C^2}} = \boxed{\frac{1}{1+\omega^2R^2C^2}}$$

$$\varphi_e(\omega) = \varphi_1(\omega) + \varphi_2(\omega) = -\operatorname{arctg} \omega RC + (-\operatorname{arctg} \omega RC) = \boxed{-2\operatorname{arctg}(\omega RC)}$$

12.14.



$$H_{1(j\omega)} = H_{2(j\omega)}$$

$$U_{ki1} = U_{be} \cdot H_{1(j\omega)} \qquad U_{ki2} = U_{ki1} \cdot H_{2(j\omega)}$$

$$U_{ki2} = U_{be} \cdot H_{1(j\omega)} \cdot H_{2(j\omega)}$$

$$H_{e(j\omega)} = H_{1(j\omega)} \cdot H_{2(j\omega)}$$

$$H_{e(j\omega)} = A_{1(j\omega)} \cdot e^{j\varphi_1(\omega)} \cdot A_{2(j\omega)} \cdot e^{j\varphi_2(\omega)}$$

$$H_{e(j\omega)} = A_{1(j\omega)} \cdot A_{2(j\omega)} \cdot e^{j(\varphi_{1\omega} \cdot \varphi_{2\omega})}$$

$$A_{e(j\omega)} = A_{1(j\omega)} \cdot A_{2(j\omega)} = \frac{\omega RC}{\sqrt{1+\omega^2R^2C^2}} \cdot \frac{\omega RC}{\sqrt{1+\omega^2R^2C^2}} = \boxed{\frac{\omega^2R^2C^2}{1+\omega^2R^2C^2}}$$

$$\varphi_{e(j\omega)} = \varphi_{1(j\omega)} + \varphi_{2(j\omega)} = \operatorname{arctg}\frac{1}{\omega RC} + \operatorname{arctg}\frac{1}{\omega RC} = \boxed{2\operatorname{arctg}\frac{1}{\omega RC}}$$

13. $X_c = R \qquad |X_c| = \frac{1}{\omega c} = R$

$$\varphi_{(\omega)} = -\operatorname{arctg}(\omega \cdot R \cdot c)$$

$$\varphi_{(e)} = \varphi_{(\omega)} + \varphi_{(\omega)}$$

$$\varphi_{(e)} = -\operatorname{arctg}(\omega \cdot R \cdot c) + (-\operatorname{arctg}(\omega \cdot R \cdot c))$$

$$\varphi_{(e)} = -\operatorname{arctg}\left(R \cdot \frac{1}{R}\right) + \left(-\operatorname{arctg}\left(R \cdot \frac{1}{R}\right)\right.$$

$$\varphi_{(e)} = -45^\circ + (-45^\circ) = -90^\circ$$

$$\varphi_{(e)} = -\frac{\pi}{4} + \frac{\pi}{-4} = -\frac{\pi}{2}$$

14. $X_c = R \quad |X_c| = \frac{1}{\omega C} = R$

$$\varphi_{(\omega)} = \operatorname{arctg}\left(\frac{1}{\omega RC}\right)$$

$$\varphi_{(e)} = \varphi_{(\omega)} + \varphi_{(\omega)}$$

$$\varphi_{(e)} = \operatorname{arctg}\left(\frac{1}{\omega RC}\right) + \operatorname{arctg}\left(\frac{1}{\omega RC}\right)$$

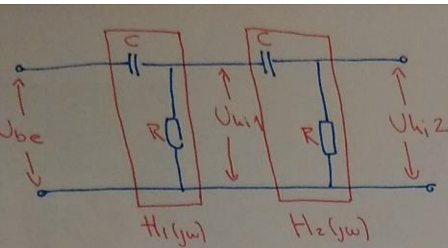
$$\varphi_{(e)} = \operatorname{arctg}\left(\frac{1}{R \cdot \frac{1}{R}}\right) + \operatorname{arctg}\left(\frac{1}{R \cdot \frac{1}{R}}\right)$$

$$\varphi_{(e)} = \operatorname{arctg}(1) + \operatorname{arctg}(1)$$

$$\varphi_{(e)} = 45^\circ + 45^\circ$$

$$\varphi_{(e)} = 90^\circ \Rightarrow \frac{\pi}{2}$$

12.14.



