TET4100 Kretsanalyse – Løsning

Institutt: Elkraftteknikk Dato: 2012.08.15

Øving 7

27) Operasjonsforsterker 7.A

27.1) Egenskapene til en ideell operasjonsforsterker:

- uendelig forsterkning: $v_n = v_p$
- uendelig inngangsresistans: $i_n = i_p = 0$
- null utgangsresistans: $R_{ut} = 0$
- absolutt lineær

27.2) $I_1 = \frac{V_a}{R_a + R_0}$ $\quad P_1 = R_0 \cdot I_1^2 = R_0 \cdot \left(\frac{V_a}{R_a + R_0}\right)^2 = 432 \text{ nW}$

$I_2 = \frac{V_a}{R_0}$ $\quad P_2 = R_0 \cdot I_2^2 = R_0 \cdot \left(\frac{V_a}{R_0}\right)^2 = \frac{V_a^2}{R_0} = 19{,}2 \ \mu\text{W}$

$$\frac{P_2}{P_1} = \frac{\frac{V_a^2}{R_0}}{R_0 \cdot \left(\frac{V_a}{R_a + R_0}\right)^2} = \left(\frac{R_a + R_0}{R_0}\right)^2 = 44{,}44$$

27.3) $I_1' = \frac{V_a}{R_a + R_0} = \frac{V_a}{R_0}$ $\quad P_1' = R_0 \cdot I_1'^2 = R_0 \cdot \left(\frac{V_a}{R_0}\right)^2 = \frac{V_a^2}{R_0} = 19{,}2 \ \mu\text{W}$

I_2 og P_2 er uforandret

Om $R_a = 0$ blir effektene $P_1 = P_2$

Operasjonsforsterkeren fører til at den utgangsresistans av kilden R_a ikke har noen innvirkning på kretsen.

28) Operasjonsforsterker 7.B

28.1) $v_p = 0 \quad \rightarrow \quad v_n = v_p = 0 \quad \rightarrow \quad \frac{V_s}{R_s} + \frac{V_0}{R_f} = 0$

$V_0 = -\frac{R_f}{R_s} \cdot V_s = -3\,V_s$

$V_s = 2V \Rightarrow V_0 = -6\,V$

$V_s = 4V \Rightarrow V_0 = -12\,V$

hvis $|V_0| > V_{CC}$ blir det begrenset til $|V_0| = V_{CC}$

28.2) $|V_0| \le V_{CC}$

$|V_0| = \frac{R_f}{R_s} \cdot |V_s|$

$|V_s| \le \frac{R_s}{R_f} \cdot V_{CC} = \frac{10}{3}\,V = 3{,}33\,V$

28.3) $K = \frac{R_f'}{R_s} \quad \rightarrow \quad R_f' = K \cdot R_s = 5 \cdot 40\,k\Omega = 200\,k\Omega$

$|V_s| \le \frac{R_s}{R_f'} \cdot V_{CC} = \frac{1}{K} \cdot V_{CC} = \frac{10}{5} = 2\,V$

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29) Operasjonsforsterker 7.C

29.1)

$$i_C = -i_R$$

$$i_C(\tau) = C\frac{d\,v_C(\tau)}{d\tau} \qquad i_R(\tau) = \frac{1}{R_1}v_{inn}(\tau)$$

$$C\frac{d\,v_C(\tau)}{d\tau} = -\frac{1}{R_1}v_{inn}(\tau)$$

$$v_n = 0 \quad \rightarrow \quad v_{ut} = v_C$$

$$\frac{d\,v_{ut}(\tau)}{d\tau} = -\frac{1}{R_1 C}v_{inn}(\tau)$$

$$\int_0^t \frac{d\,v_{ut}(\tau)}{d\tau}d\tau = -\frac{1}{R_1 C}\int_0^t v_{inn}(\tau)\,d\tau$$

$$v_{ut}(t) = -\frac{1}{R_1 C}\int_0^t v_{inn}(\tau)\,d\tau$$

29.2)

