

PH421: Paradigms in Physics – Oscillations

FOURIER ANALYSIS – PROJECTIONS OF HARMONIC FUNCTIONS

Suggested time: 10 minutes

Work in groups at the whiteboards and remember to assign roles of taskmaster, cynic and recorder. No calculators or computers for this exercise, please! The reason is that you must be able to quickly recognize the positions of the zeroes and maxima/minima of the basic harmonic functions, gain insight into symmetry, and practice some algebra skills.

1. Draw graphs of the following functions and establish **graphically** whether the integral of the given functions over the time interval  $T = 2\pi/\omega$  are zero or non-zero.

Even Groups: (i)  $\sin(\omega t)$  (ii)  $\sin(\omega t)\sin(2\omega t)$  (iii)  $\sin^2(\omega t)$

Odd Groups: (i)  $\cos(\omega t)$  (ii)  $\cos^2(2\omega t)$  (iii)  $\cos(\omega t)\sin(3\omega t)$

2. Calculate the same integrals **analytically**, thus convincing yourselves that any zero answers above are correct, and finding values for the non-zero integrals:

Here's a *huge* time saver for the analytical part and another helpful use of complex

numbers: try writing  $\cos(n\omega t) = \frac{e^{in\omega t} + e^{-in\omega t}}{2}$  and  $\sin(n\omega t) = \frac{e^{in\omega t} - e^{-in\omega t}}{2i}$ . Remember these from Homework #1?