NATIONAL INSTITUTE OF TECHNOLOGY SILCHAR
ENGINEERING MECHANICS (ME 1101)
Second Semester (All Branch)
ASSIGNMENT – 18

1. A $10\,kg$ block is suspended by a helical spring having a constant $k = 10\,N/cm$. Neglecting the mass of the spring, find the period T for small amplitude of vertical vibration. $Ans.\, T = 0.628\,sec$

2. If $10\,N$ tension produces an elongation of $1\,cm$ in a given spring, find the frequency of vibration of a $1\,N$ weight suspended from the end of the spring. $Ans.\, f = 15.92\,Hz$

3. A $16\,N$ weight produces a static elongation of $1.2\,cm$ in a given spring. Determine the period of vibration of a weight $W = 20\,N$ suspended by the same spring. $Ans.\, T = 0.24\,sec$

4. A $5\,N$ weight suspended vertically by a spring vibrates with an amplitude of $8\,cm$ and a frequency of $60\,oscillations/minute$. Find (a) the spring constant k, (b) the maximum tension induced in the spring and (c) the maximum velocity of the weight. $Ans.\, k = 19.8\,\frac{N}{m},\ T_{max} = 5.4\,N,\ \dot{x}_{max} = 0.5\,m/sec$

5. The body of a freight car weighs $25000\,N$ when empty and is observed to settle $7.6\,cm$ during the loading of $30000\,N$ of cargo. What period of vertical vibration will the car have on its springs: (a) when loaded; (b) when empty? $Ans.\, T_1 = 0.74\,sec, T_2 = 0.5\,sec$

6. The two springs shown in Fig. A each have a spring constant $k = 1.25\,N/cm$ and the attached ball has the weight $2\,N$. If the ball is initially displaced $3\,cm$ to the right, find the period of oscillation of the ball and the velocity with which it passes through its middle position. Neglect friction. $Ans.\, T = 0.178\,sec,\ \dot{x}_{max} = 106\,cm/sec$

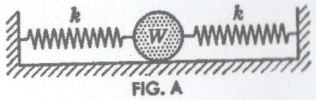

FIG. A

7. How will the results of Prob. 6 be changed if there is an initial $4\,N$ tension in each spring? $Ans.$ *No change in* T *and* $\dot{x}_{max}$

[Turn over]

8. A small pan suspended from a helical spring as shown in Fig. B when empty has an observed period of vibration T_0. When carrying a known weight P, the observed period of vibration is T_1 and when carrying an unknown weight W (without P), the observed period is T_2. Find the magnitude of the weight W. $Ans.\ W = \frac{P(T_2^2 - T_0^2)}{T_1^2 - T_0^2}$


FIG. B

9. If in the case of the arrangement shown in Fig. B the observed period of vibration with a known weight P on the pan is T_1 and the observed period of vibration with a known weight Q on the pan is T_2, find the spring constant k. $Ans.\ k = \frac{4\pi^2(P-Q)}{g(T_1^2 - T_2^2)}$

10. A prismatic bar AB of weight W is placed horizontally on the top edges of two identical discs which rotate with equal angular speeds in opposite directions as shown in the Fig. C. Show that if the centre of gravity C of the bar is displaced from the middle plane Om and then the bar is released, it will perform simple harmonic motion, the period of which depends on the distance a and the coefficient of kinetic friction μ between the bar and the discs. If the observed frequency of vibrations is $40\,\frac{oscillations}{minute}$, find the coefficient of kinetic friction, μ. The distance $a = 25\,cm$. $Ans.\ \mu = 0.43$

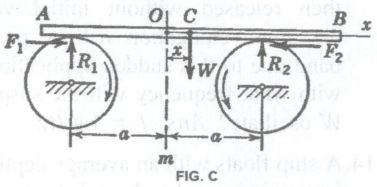

FIG. C

11. To keep the bar in Prob. 10 from falling to one side, the rims of the disc are grooved as shown in Fig. D. How will the period of oscillation of the bar be affected by such grooves? $Ans.\ T = 2\pi\sqrt{\frac{a\,\sin\alpha}{\mu g}}$

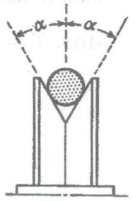

FIG. D

12. A solid right circular cylinder of weight $W = 5\ N$ and cross-sectional area $A = 116\ cm^2$ is suspended by a spring of constant $k = 0.2\ N/cm$ and hangs partially submerged in water ($\rho = 1000\ kg/m^3$) as shown in Fig. E. Calculate the period T for small vertical oscillations. Neglect inertia of the water. *Ans.* $T = 0.38\ sec$

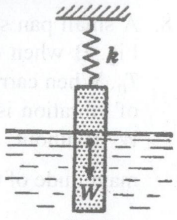

FIG. E

13. A weight W when attached to the end of a rubber band produces in it a static elongation $\delta_{st} = 12.7\ cm$ as shown in Fig. F. If the weight is raised until the tension in the band is zero and then released without initial velocity, what maximum elongation will be produced in the band due to this sudden application of load and with what frequency will the suspended weight W oscillate? *Ans.* $f = 1.4\ Hz$

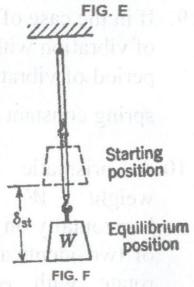

FIG. F

14. A ship floats with an average depth of immersion equal to h, and the area of the water line section is A as shown in Fig. G. Neglecting friction and the inertia of any water that may be set in motion, prove that, if the ship is displaced downward slightly from its floating position and then released, it will oscillate up and down with a simple harmonic motion. Find also the period T of this oscillation. *Ans.* $T = 2\pi\sqrt{\frac{h}{g}}$

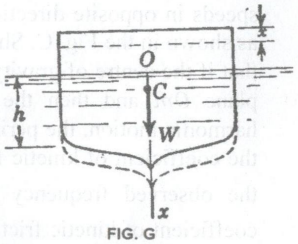

FIG. G

15. A small ball of weight W is attached to the middle of a tightly stretched perfectly flexible wire AB of length $2l$ as shown in the Fig. H. Prove that for small lateral displacements and high initial tension in the wire the ball will have a simple harmonic motion, and calculate the period. *Ans.* $T = 2\pi\sqrt{\frac{Wl}{2Sg}}$

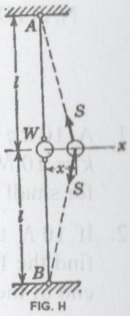

FIG. H

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