Tutorial-2 (PHY201)

1. A simple pendulum has a length L=1m. In free vibration the amplitude of its swing falls off by a factor e in 50 swings. The pendulum is set into forced vibration by moving its point of suspension horizontally in SHM with an amplitude of 1mm.
   (a) Setup up the equation of motion if the horizontal displacement of the bob is x and the horizontal displacement of the support is X. Use small amplitude approximation.
   (b) Solve the equation for steady state if X= $X0\ cos(\omega t + \alpha)$
   (c) At exact resonance what it the amplitude of the motion of the pendulum bob?

2. The power input to maintain forced vibrations can be calculated by recognizing that this power is the mean rate of doing work against the resistive force -bv
   (a) Show that the instantaneous rate of doing work against this force is bv^2
   (b) Using x= $Acos(\omega t - \alpha)$ show that the mean rate of doing work is $0.5b(\omega A)$^2

3. According to classical electromagnetic theory an accelerated electron radiates energy at the rate Ke^2a^2/c^3 where $K=6x10^9$ $N\text{-}m^2/C^2$, e=electronic charge, , a = instantaneous acceleration, and c=speed of light.
   (a) If an electron were oscillating in a straight line with a frequency v Hz and amplitude A, how much energy would it radiate away in one cycle assuming it to follow SHM.
   (b) What is Q of this oscillator
   (c) How many periods of oscillations would elapse before the amplitude is down by half
   (d) Using a typically optical frequency in visible spectrum, estimate numerically the Q and the half life period of the radiating system.

4. A RLC circuit is made by connecting a capacitor C, a pure inductor L, and a resistor R in series. The circuit is driven by an AC voltage, $V(t) = V0cos(\omega t)$.
   (a) Setup the equation of motion of charge Q stored on the capacitor.
   (b) Use complex exponential method for obtaining steady state charge and phase lag.
   (c) What is the maximum power consumed by the circuit. Use: R = 1 kOhm, L=1 microH, V0 = 1 V and resonance frequency of 1GHz, to estimate a numerical value.