

PH1140 B08 Written Homework Two - Superimposed Oscillations Due November 14, 2008

1. As you know, a displacement x may be obtained from the corresponding phasor z by taking the real part $x = \text{re}(z)$. Try doing the reverse. From the displacement $x = \sin(\omega t) + \cos(\omega t)$ obtain the corresponding phasor z .
2. Give the two parallel oscillations $y_1 = A \cos(35\pi t)$ and $y_2 = A \cos(42\pi t)$, find the beat period of the combined motion $y = y_1 + y_2$ and graph $y(t)$ over one beat period.
3. Given the two perpendicular oscillations $x = 8 \cos(15\pi t)$ and $y = 8 \cos(30\pi t + \pi/3)$, graph the Lissajous figure of the combined motion $\vec{r} = x\hat{i} + y\hat{j}$.

Suggestion for 2 and 3: use the [Phasor Applet](#) and [Lissajous Applet](#) to assist you.

4. Josephine and Jeremiah Sundial attempt to improve their punctuality by hanging two purportedly identical clocks in their kitchen and study. They synchronize and start the clocks. Unbeknownst to them, only one of the clocks gives the correct time. The other clock is slower and loses three seconds per day.

- a) What are the periods and frequencies of the clocks?
- b) How many days must elapse before the clocks once again give the same time?

5. Using the two clocks as mechanical timers, Josephine and Jeremiah construct two mobiles that oscillate to and fro with linear amplitudes A and B . They hang the first mobile from the ceiling, and hang the second mobile from the first. A golden butterfly mounted on the second mobile experiences the combined parallel motions of the two mobiles. The first mobile is driven by the first clock, while the second mobile is driven by the second clock.

- a) What are the beat period and beat frequency of the butterfly's motion?
- b) What are the combo period and combo frequency of the butterfly's motion?
- c) Describe the butterfly's motion using i) phasors and ii) sinusoids.