$$H_{1(j\omega)} = H_{2(j\omega)}$$

$$U_{ki1} = U_{be} \cdot H_{1(j\omega)} \qquad U_{ki2} = U_{ki1} \cdot H_{2(j\omega)}$$

$$U_{ki2} = U_{be} \cdot H_{1(j\omega)} \cdot H_{2(j\omega)}$$

$$H_{e(j\omega)} = H_{1(j\omega)} \cdot H_{2(j\omega)}$$

$$H_{e(j\omega)} = A_{1(j\omega)} \cdot e^{j\varphi_1(\omega)} \cdot A_{2(j\omega)} \cdot e^{j\varphi_2(\omega)}$$

$$H_{e(j\omega)} = A_{1(j\omega)} \cdot A_{2(j\omega)} \cdot e^{j(\varphi_1 \omega \cdot \varphi_2 \omega)}$$

$$A_{e(j\omega)} = A_{1(j\omega)} \cdot A_{2(j\omega)} = \frac{\omega R C}{\sqrt{1+\omega^2 R^2 C^2}} \cdot \frac{\omega R C}{\sqrt{1+\omega^2 R^2 C^2}} = \boxed{\frac{\omega^2 R^2 C^2}{1+\omega^2 R^2 C^2}}$$

$$\varphi_{e(j\omega)} = \varphi_{1(j\omega)} + \varphi_{2(j\omega)} = \operatorname{arctg}\frac{1}{\omega R C} + \operatorname{arctg}\frac{1}{\omega R C} = \boxed{2 \operatorname{arctg}\frac{1}{\omega R C}}$$

15. $X_C = R \qquad |X_C| = \frac{1}{\omega C} = R$

$$A(\omega) = \frac{1}{\sqrt{1+\omega^2 R^2 C^2}} \qquad A(\omega) = \frac{\omega \cdot R \cdot C}{\sqrt{1+\omega^2 R^2 C^2}}$$

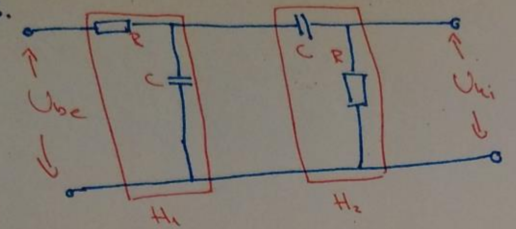
$$A(e) = A(\omega) \cdot A(\omega)$$

$$A(e) = \frac{1}{\sqrt{1+\omega^2 R^2 C^2}} \cdot \frac{\omega \cdot R \cdot C}{\sqrt{1+\omega^2 R^2 C^2}}$$

$$A(e) = \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} = \frac{1}{2}$$

$$A(e) = -6\,dB$$

15. 16.



$$U_{ki1} = U_{be} \cdot H_{1(j\omega)} \qquad U_{ki2} = U_{ki1} \cdot H_{2(j\omega)}$$

$$U_{ki2} = U_{be} \cdot H_{1(j\omega)} \cdot H_{2(j\omega)}$$

$$H_{e(j\omega)} = H_{1(j\omega)} \cdot H_{2(j\omega)}$$

$$H_{e(j\omega)} = A_{1(j\omega)} \cdot e^{j\varphi_{1(\omega)}} \cdot A_{2(j\omega)} \cdot e^{j\varphi_{2(\omega)}}$$

$$H_{e(j\omega)} = A_{1(j\omega)} \cdot A_{2(j\omega)} \cdot e^{j(\varphi_{1(\omega)} + \varphi_{2(\omega)})}$$

$$A_{e(j\omega)} = A_{1(j\omega)} \cdot A_{2(j\omega)} = \frac{1}{\sqrt{1+\omega^2R^2C^2}} \cdot \frac{\omega RC}{\sqrt{1+\omega^2R^2C^2}} = \frac{\omega RC}{1+\omega^2R^2C^2}$$

$$\varphi_{e(j\omega)} = \varphi_{1(j\omega)} + \varphi_{2(j\omega)} = -\operatorname{arctg}(\omega RC) + \operatorname{arctg}\left(\frac{1}{\omega RC}\right)$$

