Phys.214 Final Exam (two hours)

1- Consider three wave sources S_1, S_2, and S_3. The source S_1 emits a wave of frequency 262 Hz, while S_2 emits a wave of frequency 266 Hz. When the wave emitted by the source S_3 interferes with that emitted by S_1, a beat frequency of 1 Hz is produced. When the wave emitted by the source S_3 interferes with that emitted by S_2, a beat frequency of 3Hz is produced. What is the frequency of the wave emitted by the source S_3? (10 pts)

2- Two vibrations at right angles to one another are described by the equations

$x = 10\cos(5\pi t)$ and $y = 10cos(10\pi t + \pi/3)$.

Construct the Lissajous figure of the combined motion. Note that the Lissajous figure is a graph describing the superposition of the motions. (15 pts)

3- Demonstrate that $x = Ae^{-\alpha t}cos(\omega t)$ is a possible solution of the equation of a damped harmonic oscillator, which is given by

$d^2x/dt^2 + \gamma\, dx/dt + \omega_0^2 x = 0$

and find α and ω in terms of γ and ω_0. (20 pts)

4- Describe the TRANSIENT behavior of a damped oscillator when the periodic driving force is off resonance and when the periodic driving force is at exact resonance. (20 pts)

5- Derive the frequencies of the transverse and longitudinal normal modes of N coupled oscillators, and provide the total number of normal modes (transverse + longitudinal) in the system. (20 pts)

6- Two stretched strings, each of length 1.2 m, support standing waves. On the first string (string I), there is a second harmonic standing wave of frequency 660 Hz. However, the same frequency of 660Hz is the third harmonic on the second string (string II). Find the speed at which individual waves travel on each string. (15 pts)

7- A tube open at one end is cut into two tubes (of nonequal lengths). the piece that is open at both ends has a fundamental frequency of 475 Hz, while the piece that is open at one end only has a fundamental frequency of 675 Hz. What is the fundamental frequency of the original tube? (15 pts)