$$v_{inn}(\tau<0) = 0$$

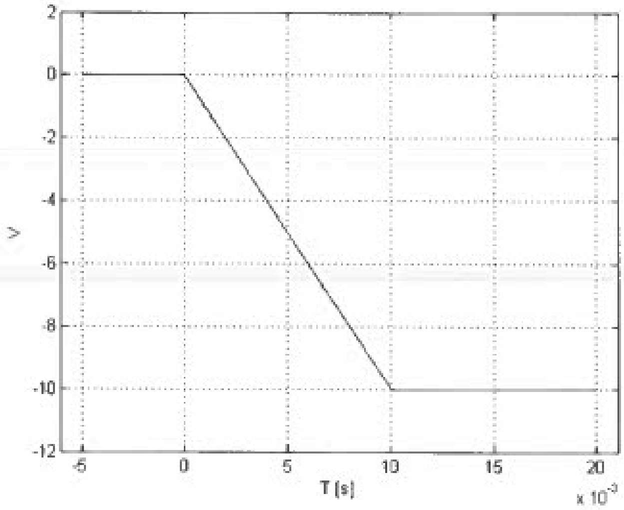
$$v_{inn}(0<\tau<t_x) = V_{inn}$$

$$v_{inn}(t_x<\tau) = 0$$

$$v_{ut}(t<0) = 0$$

$$v_{ut}(0<t<t_x) = -\frac{1}{R_1 C}V_{inn}\cdot t = -1000t$$

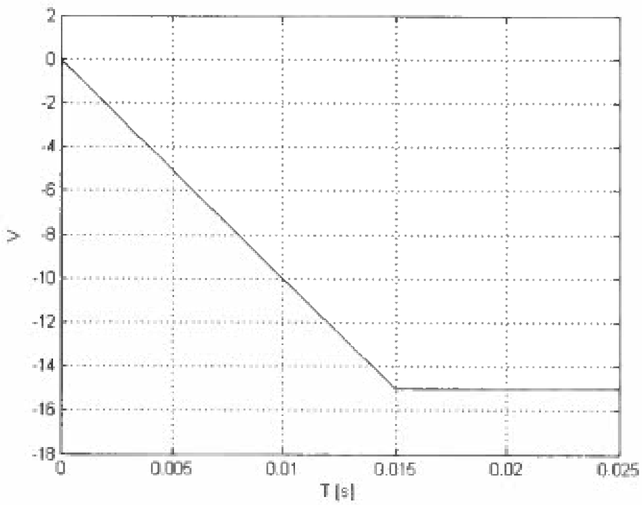
$$v_{ut}(t_x<t) = -\frac{1}{R_1 C}V_{inn}\cdot t_x = -10\,V$$



29.3) $V_{ut,min} = -V_{cc}$

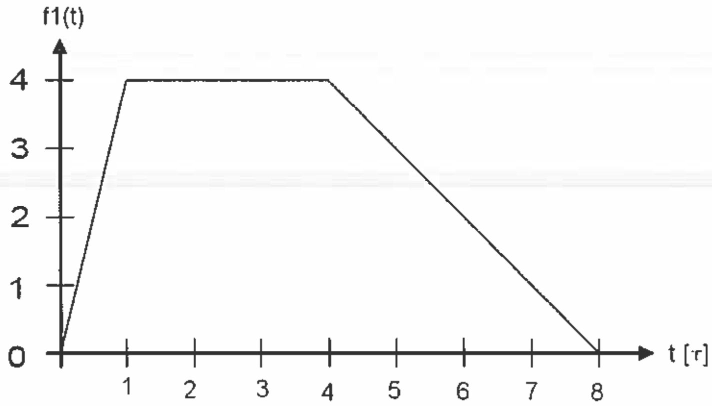
$$v_{ut,min}(t_{met}) = -\frac{1}{R_1 C} V_{inn} \cdot t_{met} = -V_{cc}$$

$$t_{met} = \frac{V_{cc}}{V_{inn}} R_1 C \;= 15\ \text{ms}$$



30) Signaler 7.D

30.1)



