Tutorial 7

Remote Mid-semester Examination paper

1. Answer the following questions briefly

   (a) Consider the force F = $2xy^3$ **i** $+3x^2 y^2$ **j**. Is it conservative? How?

   (b) In the case of elastic collisions to study change in particle's velocity, one has to observe focus only scattering angle in the center of mass frame of reference. Is statement correct? Justify your response.

   (c) Compare the work done by the frictional force w.r.t. the work done by the spring force on a body using Stoke's theorem.

   (d) For a door closure, which kind of damping will be more appropriate: lightly damped, critically damped or heavily damped. Justify your response.

   (e) Under what circumstances Newton's Laws of motion fails? Can you think of reasons for that?

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2. In figure (a), a simple pendulum consists of a bob of mass m_1 suspended from a pivot by a string of negligible mass. The bob is pulled out and released from a height h_0 as measured from the bob's lowest point directly under the pivot point and then swings downward in a circular orbit.

   At the bottom of the swing, the bob collides with a block of mass m_2 that is initially at rest on a frictionless table. Assume that there is no friction at the pivot point.

   a) Assume that the kinetic energy of the bob before the collision is equal to the kinetic energy of the bob and the block after the collision (the collision is elastic). Also assume that the bob and the block move in opposite directions but with the same speed after the collision (Figure b). What is the mass m_2 of the block?

   b) Suppose the bob and block stick together after the collision due to some putty that is placed on the block. What is the speed of the combined system immediately after the collision? (Assume now that m_2 is the combined mass of the block and putty.) Further, what is the change in kinetic energy of the block and bob due to the collision?

   c) After the collision, the bob and block move together in circular motion. What is the height h_f above the low point of the bob's swing when they both first come to rest after the collision (Figure c)? Ignore any air resistance.

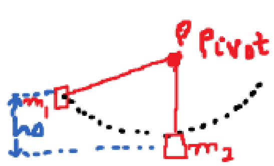

Fig (a)

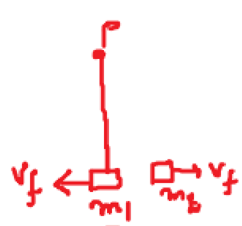

Fig (b)

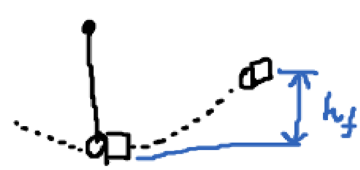

Fig (c)

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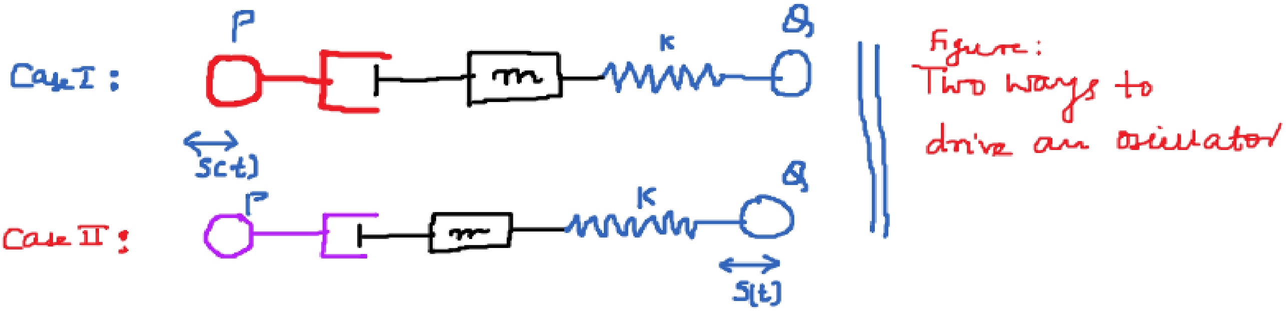
3. Below given figure shows a simple oscillator with damping. In this, a mass *m* is attached to a spring (spring constant *k)* and a damper with damping force proportional to $-bv$. The spring and the damper are attached to the walls on the opposite sides of the mass (see Figure). The oscillator can be driven either by moving an attachment point on the damper (Case I) or the end of the spring (Case II). In both cases, the position of the attachment point as a function of time is $s(t) = s_0 \cos(\omega_d t)$.

   For BOTH of the above cases, answer each of the following questions. (i). Write the equations of motion of the mass *m*. (ii). Find the amplitude of steady state solution in terms of given parameters.



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