Dr. Babasaheb Ambedkar Technological University Lonere Raigad

Department of Civil Engineering

Question Bank

Subject – BTES203/ BTES203/__Engineering Mechanics

Module 1

1. Why there is a need to idealize a body as a particle, a rigid body, a deformable body or continuum. Explain in detail.
2. What is the advantage of drawing a free body diagram? Is it possible to draw a free body diagram of a body or system undergoing acceleration? Give examples.
3. State the Newton's second law of motion and show that the first & third laws are contained in it?
4. Use Newton's law of universal gravitation to calculate the weight of a 70-kg person standing on the surface of the earth as shown in figure 4.1 Then repeat the calculation by using W = mg and compare your two results.
5. The uniform steel and titanium spheres are positioned as shown in figure 4.2 Determine the magnitude of the small gravitational force of mutual attraction if r = 50 mm.

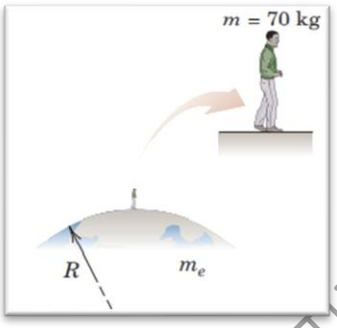

Fig. No. 4.1

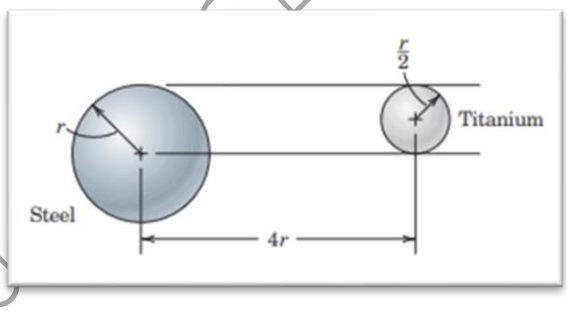

Fig. No. 4.2

6. Explain in detail Principle of Transmissibility of forces?
7. Classify the system of forces with neat sketches & explain them in detail?
8. Define the Resultant force and what are the methods to find out resultant of system forces. Explain them in detail with procedure?
9. What are the assumptions in engineering mechanics?
10. Explain the concept of idealization of engineering problems?
11. What are the objectives of engineering analysis and design?
12. What are the types of 2D supports and explain them in detail with neat sketches?
13. What are the types loads and explain them in detail with neat sketches?
14. Define the following terms: a) Force, b) Couple, c) Moment d) Resultant e) Equilibrant
15. State and explain in detail Varignon's theorem with example?
16. How will you represent the moment of a force geometrically?
17. What is a lever? Classify and explain them in detail?
18. What do you understand by the term '**leverage**'? Explain its applications.
19. A beam AB of length 5 m supported at A and B carries 2-point loads W_1 and W_2 of 3 kN and 5 kN which are 1 m apart. If the reaction at B is 2 kN more than that at A, find the distance between the support A and the load 3 kN?
20. A tricycle weighing 200 N has a small wheel symmetrically placed 500 mm in front of two large wheels which are placed 400 mm apart. If centre of gravity of the cycle be at a horizontal distance of 150 mm from the rear wheels and that of the rider, whose weight

is 150 N, be 100 mm from the rear wheels, find the thrust on the ground under the different wheels.

21. A beam AB 5 m long is supported at its ends A and B. 2- point loads W_1 & W_2 are placed at C and D, 1 m and 3 m respectively from the end A. If the reaction at A is twice the reaction at B, find the ratio of the loads W_1 and W_2.
22. An oil drum of 500 mm diameter and 1.5 long is to be rolled across a footstep of 100 mm high. Find the minimum push required at the top of the drum. Take density of the oil as 1 kg/litre. Neglect weight of the drum.
23. Two unlike parallel forces are acting at a distance of 450 mm from each other. The forces are equivalent to a single force of 90 N, which acts at a distance of 200 mm from the greater of the two forces. Find the magnitude of the forces.
24. Consider the volleyball net shown in figure 24.1. Determine the angle formed by guy wires:
    a) AB and AC b) AC and AD
25. A hexagonal plate is acted upon by the force P and the couple shown in fig 25.1. Determine the magnitude and the direction of the smallest force P for which this system can be replaced with a single force at E.

