

HW 4:

1a,

$$(4.2 + j6.8) + (7.6 + j0.2)$$

$$= (4.2 + 7.6) + j(6.8 + 0.2)$$

$$= 11.8 + j \cancel{13.0} 7.0$$

1b.

$$(4 \times 10^{-6} + j76) + (7.2 \times 10^{-7} - j5)$$

$$= (4 \times 10^{-6} + 7.2 \times 10^{-7}) + j(76 - 5)$$

$$= 4.72 \times 10^{-6} + j71$$

1c.

$$42 \angle 45^\circ + 62 \angle 60^\circ - 70 \angle 120^\circ$$

$$= 42(\cos 45^\circ + j \sin 45^\circ)$$

$$+ 62(\cos 60^\circ + j \sin 60^\circ)$$

$$- 70(\cos 120^\circ + j \sin 120^\circ)$$

$$= 42(\sqrt{2}/2 + j\sqrt{2}/2) + 62(1/2 + j\sqrt{3}/2)$$

$$- 70(-1/2 + j\sqrt{3}/2) = 95.69 + j22.7$$

1d)

$$(400 - j200)(-0.01 - j0.5)(-1 + j3)$$

$$\sqrt{400^2 + 200^2} = 447.2; \tan^{-1}\left(\frac{-200}{400}\right) = -26.57^\circ$$

$$\sqrt{0.01^2 + 0.5^2} = 0.5; \tan^{-1}\left(\frac{-0.5}{-0.01}\right) = 88.85^\circ$$

$$\sqrt{1^2 + 3^2} = \sqrt{10}; \tan^{-1}\left(\frac{3}{-1}\right) = -71.57^\circ$$

$$C_{\text{total}} = C_1 C_2 C_3 = 707.08$$

$$\phi_{\text{total}} = \phi_1 + \phi_2 + \phi_3 = -9.289 - 9.29$$

$$1e) \frac{-4.5 - j6}{0.1 - j0.8}$$

$$\sqrt{4.5^2 + 6^2} = 7.5 \quad \tan^{-1}\left(\frac{-6}{-4.5}\right) = 53.13^\circ$$

$$\sqrt{0.1^2 + 0.8^2} = 0.81 \quad \tan^{-1}\left(\frac{-0.8}{0.1}\right) = -82.87^\circ$$

$$\Rightarrow \frac{7 \angle 53.13}{0.81 \angle 82.87} = \frac{8.64}{\cancel{0.81}} \angle -29.74^\circ$$

$$\text{or } 8.64 \angle -44^\circ$$

$$1f) \frac{42 \angle 10^\circ}{7 \angle 60^\circ}$$

$$= 6 \angle -50^\circ$$

$$1g) \frac{8 \angle 60^\circ}{2(\cos 0 + j \sin 0)}$$

$$\frac{(2 \angle 0^\circ) + (100 + j400)}{8 \angle 60^\circ}$$

$$\frac{2 + j0 + (100 + j400)}{8 \angle 60^\circ}$$

$$= \frac{102 + j400}{8 \angle 60^\circ} = \frac{412.9 \angle 75.7^\circ}{8 \angle 60^\circ}$$

$$= 51.61 \times 10^{-3} \angle -15.69^\circ$$

$$1h) \frac{(6 \angle 20^\circ)(120 \angle -40^\circ)(3 + j8)}{2 \angle -30^\circ}$$

$$= \frac{(720 \angle -20^\circ)(8.54 \angle 69.44^\circ)}{2 \angle -30^\circ}$$

$$= \frac{6148.8 \angle 49.44^\circ}{2 \angle -30^\circ} = 3074.4 \angle 79.44^\circ$$

$$2d) I = 40A, \tau = 0.5ms$$

$$I_i = 10A$$

$$a) f = \frac{1}{T} = \frac{1}{0.5 \times 10^{-3}} = 2000 \text{ Hz}$$

$$2b) \omega = 2\pi f = \frac{2\pi}{T} = \frac{2\pi}{0.5 \times 10^{-3}}$$

$$= 4000\pi \text{ rad/s} \approx 12566 \text{ rad/s}$$

2c)

$$i(t) = I_m \cos(\omega t + \phi)$$

$$\Rightarrow i(t) = 40 \cos(4000\pi t + \phi)$$

initial current is 10 A

$$\Rightarrow 10 = 40 \cos(4000\pi t + \phi)$$

$$\Rightarrow 10 = 40 \cos \phi$$

$$\Rightarrow \phi = 75.52^\circ$$

$$\Rightarrow i(t) = 40 \cos(4000\pi t + 75.52^\circ)$$

$$2d) \cancel{V_{rms}} = V_{rms} = V_m / \sqrt{2}$$

$$= \frac{40}{\sqrt{2}} = 20\sqrt{2}$$

or 14.14 A

$$3) \cancel{Z_{in}} = Z_{in} = j1000(0.1) +$$

$$\left(j(0.4)1000 + \frac{1}{j1000(5 \times 10^{-6})} \right) //$$

$$\left(j(0.2)(10)^3 + \frac{1}{j \times 10^3 \times (1.25 \times 10^{-6})} \right)$$

$$\Rightarrow Z_{in} = j100 + (j400 - j200) //$$

$$(j200 - j800)$$

$$\Rightarrow Z_{in} = 400j$$

$$4a) \omega = 2000 \text{ rad/s}$$

$$V_s = 3\sqrt{2} \angle 45^\circ$$

a)

$$X_{0.6} = j1200$$

$$X_{0.3} = j600$$

$$X_{0.4} = j800$$

$$X_{5\mu F} = -j100$$

$$Z_{eq} = [(j100 + j600) //$$

$$(j600 - j100)] + (j1200 // j800)$$

$$= j980$$

$$V_L = \frac{j1200}{j980} \times 3\sqrt{2} \angle 45^\circ$$

$$= 1.22 \angle 0 \times 3\sqrt{2} \angle 45^\circ$$

$$= 5.18 \angle 45^\circ$$

$$= 3.66 + j3.66$$

b) both have same ϕ so none of them are leads or lags