30.2)

$$f_2(t)=4\cdot[u(t-\tau)-u(t-2\tau)]$$
$$+\left(\frac{4}{3}\frac{t}{\tau}-\frac{14}{3}\right)\cdot[u(t-2\tau)-u(t-5\tau)]$$
$$+\left(-2\frac{t}{\tau}+12\right)\cdot[u(t-5\tau)-u(t-6\tau)]$$

30.3)

$$f_2(t)=4\cdot[u(t-\tau)]+\left(\frac{4}{3}\frac{t}{\tau}-\frac{26}{3}\right)[u(t-2\tau)]$$
$$+\left(-\frac{10}{3}\frac{t}{\tau}+\frac{50}{3}\right)\cdot[u(t-5\tau)]+\left(2\frac{t}{\tau}-12\right)\cdot[u(t-6\tau)]$$

$$f_2(t)=4\cdot[u(t-\tau)]+\left(\frac{4}{3}\frac{t-2\tau}{\tau}-6\right)\cdot[u(t-2\tau)]$$
$$+\left(-\frac{10}{3}\frac{t-5\tau}{\tau}\right)\cdot[u(t-5\tau)]+\left(2\frac{t-6\tau}{\tau}\right)\cdot[u(t-6\tau)]$$

$$L\{u(t-a)\cdot f(t-a)\}=e^{-as}\cdot F(s)$$

$$F_2(s)=4\cdot\frac{1}{s}\cdot e^{-\tau\cdot s}+\frac{4}{3}\frac{1}{\tau}\cdot\frac{1}{s^2}\cdot e^{-2\tau\cdot s}-6\cdot\frac{1}{s}\cdot e^{-2\tau\cdot s}-\frac{10}{3}\frac{1}{\tau}\cdot\frac{1}{s^2}\cdot e^{-5\tau\cdot s}+2\frac{1}{\tau}\cdot\frac{1}{s^2}\cdot e^{-6\tau\cdot s}$$

$$F_2(s)=\left(4\cdot e^{-\tau\cdot s}-6\cdot e^{-2\tau\cdot s}\right)\cdot\frac{1}{s}+\left(\frac{4}{3}\cdot e^{-2\tau\cdot s}-\frac{10}{3}\cdot e^{-5\tau\cdot s}+2\cdot e^{-6\tau\cdot s}\right)\cdot\frac{1}{\tau}\frac{1}{s^2}$$

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31) Innføring LaPlace 7.E

31.1) $$L\{f(t)\}=\int_0^\infty f(t)\cdot e^{-st}\,dt=\int_0^\infty \cos(\omega t)\cdot e^{-st}\,dt$$

$$L\{f(t)\}=\int_0^\infty \frac{1}{2}\left(e^{j\omega t}+e^{-j\omega t}\right)\cdot e^{-st}\,dt$$

$$L\{f(t)\}=\frac{1}{2}\int_0^\infty \left(e^{-t(s-j\omega)}+e^{-t(s+j\omega)}\right)dt$$

$$L\{f(t)\}=\frac{1}{2}\left[-\frac{1}{s-j\omega}e^{-t(s-j\omega)}-\frac{1}{s+j\omega}e^{-t(s+j\omega)}\right]_0^\infty$$

$$L\{f(t)\}=0-\frac{1}{2}\left(-\frac{1}{s-j\omega}-\frac{1}{s+j\omega}\right)$$

$$L\{f(t)\}=\frac{1}{2}\left(\frac{1}{s-j\omega}+\frac{1}{s+j\omega}\right)$$

$$L\{f(t)\}=\frac{1}{2}\left(\frac{s+j\omega}{s^2+\omega^2}+\frac{s-j\omega}{s^2+\omega^2}\right)$$

$$L\{f(t)\}=\frac{s}{s^2+\omega^2}$$