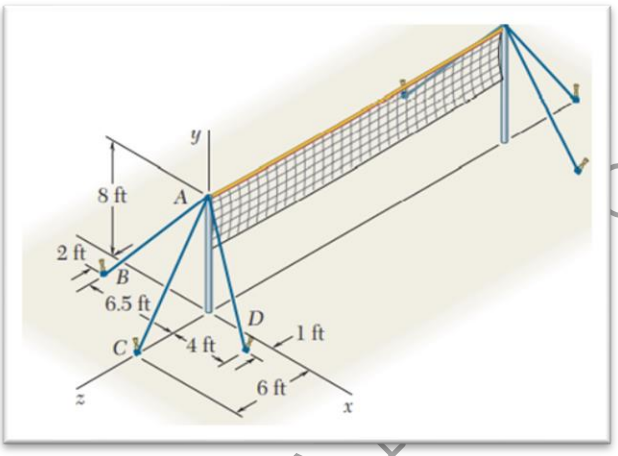

Fig. No. 24.1

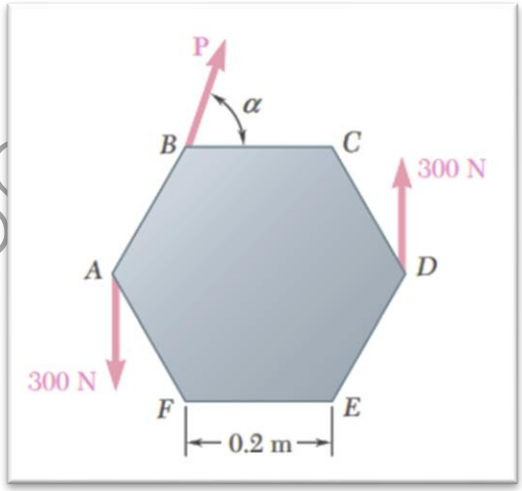

Fig. No. 25.1

26. Find the magnitude & direction of the resultant of the concurrent forces of 8 N, 12 N, 15N & 20 N making angles of 30°, 70°, 120° & 155° respectively with a fixed line.
27. The 4-kN force F is applied at point A as shown in fig 27.1. Compute the moment of F about point expressing it both as a scalar and as a vector quantity. Determine the coordinates of the points on the x- and y-axes about which the moment of F is zero.
28. The tension in cable AB is 100 N as shown in the fig.28.1. Determine the moment about O of this tension as applied to point A of the T-shaped bar. The dimension b is 600 mm.

