Physics 22 Problem Set 5

Harry Nelson

Due Wednesday, May 9 in class

Midterm on Monday May 7. Bring a bluebook, calculator, one page of notes. On material through Chapter 9.

This week we study complex numbers and we commence more in-depth study of the simple harmonic oscillator. Read sections 10.1 and 10.2, which is pp. 410-421.

The instructor is Harry Nelson, the TA is Joel Varley. A web page for the course is set up at http://hep.ucsb.edu/courses/ph22.

We meet MWF 1:00-1:50pm in 1640 Broida. There are **two sections**, attendance at **both** is mandatory. Joel Varley's section will take place Friday 11:00-11:50pm in 1802 Psychology, and Harry Nelson's will take place Friday 2:00-2:50pm in 2129 Girvetz. Harry Nelson's office hours will follow section until 5:00pm on Friday, either in 2129 Girvetz (if possible) or in the PSC. Joel Varley's office hours will will take place in the Physics Study Room (1019 Broida) on Tuesday from 9:00am to 10:00am, Thursday from 9:00am to 10:00am, and Friday noon-1:00pm.

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

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1. Simplify the following complex expressions to the form $x + \imath y$, and get numerical results for x and y:
   (a) $\frac{29}{20+21\imath}$
   (b) $\frac{1}{1+\imath}$
   (c) $\frac{5}{-3+5\imath}$
   (d) $\sqrt{i}$

2. Express the following complex numbers in polar form $re^{\imath\theta}$, and get numerical results for r and θ:
   (a) $\imath$
   (b) $-\imath$
   (c) -1
   (d) $-\sqrt{3} + \imath$

3. Find the complex numbers that are solutions to the equation:
   $$z^2 - 8z + 25 = 0$$
   and express the solutions in both cartesian and polar form.

4. Consider the complex numbers $z_1 = 3 + 4\imath$ and $z_2 = 1 - \imath$. Find, numerically, r_1, r_2, θ_1, and θ_2 for the polar descriptions of $z_1 = r_1 e^{\imath\theta_1}$ and $z_2 = r_2 e^{\imath\theta_2}$. Then multiply z_1 and z_2 together using their cartesian representations (the ones given first for them), express their cartesian product in polar form, and check that the results agree with $r_1 r_2 e^{\imath(\theta_1+\theta_2)}$.

5. Find the numerical values $|\alpha|$ and ϕ_α such that

$$\begin{aligned} x(t) &= -5\sin\omega t + 12\cos\omega t && (1) \\ &= \mathrm{Re}(|\alpha| e^{\imath(\omega t+\phi_\alpha)}) && (2) \end{aligned}$$
