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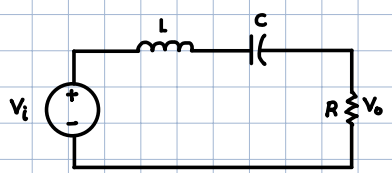
EEE 117 - 02

FINALS
19 MAY 2022

Q1.
a. false
b. false
c. true
d. true
e. true
f. false
g. true
h. false
i. true
j. true
k. true
l. false
m. true
n. false
o. false
p. true
q. true
r. false
s. true
t. true

Q2.



$C = 7\,\mu F = 7 \times 10^{-6}\ F$

$Q = 4$

$f_o = 12\ kHz \longrightarrow \omega_o = 24k\pi$

(a) $\omega_o = \sqrt{\frac{1}{LC}} \longrightarrow L = \frac{1}{\omega_o^2 C} = \frac{1}{(24k\pi)^2 (7\times10^{-6})} = \boxed{2.5129 \times 10^{-5}\ H}$

$Q = \sqrt{\frac{L}{CR^2}} \longrightarrow R = \sqrt{\frac{L}{CQ^2}} = \sqrt{\frac{2.5129\times10^{-5}}{(7\times10^{-6})(4)^2}} = \boxed{0.4737\ \Omega}$

(b) $\omega_{c1} = \frac{-R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \left(\frac{1}{LC}\right)}$

$= \frac{-0.4737}{2(2.5129\times10^{-5})} + \sqrt{\left[\frac{0.4737}{2(2.5129\times10^{-5})}\right]^2 + \left[\frac{1}{(2.5129\times10^{-5})(7\times10^{-6})}\right]}$

$= 66\,560.09\ rad/s$

$f_{c1} = \frac{66\,560.09}{2\pi} = 10\,593.37\ Hz = \boxed{10.59\ kHz}$

(c) $\omega_{c2} = \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \left(\frac{1}{LC}\right)}$

$= \frac{0.4737}{2(2.5129\times10^{-5})} + \sqrt{\left[\frac{0.4737}{2(2.5129\times10^{-5})}\right]^2 + \left[\frac{1}{(2.5129\times10^{-5})(7\times10^{-6})}\right]}$

$= 85\,410.82\ rad/s$

$f_{c2} = \frac{85\,410.82}{2\pi} = 13\,593.55\ Hz = \boxed{13.59\ kHz}$

(d) $\beta = \omega_{c2} - \omega_{c1} = 13\,593.55\ Hz - 10\,593.37\ Hz$

$= 3000.18\ Hz = \boxed{3\ kHz}$

Q3. (a) $H(s) = \frac{V_o}{V_i} = \frac{-Z_2}{Z_1} = -\frac{R_2 / (1+C_2R_2s)}{R_1/(1+C_1R_1s)}$ $\qquad Z = \frac{R \cdot 1/Cs}{R + 1/Cs} = \frac{R}{1+RCs}$

$$= \boxed{\frac{-R_2}{R_1} \cdot \frac{1+C_1R_1s}{1+C_2R_2s}}$$

(b) $H(j\omega) = \frac{-R_2}{R_1} \cdot \frac{1+C_1R_1j\omega}{1+C_2R_2j\omega}$

$\omega \to 0$: $H(j\omega) = \boxed{\frac{-R_2}{R_1}}$

(c) $H(j\omega) = \frac{-R_2}{R_1} \cdot \frac{1+C_1R_1j\omega}{1+C_2R_2j\omega}$