16. $X_C = R \quad |X_C| = \frac{1}{\omega C} = R$

$$\varphi_{(\omega)} = -\operatorname{arctg}(\omega \cdot R \cdot C) \qquad \varphi_{(\omega)} - \operatorname{arctg}\left(\frac{1}{\omega \cdot R \cdot C}\right)$$

$$\varphi_{(e)} = \varphi_{(\omega)} + \varphi_{(\omega)}$$

$$\varphi_{(e)} = -\operatorname{arctg}(\omega R C) + \operatorname{arctg}\left(\frac{1}{\omega R C}\right)$$

$$\varphi_{(e)} = -\operatorname{arctg}(1) + \operatorname{arctg}(1)$$

$$\varphi_{(e)} = 0^\circ \Rightarrow 0$$

17. $X_c = R \quad |X_c| = \frac{1}{\omega c} = R$

$$A(\omega) = \frac{1}{\sqrt{1 + R^2 \omega^2 C^2}}$$

$$A_{(e)} = A(\omega) \cdot A(\omega) \cdot A(\omega) \cdot A(\omega) \cdot A(\omega)$$

$$A_{(e)} = \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}}$$

$$A_{(e)} = \left(\frac{1}{\sqrt{2}}\right)^5 \Rightarrow \frac{1}{4\sqrt{2}} \Rightarrow -15dB$$

18. $X_c = R \qquad |X_c| = \frac{1}{\omega C} = R$

$$A(\omega) = \frac{\omega R C}{\sqrt{1 + \omega^2 R^2 C^2}}$$

$$A(e) = A(\omega) \cdot A(\omega) \cdot A(\omega) \cdot A(\omega) \cdot A(\omega)$$

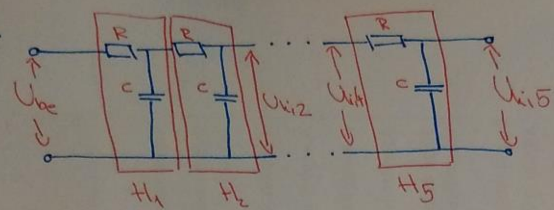
$$A(e) = \frac{\omega R C}{\sqrt{1 + \omega^2 R^2 C^2}} \cdots$$

$$A(e) = \frac{\frac{1}{R} \cdot R}{\sqrt{1 + R^2 \cdot \frac{1}{R^2}}}$$

$$A(e) = \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}}$$

$$A(e) = \left(\frac{1}{\sqrt{2}}\right)^5 = \frac{1}{4\sqrt{2}} = -15\,dB$$

17.19.



$$H_1 = H_2 = H_3 = H_4 = H_5$$

$$U_{ki1} = U_{be} \cdot H_{1(j\omega)} \qquad U_{ki2} = U_{ki1}\, H_{2(j\omega)} \ldots \qquad U_{ki5} = U_{ki4} \cdot H_{5(j\omega)}$$

$$U_{ki5} = U_{be} \cdot H_{1(j\omega)} \cdot H_{2(j\omega)} \cdot H_{3(j\omega)} \cdot H_{4(j\omega)} \cdot H_{5(j\omega)}$$

$$H_{e(j\omega)} = H_{1(j\omega)} \cdot H_{2(j\omega)} \ldots H_{5(j\omega)}$$

$$H_{e(j\omega)} = A_{1(j\omega)} \cdot e^{j\varphi_1(\omega)} \cdot A_{2(j\omega)} \cdot e^{j\varphi_2(\omega)} \ldots A_{5(j\omega)} \cdot e^{j\varphi_5(\omega)}$$

