... C.E1. (2)

2. Change the input phase by $\frac{\pi}{3}$ and calculate the output

This circuit, made of only resistors, capacitors and inductors, can be seen as an LTI system. A phase shift of $\frac{\pi}{3}$ in the input means:

$$v_g' = 5\cos\left(10^5 t + \frac{\pi}{3}\right) = Re\left(5e^{j(10^5 t + \frac{\pi}{3})}\right) = Re\left(5e^{j10^5 t} \cdot e^{j\frac{\pi}{3}}\right) = Re\left(e^{j\frac{\pi}{3}} V_g\right)$$

This being an LTI, if we multiply the input phasor by a constant $\alpha = e^{j\frac{\pi}{3}}$, the homogeneity property states that the output will be equal to the previous output, scaled by the ~~same~~ same factor. =>

$$V_o' = e^{j\frac{\pi}{3}} V_o \Rightarrow v_o' = 3.616 \cdot \cos\left(10^5 t - 0.7086 + \frac{\pi}{3}\right) = \boxed{3.616 \cdot \cos\left(10^5 t + 0.3386\right)}$$

3. Delay the input signal by T=3 sec and calculate the output.

$$v_g'' = 5\cos\left(10^5(t-3)\right) = Re\left(5e^{j10^5 t} \cdot e^{-j3\cdot 10^5}\right) = Re\left(e^{-j3\cdot10^5} V_g\right)$$

Again, taking advantage of homogeneity:

$$V_o'' = e^{-j3\cdot10^5} V_o \Rightarrow v_o'' = 3.616 \cdot \cos\left(10^5(t-3) - 0.7086\right) = \boxed{3.616 \cdot \cos\left(10^5 t - 3\cdot 10^5 - 0.7086\right)}$$

4. Change the input to $v_g(t) = 2\cos(10\pi t - \pi/3) - 4\sin(2\pi t + 1.2)$ and calculate the output.

Again, this becomes solvable when you use linearity:

$$v_g(t) = v_{g1}(t) + v_{g2}(t) \longrightarrow v_o(t) = v_{o1}(t) + v_{o2}(t), \text{ where } v_{g1}(t) \rightarrow v_{o1}(t), \quad v_{g2}(t) \rightarrow v_{o2}(t).$$

~~I have written all of the~~ I have spent too much time writing the Python code to solve this, since the numbers are quite... complex.

$$\boxed{v_o(t) = 8\cdot 10^8 \cdot Re\left(\frac{-e^{j(2\pi t - \pi + 1.2)}}{3600\pi + 0.016j\pi^2 + 2.5\cdot 10^8 j} + \frac{1}{10}\cdot\frac{e^{j(10\pi t - \frac{5\pi}{6})}}{3600\pi + 0.08j\pi^2 + 5\cdot 10^7 j}\right)}$$