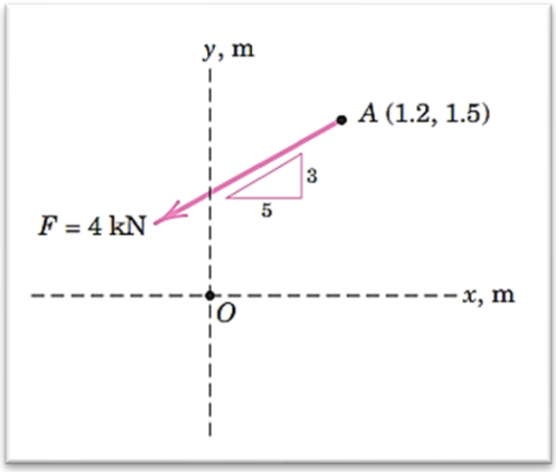

Fig. No. 27.1

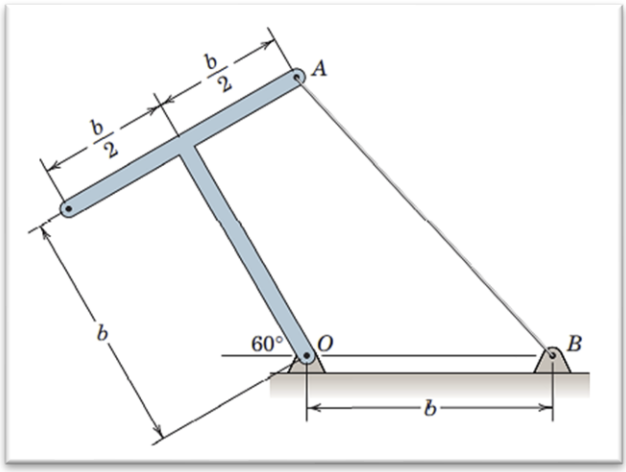

Fig. No. 28.1

29. The 30-N force P is applied perpendicular to the portion BC of the bent bar as shown in fig 29.1. Determine the moment of P about point B and about point A.

30. Determine the moments of the tension T about point P and about point O for the figure as shown in 30.1.

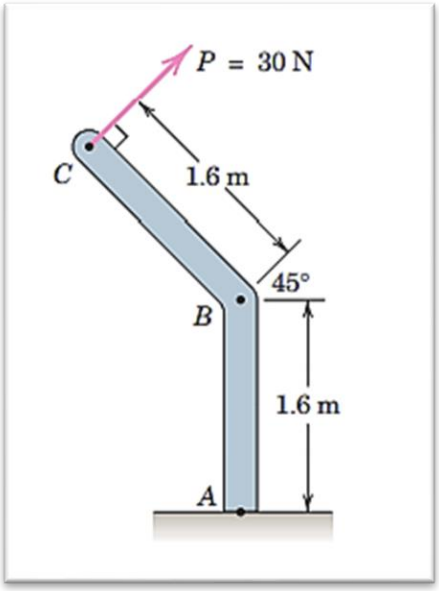

Fig No. 29.1

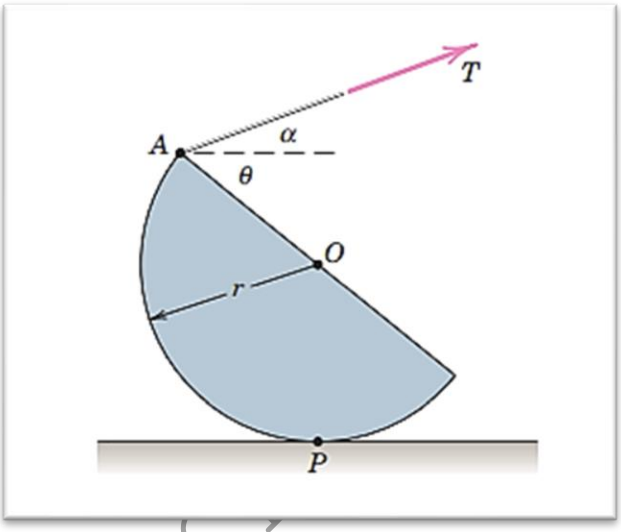

Fig No. 30.1

Module 2

1. Define the term Centroid and centre of gravity?
2. What is meant by the state of equilibrium of a body? State the dynamical conditions of equilibrium and comment whether the conditions are both necessary and sufficient or not?
3. State and explain the Lami's theorem and prove that?
4. Two men carry a weight of 2 kN by means of two ropes fixed to the weight. One rope is inclined at 45° and the other at 30° with their vertices. Find the tension in each rope.
5. Three forces acting on a particle are in equilibrium. The angles between the first and second is 90° and that between the second and third is 120°. Find the ratio of the forces.
6. A gardener uses a 60 N wheelbarrow to transport a 250 N bag of fertilizer as shown in fig in 6.1. What force must she exert on each handle?