$$H_{e(j\omega)} = A_{e(j\omega)} \cdot e^{j\varphi_e(\omega)}$$

$$A_{e(j\omega)} = A_{1(j\omega)} \cdot A_{2(j\omega)} \ldots A_{5(j\omega)} = \frac{1}{\sqrt{1+R^2 \cdot C^2 \cdot \omega^2}} \cdot \frac{1}{\sqrt{1+R^2\omega^2C^2}} \cdots \frac{1}{\sqrt{1+R^2C^2\omega^2}}$$

$$\boxed{A_{e(j\omega)} = \left(\frac{1}{\sqrt{1+\omega^2R^2C^2}}\right)^5}$$

$$\varphi_{e(j\omega)} = \varphi_{1(j\omega)} + \varphi_{2(j\omega)} \ldots \varphi_{5(j\omega)} = -\mathrm{arctg}(\omega R C) + (-\mathrm{arctg}\cdot(\omega R C)) \ldots$$

$$\boxed{\varphi_{e(j\omega)} = -5\,(\mathrm{arctg}(\omega R C))}$$

19. $X_C = R \qquad |X_C| = \frac{1}{\omega C} = R$

$$\varphi(\omega) = -\operatorname{arctg}(\omega \cdot R \cdot C)$$

$$\varphi(e) = \varphi(\omega) + \varphi(\omega) + \varphi(\omega) + \varphi(\omega) + \varphi(\omega)$$

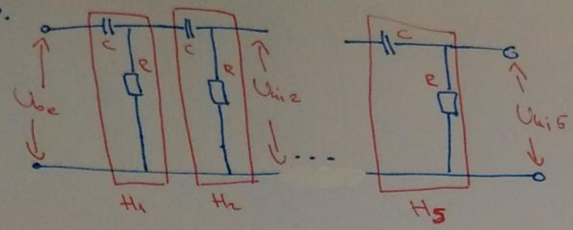
$$\varphi(e) = -\operatorname{arctg}(\omega \cdot R \cdot c)$$

$$\varphi(e) = -\operatorname{arctg}(1) + (-\operatorname{arctg}(1)) + (-\operatorname{arctg}(1)) - \dots$$

$$\varphi(e) = -45^\circ - 45^\circ - 45^\circ - 45^\circ - 45^\circ$$

$$\varphi(e) = -225^\circ \Rightarrow -\frac{5\pi}{4}$$

12.20.



$H_1 = H_2 = \dots H_5$

$U_{ki} = U_{be} \cdot H_1(j\omega)$ $\quad U_{ki2} = U_{ki1} \cdot H_2(j\omega)$ $\quad U_{ki5} = U_{ki4} \cdot H_5(j\omega)$

$U_{ki} = U_{be} \cdot H_1(j\omega)\, H_2(j\omega) \cdot H_3(j\omega) \cdot H_4(j\omega) \cdot H_5(j\omega)$

$H_e(j\omega) = H_1(j\omega) \cdot H_2(j\omega) \dots H_5(j\omega)$

$H_e(j\omega) = A_1(j\omega) \cdot e^{j\varphi_1(\omega)} \cdot A_2(j\omega) \cdot e^{j\varphi_2(\omega)} \dots A_5(j\omega) \cdot e^{j\varphi_5(\omega)}$

$H_e(j\omega) = A_e(j\omega) \cdot e^{j\varphi_e(\omega)}$

$A_e(j\omega) = A_1(j\omega) \cdot A_2(j\omega) \dots A_5(j\omega) = \frac{\omega RC}{\sqrt{1+\omega^2R^2C^2}} \cdot \frac{\omega RC}{\sqrt{1+\omega^2R^2C^2}} \dots = \boxed{\frac{\omega RC}{\sqrt{1+\omega^2R^2C^2}}}$

