$A = \frac{f_0/m}{\omega_0^2 - \omega^2}$

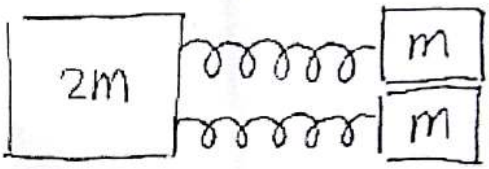
# Mid Sem Exam–1 (PHY201)

*Duration: 1Hr, Maximum Marks:20*

**Q-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.

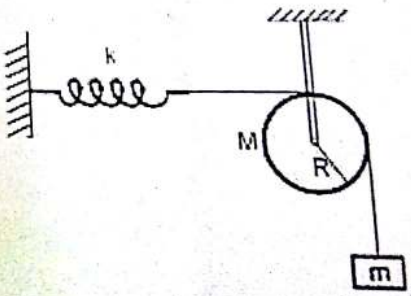
(a) Setup up the equation of motion if the horizontal displacement of the bob is x and the horizontal displacement of the support is X. Use appropriate approximation.
(b) Solve the equation for steady state if $X = X0\ cos(\omega t + \alpha)$
(c) At exact resonance what it the amplitude of the motion of the pendulum bob? (2+2+1)

**Q-2:** Three independent objects with masses as labelled in the image are connected by two identical springs as shown in figure. The spring constant of both the springs is k.




(a) Setup the three coupled equations of motion.
(b) State the normal mode conditions and solve the above equations for normal mode frequencies.
(c) Make a sketch of oscillating masses in different normal modes. (3+2+2)

**Q-3:** A mass m is attached to a massless spring of spring constant k via a friction-less pulley of radius R and mass M (see Figure). Determine the frequency of small vertical oscillations assuming the pulley to rotate. Take the moment of inertia of pulley to be $\frac{1}{2}MR^2$.




(3)

**Q-4:** According to classical electromagnetic theory an accelerated electron of mass $m_e$ radiates energy at the rate $P(t) = C\,a^2(t)$ where C is a constant and $a(t)$ denotes instantaneous acceleration of the electron. Consider the electron to behave as a damped harmonic oscillator ($\gamma << 1$) oscillating at a frequency v. What is the quality factor Q of this oscillator? Estimate its numerical value for $v = 10^{14}$ Hz.

[Use $C = 0.5 \times 10^{-3}$ J.s$^3$m$^{-2}$, $m_e = 9 \times 10^{-31}$ Kg]

(3+2)