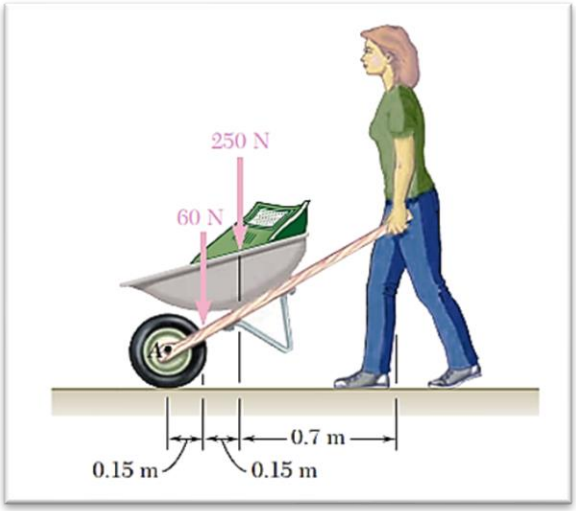

Fig No 6.1

7. Two crates, each of mass 350 kg, are placed as shown in the bed of a 1400 kg pickup truck as shown in fig no 7.1. Determine the reactions at each of the two (a) rear wheels A, (b) front wheels B.

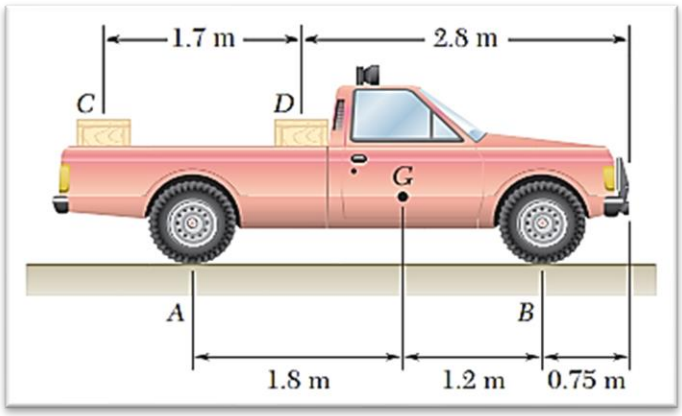

Fig No 7.1

8. The maximum allowable value of each of the reactions is 180 N. Neglecting the weight of the beam, determine the range of the distance d for which the beam is safe as shown in fig no 8.1.

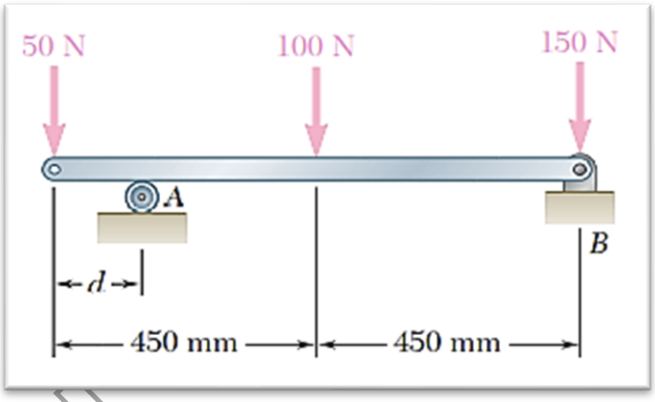

Fig. No. 8.1

9. Solve above problem no. 8, if 50 N load is replaced by 80 N load?

10. The 10 m beam AB rests upon, but is not attached to, supports at C and D as shown in fig.no.10.1. Neglecting the weight of the beam, determine the range of values of P for which the beam will remain in equilibrium.

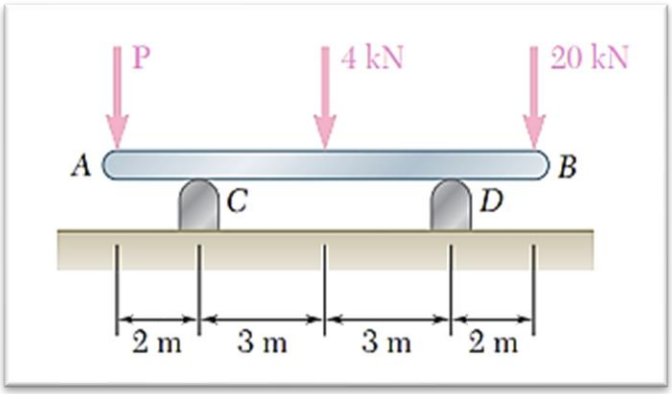

Fig. No. 10.1

11. The maximum allowable value of each of the reactions is 50 kN, and each reaction must be directed upward. Neglecting the weight of the beam, determine the range of values of P for which the beam is safe for the fig no.10.1 as shown above.