$\varphi_e(j\omega) = \varphi_1(j\omega) + \varphi_2(j\omega) \dots + \varphi_5(j\omega) = \mathrm{arctg} + \mathrm{arctg} \dots = \boxed{5\,\mathrm{arctg}\left(\frac{1}{\omega RC}\right)}$

20. $X_C = R \quad |X_C| = \frac{1}{\omega C} = R$

$$\varphi(\omega) = \operatorname{arctg}\left(\frac{1}{\omega R C}\right)$$

$$\varphi(e) = \varphi(\omega) + \varphi(\omega) + \varphi(\omega) + \varphi(\omega) + \varphi(\omega)$$

$$\varphi(e) = \operatorname{arctg}\left(\frac{1}{\omega R C}\right)$$

$$\varphi(e) = \operatorname{arctg}\left(\frac{1}{R \cdot \frac{1}{R}}\right)$$

$$\varphi(e) = \operatorname{arctg}(1)$$

$$\varphi(e) = 225^\circ = \frac{5\pi}{4}$$

21. $X_C = R \quad |X_C| = \frac{1}{\omega C} = R$

$$A(\omega)_1 = \frac{1}{\sqrt{1+\omega^2 R^2 C^2}} \qquad A(\omega)_2 = \frac{\omega \cdot R \cdot C}{\sqrt{1+\omega^2 R^2 C^2}}$$

$$A(e) = A(\omega)_1 \cdot A(\omega)_1 \cdot A(\omega)_2 \cdot A(\omega)_2 \cdot A(\omega)_2$$

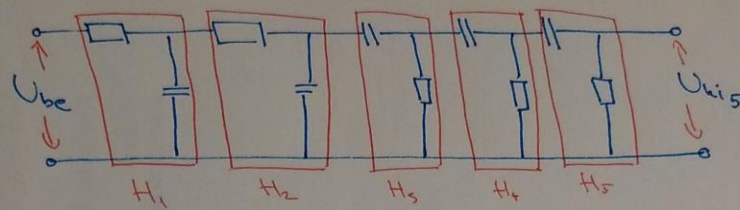
$$A(e) = \frac{1}{\sqrt{1+\omega^2 R^2 C^2}} \cdot \frac{\omega \cdot R \cdot C}{\sqrt{1+\omega^2 R^2 C^2}}$$

$$A(e) = \frac{1}{\sqrt{1+R^2 \frac{1}{R^2}}} \cdot \frac{R \cdot \frac{1}{R}}{\sqrt{1+R^2 \cdot \frac{1}{R^2}}}$$

$$A(e) = \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}} \cdot \frac{1}{\sqrt{2}}$$

$$A(e) = \left(\frac{1}{\sqrt{2}}\right)^5 = \frac{1}{4\sqrt{2}} = 15\,dB$$

21. 22.



$H_1 = H_2$

$H_3 = H_4 = H_5$

$$A_{e(j\omega)} = A_{1(j\omega)} \cdot \ldots A_{5(j\omega)}$$

$$A_{e(j\omega)} = \left(\frac{1}{\sqrt{1+\omega^2R^2C^2}}\right)^2 \cdot \left(\frac{\omega RC}{\sqrt{1+\omega^2R^2C^2}}\right)^3$$

$$\varphi_{e(j\omega)} = \varphi_{1(j\omega)} + \varphi_{2(j\omega)} + \varphi_{3(j\omega)} + \varphi_{4(j\omega)} + \varphi_{5(j\omega)}$$

$$\varphi_e = -2\,\mathrm{arctg}(\omega RC) + 3\,\mathrm{arctg}\left(\frac{1}{\omega RC}\right)$$

