CSU11021 Examination Chike Okafor

Q1. $P = VI$

But $V = IR$

So $I = \dfrac{V}{R}$

Thus $P = V\left(\dfrac{V}{R}\right)$

$$P = \frac{V^2}{R}$$

$V = 10V$

$R = 100 + 75 = 175\Omega$

$$P = \frac{(10)^2}{175} = \frac{100}{175} = \frac{4}{7}$$

$$= 0.571428571 4\ldots$$

$$\approx \boxed{0.572W}$$

Q2. $v(t) = V_{peak} \sin(\omega t + \varphi)$

$$= 10 \sin\left(2\pi(50)t + \frac{\pi}{3}\right)$$

$$= \boxed{10 \sin\left(100\pi t + \frac{\pi}{3}\right) V}$$

Q3 For a potential divider,

$$v_2(t) = v(t)\left(\frac{R_2}{R_1+R_2}\right)$$

So

$$v_2 = 10\left(\frac{200}{100+200}\right)$$

$$= 10\left(\frac{2}{3}\right)$$

$$= 6.\overline{666}\ V$$

$$\approx \boxed{6.67\ V}$$

Q4 $v(t) = L\ \dfrac{di(t)}{dt}$

$$i(t) = 10\sin(100\pi t)\cos\left(\frac{\pi}{4}\right) + 10\cos(100\pi t)\sin\left(\frac{\pi}{4}\right)$$
$$= 5\sqrt{2}\,(\sin 100\pi t + \cos 100\pi t)$$

$$\frac{di(t)}{dt} = 5\sqrt{2}\left(100\pi\cos(100\pi t) - 100\pi\sin(100\pi t)\right)$$

To write this expression in the form $R\cos(x-\alpha)$, I will compare the two expressions.

$$R\cos(x-\alpha) = R\cos\alpha\cos x + R\sin\alpha\sin x$$

$$100\pi\cos 100\pi t + (-100\pi)\sin 100\pi t$$
$$= R\cos\alpha\cos x + R\sin\alpha\sin x$$

So $100\pi = R\cos\alpha$
$-100\pi = R\sin\alpha$

$$(100\pi)^2 + (-100\pi)^2 = R^2\cos^2\alpha + R^2\sin^2\alpha$$
$$= R^2(\cos^2\alpha + \sin^2\alpha)$$
$$= R^2$$

So $R = \sqrt{(100\pi)^2 + (-100\pi)^2}$
$= 100\pi\sqrt{2}$

α can be found by:

$$\frac{R\sin\alpha}{R\cos\alpha} = \frac{100\pi}{-100\pi}$$

$$\tan\alpha = -1$$

So $\alpha = -\frac{\pi}{4}$

So:
$$V = (100\pi\sqrt{2})(5\sqrt{2})(10\times10^{-3})\cos\left(100\pi t - \frac{\pi}{4}\right) h$$

$R = 100\Omega$

$\frac{\pi}{4} \approx 0.78539... \approx 0.78$

So $\boxed{V = 1000\pi \cos(100\pi t - 0.78)V}$

Q5. $C = \frac{q}{V}$

So $q = CV$

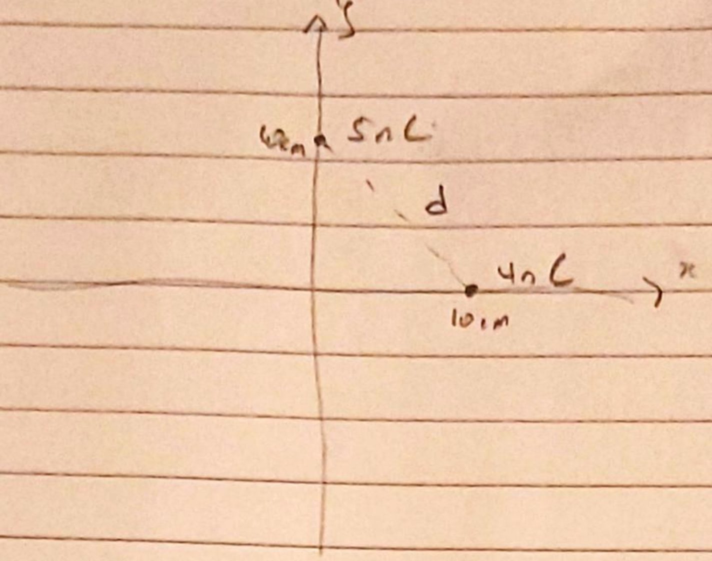
$C_1 = 8\times10^{-6} + 5\times10^{-6} = 1.3\times10^{-5}\ F$

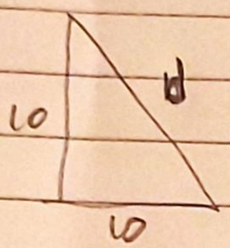
$$C_T = \frac{1}{\frac{1}{10\times10^{-6}} + \frac{1}{1.3\times10^{-5}}}$$

$C_T = 5.65\times10^{-6}$
$= 5.65\,\mu C$

$q = 20(5.65\,\mu C)$
$= 1.13\times10^{-4}\ C$
$= \boxed{113\,\mu C}$

Q6





$$d = 10\sqrt{2} \text{ cm} = \frac{\sqrt{2}}{10} \text{ m}$$

$$F = \frac{1}{4\pi\varepsilon} \frac{q_1 q_2}{d^2}, \quad \varepsilon = 8.854 \times 10^{-12}$$

$$F = \frac{1}{4\pi(8.854 \times 10^{-12})} \frac{(4 \times 10^{-9})(5 \times 10^{-9})}{\left(\frac{\sqrt{2}}{10}\right)^2}$$

$$= 8.987742438\ldots \ \mu N$$

As both charges are positive, they repel each other.

So $8.98(\vec{x} - \vec{y})\ \mu N$

Q7. $F_1 = \frac{1}{4\pi(8.854\times10^{-12})}\frac{(10\times10^{-12})}{(0.1)^2} = 8.9877\ldots N$

$F_2 = \frac{1}{4\pi(8.854\times10^{-12})}\frac{(5\times10^{-12})}{(0.1)^2} = 4.49387\ldots N$

$F_1 + F_2 = 13.48161366\ldots$
$\approx \boxed{13.48\ N}$

Q8. $50\ km/hr = \frac{50(1000)}{3600} = 13.889\ ms^{-1}$

$E = \frac{d\varphi_m}{dt}$
$= (40\times10^{-6})(2)(13.889)$
$= \frac{1}{900}$
$\approx \boxed{1111.11\ \mu V}$