NATIONAL INSTITUTE OF TECHNOLOGY SILCHAR
ENGINEERING MECHANICS (ME 1101)
Second Semester (All Branch)
ASSIGNMENT – 15

1. An elevator of gross weight W = 1000 *N* starts to move upwards with constant acceleration and acquires a velocity *v* = 6 *m/sec*, after travelling a distance *s* = 6 *m*. Find the tensile force *S* in the cable during this accelerated motion. Neglect friction. *Ans.* 1306 *N*

2. The elevator of prob. 1, when stopping, moves with constant deceleration and from the constant velocity *v* = 6 *m/sec* comes to rest in 2 *sec*. Determine the force *R* transmitted during stopping to the floor of the elevator by the feet of a man weighing 60 *kg*. *Ans. 408 N*

3. A train weighing 200 *tons* without the locomotive starts to move with constant acceleration along a straight horizontal track and in the first 60 *sec* acquires a velocity of 72 *kph*. Determine the tension *S* in the draw-bar between the locomotive and train if the total resistance to motion due to friction and air resistance is constant and equal to 0.005 times the weight of the train. *Ans. 76470 N*

4. The driver of an automobile, travelling along a straight level highway, suddenly applies the brakes so that the car slides for 2 *sec*, covering a distance of 10 *m* before coming to stop. Assuming that during this time the car moved with constant deceleration; find the coefficient of friction between the tires and the pavement. *Ans.* μ = 0.5

5. A mine cage of weight W = 1000 *kg* starts from rest and moves downward with constant acceleration, travelling a distance *s* = 30 *m* in 10 *sec*. Find the tensile force in the cable during this time. *Ans. 9200 N*

[Turn over]

6. A particle of weight *W* dropped vertically into a medium that offers a resistance proportional to the square of velocity of the particle. The buoyancy of the medium is negligible, and the resisting force is *f* when the velocity is 1 *m/sec*. What uniform velocity will the particle finally attain? *Ans.* $v = \sqrt{\frac{W}{f}}$

7. A weight *W* = 50 *kg* is supported in a vertical plane by a string and pulleys arranged as shown in *Fig. A*. If the free end *A* of the string is pulled vertically downward with constant acceleration *a* = 4 *m/sec*^{2}, find the tension *S* in the string. Neglect friction in the pulleys. *Ans. S* = 295 *N*

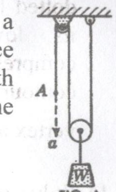

FIG. A

8. Weight *W* and 2*W* are supported in a vertical plane by a string and pulleys arranged as shown in *Fig. B*. Find the magnitude of an additional weight *Q* applied on the left which will give a downward acceleration *a* = 0.1g to the weight *W*. Neglect friction and inertia of pulleys. *Ans.* $Q = \frac{W}{6}$

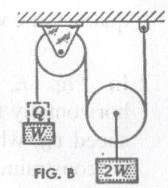

FIG. B

9. A weight *W* attached to the end of a small flexible rope of diameter *d* is raised vertically by winding the rope on a reel as shown in *Fig. C*. If the reel is turned uniformly at the rate of *n rps*, what will be the tension *S* in the rope? Neglect inertia of the rope and slight lateral motion of the suspended weight *W*. *Ans.* $T = W\left(1 + \frac{2\pi n^2 d}{g}\right)$

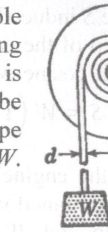

FIG. C

10. In *Fig. D,* a weight W is raised vertically by means of a cam which moves horizontally from right to left with constant speed v_0. Counting time t from the instant when the cam is in the position shown by dotted lines and the weight W is in its lowest position, find the compressive force S in the vertical rod CD as a function of time. The contour ACB of the cam face is a parabola with vertical axis and vertex at A. Neglect friction. *Ans.* $S = W\left(1+\frac{2hv_0^2}{l^2g}\right)$

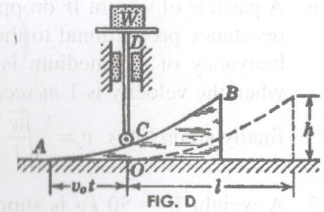

FIG. D

11. Solve prob. 10, if the contour ACB of the cam face in *Fig. D* is a quarter sine wave. *Ans.* $S = W\left(1+\frac{2h\pi^2 v_0^2}{4l^2g}\cos\frac{\pi v_0 t}{2l}\right)$

12. In *Fig. E,* the cam AB moves horizontally to the left with constant speed v_0, while the cam follower C is constrained to move vertically. Find the maximum compressive force S induced in rod CD during the sweep of the cam, if its face ACB is a half cosine wave. Neglect friction. *Ans.* $S = W\left(1+\frac{h\pi^2 v_0^2}{2l^2 g}\right)$

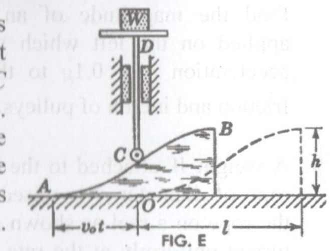

FIG. E

13. For the engine represented in *Fig. F,* the combined weight of the piston and piston rod W = 100 N, the crank radius r = 10 *cm*, and the uniform speed of rotation n = 120 *rpm*. Determine the magnitude of the resultant force acting on the piston: (a) When it is in an extreme position; (b) When in its middle position. *Ans.*

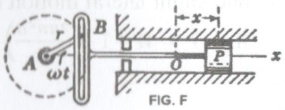

FIG. F

14. Two equal weights W and a single weight Q are attached to the ends of a flexible but inextensible cord overhanging a pulley as shown in *Fig. G*. If the system moves with constant acceleration a as indicated by the arrows, find the magnitude of the weight Q. Neglect air resistance and the inertia of the pulley. *Ans.* $Q = \frac{2Wa}{g-a}$

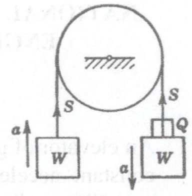

FIG. G

15. In *Fig. H,* a piston of weight W, constrained to move vertically, is raised and lowered by a cam ACB that moves horizontally with constant speed v_0. The face of the cam has the shape of a full cosine wave of length l and maximum height h as shown. Find the greatest speed v_0 that the cam may have without losing contact with the cam follower D, throughout the cycle. Neglect friction in the sleeve which guides the rise and fall of the piston. *Ans.* $v_0 \le \sqrt{\frac{gl^2}{2\pi^2 h}}$

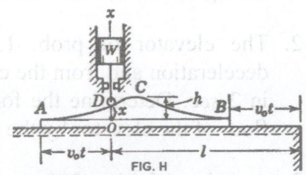

FIG. H

16. A balloon of gross weight W is falling vertically downward with constant acceleration a. What amount of ballast Q must be thrown out in order to give the balloon an equal upward acceleration a? Air resistance should be neglected. *Ans.* $Q = \frac{2Wa}{g+a}$

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