$\omega \to \infty$: $H(j\omega) = \frac{-R_2}{R_1} \cdot \frac{C_1R_1 - j/\infty}{C_2R_2 - j/\infty}$

$$= \boxed{-\frac{R_2}{R_1} \cdot \frac{C_1R_1}{C_2R_2}}$$

(d) $H_{MAX} = -\frac{R_2}{R_1}$

CORNER FREQ: $|H(j\omega)| = \frac{1}{\sqrt{2}} H_{MAX}$

$$= \frac{1}{\sqrt{2}} \cdot \left(-\frac{R_2}{R_1}\right)$$

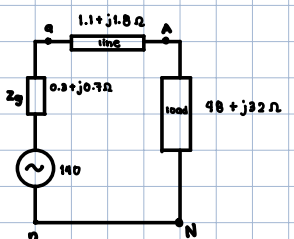
$$\frac{R_2}{R_1} \cdot \frac{\sqrt{1+(C_1R_1\omega)^2}}{\sqrt{1+(C_2R_2\omega)^2}} = \frac{1}{\sqrt{2}}\left(-\frac{R_2}{R_1}\right)$$

$$\frac{1+(C_1R_1\omega)^2}{1+(C_2R_2\omega)^2} = \frac{1}{2}$$

$$2 + 2(C_1R_1\omega)^2 = 1 + (C_2R_2\omega)^2$$

$$\boxed{\omega_c = \sqrt{\frac{1}{2(C_1R_1)^2 + (C_2R_2)^2}}}$$

Q4 (a)



$V_{an} = 140\angle 0°$

$V_{bn} = 140\angle 120°$

$V_{cn} = 140\angle -120°$

(b) $I = \frac{V}{Z} \longrightarrow I_{aA} = \frac{V_{an}}{Z_g + Z_{line} + Z_{load}} = \frac{140\angle 0°}{(0.3+j0.7)+(1.1+j1.8)+(48+j32)}$

$= 1.905 - j1.380 \approx 2.32\angle -34.92°$ A

$I_{aA} = \boxed{2.32\angle -34.92°\ A}$

$I_{bB} = 2.32\angle -34.92 + 120$

$= \boxed{2.32\angle 85.08°\ A}$

$I_{cC} = 2.32\angle -34.92 - 120$

$= \boxed{2.32\angle -154.92°\ A}$

(c) $V_{AN} = Z_{load} I_{aA} = (48+j32)(2.32\angle -34.93°)$

$= 133.81 - j2.90$

$= 133.84\angle -1.24°$

$V_{AN} = 133.84\angle -1.24°$ V

$V_{BN} = 133.84\angle 118.76$ V

$V_{cN} = 133.84\angle -121.24$ V

(d) $V_{AB} = (\sqrt{3}\angle -30°)V_{AN}$

$= (\sqrt{3}\angle -30°)(133.84\angle -1.24°)$

$= \boxed{231.82\angle -31.24°\ V}$

$V_{BC} = \boxed{231.82\angle 88.76\ V}$

$V_{CA} = \boxed{231.82\angle -151.24\ V}$

(e) $V_{an} = 140\angle 0 - Z_g \cdot I_{aA}$

$= 140\angle 0 - (0.3+j0.7)(2.32\angle -34.92)$

$= 138.5 - j0.933 \approx 138.5\angle -0.39°$

$V_{an} = 138.5\angle -0.39°$ V

$V_{bn} = 138.5\angle 119.61°$ V

$V_{cn} = 138.5\angle 120.39°$ V

(f) $V_{ab} = (\sqrt{3}\angle -30)V_{an}$

$= (\sqrt{3}\angle -30)(138.5\angle -0.39°)$

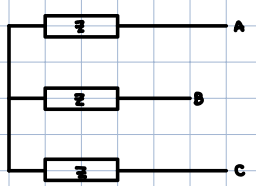
$= 239.89\angle -30.39°$

$V_{ab} = 239.89\angle -30.39°$ V

$V_{bc} = 239.89\angle 89.61°$ V

$V_{ca} = 239.89\angle -150.39°$ V

Q5



$V_{bn} = 350\angle -35°$ V

$V_{an} = 350\angle -35° + 120°$ V

$= 350\angle 85°$ V

$V_{ab} = (\sqrt{3}\angle 30°)V_{an}$

$= (\sqrt{3}\angle 30°)(350\angle 85°)$

$= 606.22\angle 115°$ V

$V_{ca} = 606.22\angle 115° - 120°$

$= 606.22\angle -5°$ V