NOTE: All angles are in degrees. All impedances are in Ohms. All frequencies are in $\frac{rad}{sec}$.

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1a. $Z = 12 + j50(0.1) = 12 + j5$. $I = \frac{V}{Z} = \frac{26\angle 0}{13\angle 22.6} = 2\angle -22.6$. $i(t) = 2\cos(50t - 22.6)$.
1b. $\frac{1}{2}|I|^2 Re[Z] = \frac{1}{2}2^2(12) = 24$. OR: $\frac{1}{2}Re[VI^*] = \frac{1}{2}Re[26(2\angle -22.6)] = 26\cos(22.6) = 24$.
1c. $Y = \frac{1}{Z} = \frac{1}{12+j5} = \frac{12-j5}{13^2}$. NEED:$-j5/13^2 + j50C = 0 \to C = 5/[(50)(13^2)] = 592\mu F$.

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2a. $V_{OC} = \frac{3/(j\omega C)}{j\omega L + \frac{1}{j\omega C}} = \frac{3}{1-\omega^2 LC}$. $Z = (j\omega L)||\frac{1}{j\omega C} = \frac{L/C}{j\omega L + \frac{1}{j\omega C}} = \frac{j\omega L}{1-\omega^2 LC}$. $I_{SC} = \frac{3}{j\omega L}$.
2b. $\omega = 0 \to (L \to \text{short}, C \to \text{open})$ or plug in (a). **Pure voltage source.**
2c. $\omega = \frac{1}{\sqrt{LC}} \to 1 - \omega^2 LC = 0 \to (V_{OC}\, \&\, Z \to \infty)$. **Pure current source.**

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3a. $V_O(t) = 6\frac{3}{0+3} + 9\sqrt{2}\frac{3}{|3+j3|}\cos(3t - \tan^{-1}(\frac{3}{3})) + 20\frac{3}{|3+j4|}\cos(4t - \tan^{-1}(\frac{4}{3}))$.

3a. Simplifies to $V_O(t) = 6 + 9\cos(3t - 45^o) + 12\cos(4t - 53^o)$.

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3b. **RC lowpass filter**$\to H(j\omega) = \frac{1/(j\omega C)}{R + \frac{1}{j\omega C}} = \frac{1/(RC)}{j\omega + \frac{1}{RC}}$. $\frac{1}{RC} = 3 \to C = \frac{1}{3}F$.

3c. DC:$\frac{1}{3} = \frac{A}{0+B}$. $B = 6 \to A = 2, C = \frac{\sqrt{2}}{6}$. $A = 2, B = 6, C = \frac{\sqrt{2}}{6}$.

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4ab. $Q = \frac{100}{103-97} = 16.7$. $\omega_o = 2\pi 10^6$. $Q = \frac{\omega_o L}{R} = \frac{2\pi 10^6 L}{20} = 16.7 \to L = \frac{(16.7)(20)}{2\pi 10^6} = 53\mu H$.
4c. $\omega_o = \frac{1}{\sqrt{LC}} \to C = \frac{1}{L\omega_o^2} = 1/[(53\cdot 10^{-6})(2\pi 10^6)^2] = 478pF$.

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4d. $\mathbf{f \to 0}$ :$|H(j2\pi f)| \simeq 2\pi f RC = 2\pi(20\Omega)478pF = 6\times 10^{-8}f \to f_1 = \frac{1}{60}MHz$
4d. $\mathbf{f \to \infty}$ :$|H(2\pi f)| \simeq \frac{R}{2\pi f L} = \frac{20\Omega}{53\mu H(2\pi f)} = \frac{6\times 10^4}{f} \to f_2 = 60MHz$. $1\,MHz = \sqrt{f_1 f_2}$.

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5a. **Zeros:** 0.3. **Poles:** 3;300. $H(j\omega) = C\frac{j\omega+0.3}{(j\omega+3)(j\omega+300)}$. $1 = C\frac{0.3}{3(300)} \to C = 3000$.
5b. $H(j\omega) = -\frac{Z_F}{Z_I} = -\frac{3000 + \frac{1}{j\omega\frac{1}{900}}}{303 + j\omega(1) + \frac{1}{j\omega\frac{1}{900}}} = -\frac{3000(j\omega+0.3)}{(j\omega)^2 + 303(j\omega) + 900}$. $H(j\omega) = \frac{3000(j\omega+0.3)}{(j\omega+3)(j\omega+300)}$.
NOTE: Answers to #5a and #5b agree (to a sign, which could easily be present).

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**SCORES:** 96[2],95[5],93,91[5],90[2],89[3],88,87,86[4],84,83,82,80[3],79,78[2],
**SCORES:** 77[2],75[2],73,71,70,68,64[2],63,61,60,58,55,51,45,40,38,34,30.
**MEDIAN:** 80. **GRADING COMMENTS BELOW**. Have a good summer!

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1. A few used $Z = 12 + j0.1$ (forgot $\omega = 50$); this was -2. Most got it (you better!).
1. A few used impedance instead of admittance in #1c; got bogged down in algebra.
2. Some wrote $V_{OC} = \frac{3\cos(\omega t)}{1-\omega^2 LC}$ and $Z = \frac{j\omega L}{1-\omega^2 LC}$. **Never** mix time and phasor domains! I didn't take off points for this (I probably should have). Few got #2c (oh well).
3. Most got these, of course, but almost 20% couldn't get it (that's pretty bad).
4. Several omitted $2\pi \to L = 333\mu H, C = 3nF$; 7/10 for this. Only 5 got #4c (oh well).
5. A few thought there was a pole or zero at $\omega = 30,000$ (certainly not on the plot).

80 80 80 79 78 78 77 77 75 75 73 71 70 68 64 64 63 61 60 58 55 51 45 40 38 34 30

96 96 95 95 95 95 95 93 91 91 91 91 91 90 90 89 89 89 88 87 86 86 86 86 84 83 82