22. $X_C = R \quad |X_C| = \frac{1}{\omega C} = R$

$$\varphi_{(\omega_1)} = -\operatorname{arctg}(\omega RC) \qquad \varphi_{(\omega_2)} = \operatorname{arctg}\left(\frac{1}{\omega RC}\right)$$

$$\varphi_{(e)} = \varphi_{(\omega_1)} + \varphi_{(\omega_1)} + \varphi_{(\omega_2)} + \varphi_{(\omega_2)} + \varphi_{(\omega_2)}$$

$$\varphi_{(e)} = -\operatorname{arctg}^{(\omega RC)} + \operatorname{arctg}\left(\frac{1}{\omega RC}\right)$$

$$\varphi_{(e)} = -\operatorname{arctg}(1) + \operatorname{arctg}(1)$$

$$\varphi_{(e)} = -45 - 45 + 45 + 45 + 45$$

$$\varphi_{(e)} = 45° \Rightarrow \frac{\pi}{4}$$

23. $X_C = R \qquad |X_C| = \frac{1}{\omega C} = R \qquad \omega_0 = \frac{1}{RC}$

$$A(\omega) = \frac{1}{\sqrt{1+(3\omega_0)^2 R^2 C^2}} = \frac{1}{1+9\frac{1}{R^2C^2}\cdot R^2\cdot C^2} = \frac{1}{\sqrt{10}} = 0{,}316$$

$$A(\omega\,dB) = 20\log\left(\frac{1}{\sqrt{10}}\right) = -10\,dB$$

24. $$A(\omega) = \frac{3\omega_0 R C}{\sqrt{1+(3\omega_0)^2 R^2 C^2}} = \frac{3\frac{1}{RC}\cdot RC}{\sqrt{1+9\frac{1}{R^2C^2}\cdot R^2\cdot C^2}} = \frac{3}{\sqrt{10}} = 0{,}95$$

$$A(\omega\,dB) = 20\log\left(\frac{3}{\sqrt{10}}\right) = -0{,}4576\,dB$$

..... 30. Néhány tantárgynak csak kevés a haszna a továbbtanulás szempontjából.

25. $\omega_0 = \frac{1}{RC}$

$$\varphi(\omega) = -\mathrm{arctg}(\omega RC)$$

$$\varphi(\omega) = -\mathrm{arctg}\left(3\frac{1}{RC} \cdot RC\right)$$

$$\varphi(\omega) = -\mathrm{arctg}(3)$$

$$\varphi(\omega) = -76{,}5651^\circ \Rightarrow -1{,}25 \text{ rad}$$

26. $\varphi(\omega) = \mathrm{arctg}\left(\frac{1}{\omega RC}\right)$

$$\varphi(\omega) = \mathrm{arctg}\left(\frac{1}{3\frac{1}{RC} \cdot RC}\right)$$

$$\varphi(\omega) = \mathrm{arctg}\left(\frac{1}{3}\right)$$

$$\varphi(\omega) = 18{,}43^\circ \Rightarrow 0{,}32 \text{ rad}$$

27.

$$\omega_0 = \frac{1}{RC}$$

$$A(\omega) = \frac{1}{\sqrt{1 + \omega^2 R^2 C^2}}$$

$$A(\omega) = \frac{1}{\sqrt{1 + (11\omega_0)^2 R^2 C^2}}$$

$$A(\omega) = \frac{1}{\sqrt{1 + 121 \frac{1}{R^2 C^2} R^2 C^2}}$$

$$A(\omega) = \frac{1}{\sqrt{122}} = 0{,}09$$

$$A(\omega\, dB) = 20 \log\left(\frac{1}{\sqrt{122}}\right) = -20{,}86$$

28.

$$A(\omega) = \frac{\omega RC}{\sqrt{1 + \omega^2 R^2 C^2}} \qquad \omega_0 = \frac{1}{RC}$$

$$A(\omega) = \frac{11\omega_0 \cdot R \cdot C}{\sqrt{1 + (11\omega_0)^2 R^2 C^2}}$$

$$A(\omega) = \frac{11 \frac{1}{RC} \cdot RC}{\sqrt{1 + 121 \frac{1}{R^2C^2} \cdot R^2 C^2}}$$

$$A(\omega) = \frac{11}{\sqrt{122}} \Rightarrow 0{,}9959$$

$$A(\omega\, dB) = 20 \log(0{,}9959) = -0{,}0356\, dB$$

29.

