



4-4-2016

**DOON UNIVERSITY, DEHRADUN**  
**Mid Semester Examination, Second Semester, 2015-16**  
**Department of Physics, School of Physical Sciences**  
**M.Sc. Physics Integrated 5 Years programme**  
**Course: PHC-152: Waves and Optics**

*Time Allowed: 2Hours*

*Maximum Marks: 30*

*Note: Attempt All Questions from Sections A,B,C.*

**SECTION: A**

**Attempt All Questions.**

*(Marks: 1 X 6 = 6)*

1. Write down the angular frequency of an oscillating mass  $m$  attached with two springs of spring constants  $k$  (as shown in the figure).



2. Draw the figure of an ideal transmission line showing its inductance and conductance part along with the voltage and current distribution.
3. In a spherical pendulum, draw the projection of the trajectory of the bob in the horizontal plane for a given phase difference of (i) zero, (ii)  $\pi$  and (iii)  $\pi/2$  in the mutually perpendicular axes on the horizontal plane. The bob is hanging with a string of length  $L$ .
4. What is slinky approximation? Write down the transverse angular frequencies for the given springs and mass as shown in the above figure in question 1.
5. Draw the Lissajous figures for the two normally superimposed oscillations with the same angular frequency but different phase difference of  $\pi/4$  and  $\pi/2$ , respectively.
6. Write down the formula for the impedance of a continuous string with the mass per length as  $m$  and the initial string tension as  $T$ .

**SECTION: B**

**Attempt All Questions.**

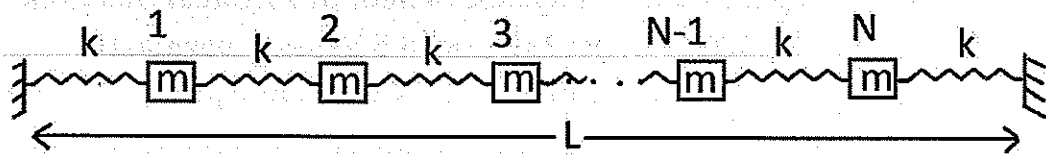
*(Marks: 3 X 4 = 12)*

7. What do you mean by small oscillations or simple harmonic motion? Show its significance by applying upon a pendulum oscillating in a vertical plane under the effect of gravity. Point out the approximation in the derivation to be used for such motion to be called "small oscillation".
8. A wooden cube with the mass density  $\rho_1$  and side length  $L$  is floating in a liquid with the mass density  $\rho_2$ . Find out the time period of its movement in vertical direction. Assume the two faces of the cube to be horizontal and the gravitational acceleration to be  $g$ .
9. Two waves of frequencies  $30/\pi$  and  $60/\pi$  Hz are superimposed collinearly. What will be the values of  $\omega_{\text{mod}}$  and  $\omega_{\text{av}}$  for their linear superposition. Show the terms for the average and the modulated waves. Draw the pictorial diagrams of displacement  $v/s$  time if the amplitude of the first oscillation is equal to the second one.
10. Derive the expression for the pressure wave propagation in a steel rod with the mass density  $\rho$  and Young's modulus  $Y$ . Hence, calculate the wave velocity in steel having Young's modulus  $0.25 \times 10^{10} \text{ Nm}^{-2}$  and mass density  $8100 \text{ kg m}^{-3}$ .

**SECTION: C Attempt All Questions.**

*(Marks: 6X 2=12)*

11. (a) Derive the terms for the normal modes for transverse direction of  $N$  masses attached with the  $N+1$  springs with the edges clamped at the end. Hence, deduce the term for a continuous string with equivalent mass per unit length by considering the spring length to be negligible in comparison to the total length.



- (a) Derive the terms for averaged total energy averaged over a wavelength and averaged over a time period in a continuous string.
12. (a) Derive the wave equation of Electromagnetic waves in propagating a medium in one direction. From the expression show the value of velocity of light in the space. Also, derive the terms related to the power transmission per unit time normal to the per unit area.
- (b) Derive the velocity of sound formula using the Newton's approximation and then using the Laplace correction in it.



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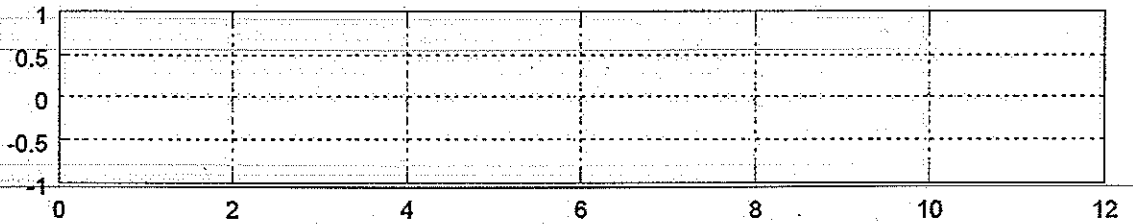
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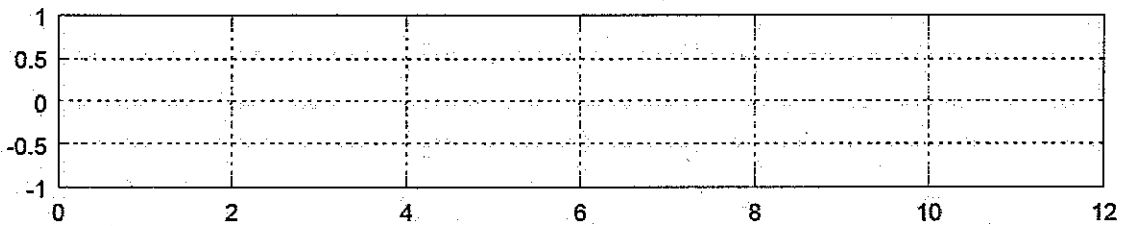
**Roll No. : .....**

**Answer 9:**

$\sin(30^\circ\omega/\pi)$



$\sin(40^\circ\omega/\pi)$



$\sin(30^\circ\omega/\pi) + \sin(40^\circ\omega/\pi)$

