ECS 332: In-Class Exercise # 9 - Sol

Instructions

1. Separate into groups of no more than three students each.
   The group cannot be the same as any of your former groups.
2. Explanation is not required for this exercise [ENRE]
3. **Do not panic.**

Date: 1 9 / 0 9 / 2019			
Name	ID (last 3 digits)		
Prapun	5	5	5

1. For each of the following signal $g(t)$, find its (normalized) average power $P_g \equiv \left\langle \left|g(t)\right|^2 \right\rangle$.

   <u>Do not use any approximation.</u>

	$g(t)$	$P_g = \langle \lvert g(t) \rvert^2 \rangle$
Linear combination of complex exponential functions [4.23]	$\sum_k c_k e^{j2\pi f_k t}$ where the f_k are distinct	$\sum_k \lvert c_k \rvert^2$
Linear combination of sinusoids [4.28]	$\sum_k A_k \cos(2\pi f_k t + \phi_k)$ where the f_k are positive and distinct	$\frac{1}{2}\sum_k \lvert A_k \rvert^2$

$g(t)$	
$g(t) = 10e^{j20\pi t}$	$P_g = 10^2 = 100.$
$g(t) = 10e^{j20\pi t} + 5e^{j40\pi t}$	First, we check that the freq. of the two terms are different which is the case here. Therefore, $P_g = 10^2 + 5^2 = 125.$
$g(t) = \left(10e^{j20\pi t} + 5e^{j40\pi t}\right)^2$	$g(t) = \left(10e^{j20\pi t}\right)^2 + 2\left(10e^{j20\pi t}\right)\left(5e^{j40\pi t}\right) + \left(5e^{j40\pi t}\right)^2 = 100e^{j40\pi t} + 100e^{j60\pi t} + 25e^{j80\pi t}.$ These terms have different freq. Therefore, $P_g = 100^2 + 100^2 + 25^2 = 20625.$
$g(t) = 4\cos\left(4t + 4^\circ\right)$	For sinusoidal signals, don't forget that we have an additional factor of $\frac{1}{2}$. $P_g = \frac{1}{2} \times 4^2 = 8.$
$g(t) = 5\cos\left(3t + 15^\circ\right) + 12\cos\left(4t + 105^\circ\right)$	First, we check that the freq. of the two terms are different and positive which is the case here. Therefore, $P_g = \frac{1}{2} \times 5^2 + \frac{1}{2} \times 12^2 = 84.5.$
$g(t) = 5\cos\left(3t + 15^\circ\right) + 12\cos\left(3t + 105^\circ\right)$	The freq. of the two terms are the same. Therefore, we must combine them first: $g(t) \Leftrightarrow 5\angle 15^\circ + 12\angle 105^\circ = 13\angle 82.38^\circ \Leftrightarrow 13\cos(3t + 82.38^\circ).$ Therefore, $P_g = \frac{1}{2} \times 13^2 = 84.5.$

Note that we don't need this angle.
We only need the magnitude for our power calculation. Knowing that the angle difference between the two terms is 90°, we can use Pythagoras' theorem: $\sqrt{5^2 + 12^2} = 13.$