$$\omega_0 = \frac{1}{RC}$$

$$\varphi(\omega) = -\operatorname{arctg}(\omega RC)$$

$$\varphi(\omega) = -\operatorname{arctg}(11\,\omega_0 \cdot RC)$$

$$\varphi(\omega) = -\operatorname{arctg}\left(11\,\frac{1}{RC} \cdot RC\right)$$

$$\varphi(\omega) = -\operatorname{arctg}(11)$$

$$\varphi(\omega) = -84{,}80^\circ \Rightarrow -1{,}48\ \text{rad}$$

30.

$$\omega_0 = \frac{1}{RC}$$

$$\varphi(\omega) = \operatorname{arctg}\left(\frac{1}{\omega RC}\right)$$

$$\varphi(\omega) = \operatorname{arctg}\left(\frac{1}{11\omega_0 RC}\right)$$

$$\varphi(\omega) = \operatorname{arctg}\left(\frac{1}{11\frac{1}{RC}\cdot RC}\right)$$

$$\varphi(\omega) = \operatorname{arctg}\left(\frac{1}{11}\right)$$

$$\varphi(\omega) = 5{,}19^\circ \Rightarrow 0{,}090 \text{ rad}$$

31. 32. $\omega_0 = \omega_u = \frac{1}{RC}$ $F_u = 1 \cdot \frac{4}{\pi}$

$$A = \frac{1}{\sqrt{1+\omega^2R^2C^2}} = \frac{1}{\sqrt{2}} \qquad \varphi = -\mathrm{arctg}\,\frac{1}{RC}\cdot RC = -\frac{\pi}{4}$$

$$U_{ki} = \frac{\pi}{4} \cdot \frac{1}{\sqrt{2}} = 0{,}90 \qquad \Theta_{ki} = \frac{\pi}{2} - \frac{\pi}{4} = \frac{\pi}{4}$$

$$U_{ki} = 0{,}9 \cdot \cos\left(\omega_0 + \frac{\pi}{4}\right)$$

33. 34.

$$\omega_0 = \omega_u = \frac{1}{RC} \qquad F_u = 1 \cdot \frac{4}{\pi}$$

$$A = \frac{\frac{1}{RC}\cdot RC}{\sqrt{1+\frac{1}{R^2C^2}R^2C^2}} = \frac{1}{\sqrt{2}} \qquad \varphi = \mathrm{arctg}\,\frac{1}{\frac{1}{RC}RC} = \frac{\pi}{4}$$

$$U_{ki} = \frac{4}{\pi} \cdot \frac{1}{\sqrt{2}} = 0{,}90 \qquad \Theta_{ki} = \frac{\pi}{2} + \frac{\pi}{4} = \frac{3\pi}{4}$$

$$U_{ki(t)} = 0{,}90 \cdot \cos\left(\omega_{0(t)} + \frac{3\pi}{4}\right)$$

35. 36.

$$\omega_0 = \omega_u = \frac{1}{RC} \qquad F_u = 2 \cdot \frac{4}{\pi} = \frac{8}{\pi}$$

sávszűrő

$$A = \frac{\omega RC}{1+\omega^2R^2C^2} = \frac{\frac{1}{\cancel{RC}} \cdot \cancel{RC}}{1+\cancel{\frac{1}{R^2C^2}}\cancel{R^2C^2}} = \frac{1}{2}$$

$$\varphi_e = -\mathrm{arctg}\, \frac{1}{RC} RC + \mathrm{arctg} \frac{1}{\frac{1}{RC} RC} = 0$$

$$U_{ki} = \frac{8}{\pi} \cdot \frac{1}{2} = \frac{4}{\pi} \qquad \Theta_{ki} = \frac{\pi}{2}$$

$$U_{ki(t)} = \frac{4}{\pi} \cdot \cos\left(\omega_{0(t)} + \frac{\pi}{2}\right)$$