Physics for Computing Science
Unit 1 (Oscillation and fundamental of wave optics)
Tutorial 1

Q1) What do you understand by periodic and simple harmonic motion? What is the criterion for the motion to be simple harmonic?

Q2) Write the differential equation for the SHM and formulae for the angular frequency and time period?

Q3) Show that for a simple harmonic oscillator, mechanical energy remains constant and it is proportional to the square of amplitude.

Q4) How is the period of SHM changed when?

(a) The mass of the particle is increased without changing the elastic constant?

(b) When the elastic constant is increased without changing the mass?

(c) When the mass and the elastic constant are changed by the same ratio?

Q5) Explain what is meant by natural frequency? Given the expression for the natural frequency of a simple pendulum.

Q6) A damped oscillator is subjected to a damping force proportional to its velocity. Set up the differential equation of the oscillation. Discuss the under-damped, over damped and critical damped motions of the oscillator.

Q7) Why are the forced oscillations of a damped oscillator not damped?

Q8) A particle executes SHM with a period of 0.002 s and amplitude 10 cm. Find its acceleration when it is 4 am away from its mean position and also obtain its maximum velocity.

Q9) A spring is hung with an object and vibrated. For the vibration frequency to double the original vibration frequency, then the mass of the object is changed to…

a) twice the mass of the original load

b) four times the mass of the original load

c) half the load mass time

d) a quarter of the original load mass

Q10) A particle oscillates with simple harmonic motion along the x axis. Its position varies with time according to the equation

X = (4.00 m) cos ($\pi t + \frac{\pi}{4}$) ; Where t is in seconds.

a) Determine the amplitude, frequency and period of the motion.

b) Calculate the velocity and acceleration of the particle at any time t.

c) What are the position and the velocity of the particle at time t = 0.

Q11) A block with a mass of 200 g is connected to a light horizontal spring of force constant 5.00 N/m and is free to oscillate on a horizontal, frictionless surface.

a) If the block is displaced 5.00 cm from equilibrium and released from rest. Find the period of its motion.

b) Determine the maximum speed and maximum acceleration of the block.
c) Express the position, velocity and acceleration of this object as function of time, assuming that $\phi = 0$

Q12) At $t = 0$, the displacement $x(0)$ of the block in a linear oscillator is -8.50 cm [Read as x at time zero]. The block's velocity $v(0)$ then is -0.920 m/s and its acceleration a(0) is +47.0 m/s^2.

a) What is the angular frequency ω of this system.

b) What are the phase constant ϕ and amplitude x_m?

Q13) A block whose mass m is 680 g is fastened to a spring whose spring constant k is 65 N/m. The block is pulled a distance x = 11 cm from its equilibrium position at x = 0 on a frictionless surface and released from rest at t = 0.

(a) What are the angular frequency, the frequency and the period of the resulting motion?

(b) What is the amplitude of the oscillation?

(c) What is the maximum speed of the oscillating block?

(d) What is the magnitude a_m of the maximum acceleration of the block?

(e) What is the phase constant ϕ for the motion?

(f) What is the displacement function x(t) for the spring-block system?

Q14) For the damped oscillator m = 250 g, k = 85 N/m and b = 70 g/s

a) What is the period of the motion?

b) How long does it take for the amplitude of the damped oscillations to drop to half its initial value?

c) How long does it take for the mechanical energy to drop to one-half its initial value?

Q15) An oscillating *LC* circuit consists of a 75.0 mH inductor and a 3.60 μF capacitor. If the maximum charge on the capacitor is 2.90 μC, what are (a) the total energy in the circuit and (b) the maximum current?

Q16) A 1.5 μF capacitor is charged to 57 V by a battery, which is then removed. At time $t = 0$, a 12 mH coil is connected in series with the capacitor to form an *LC* oscillator. (a) What is the potential difference $v_L(t)$ across the inductor as a function of time?

Q17) A series *RLC* circuit has inductance $L = 12$ mH, capacitance $C = 1.6$ μF, and resistance $R = 1.5$ Ω and begins to oscillate at time $t = 0$.

(a) At what time t will the amplitude of the charge oscillations in the circuit be 50% of its initial value?

(b) How many oscillations are completed within this time?

Q18) An LCR series circuit with inductance 1mH, capacitance 100mF and resistance 1KΩ are connected to AC voltage source. Find the frequency of source for which current through the resistor is maximum.