12. The bracket BCD is hinged at C and attached to a control cable at B as shown in fig 12.1. For the loading shown, determine (a) the tension in the cable, (b) the reaction at C.

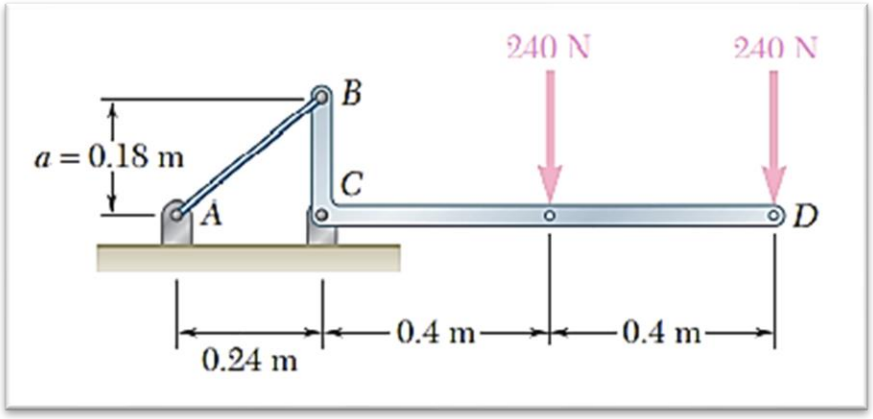

Fig. No. 12.1

13. A spherical ball of weight 50 N is suspended vertically by a string 500 mm long. Find the magnitude and direction of the least force, which can hold the ball 100 mm above the lowest point. Also find tension in the string at that point.
14. Determine the resultant R of the three tension forces acting on the eye bolt as shown in fig. no.14.1. Find the magnitude of R and the angle which R makes with the positive x-axis.
15. Determine and locate the resultant R of the two forces and one couple acting on the I-beam as shown in fig no 15.1

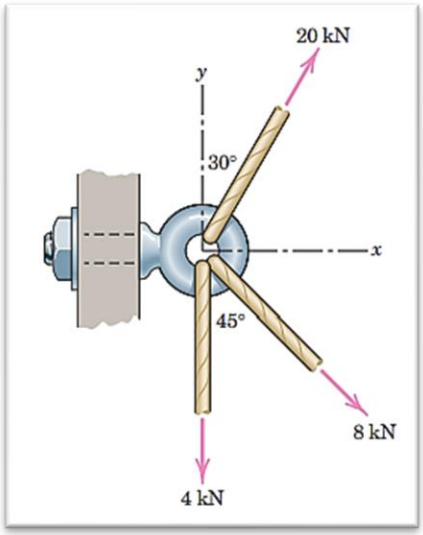

Fig.No. 14.1

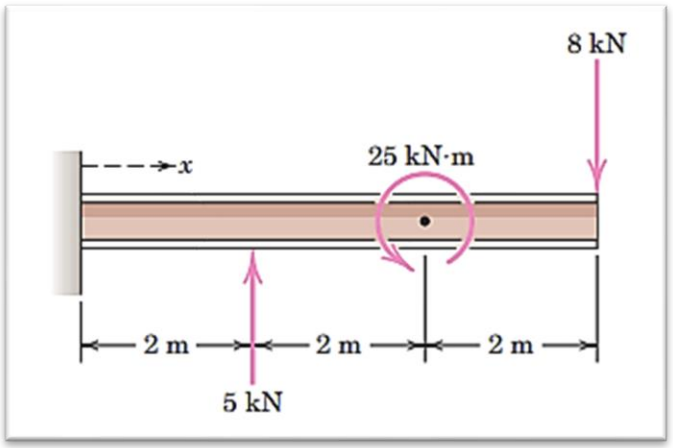

Fig.No. 15.1

16. The uniform beam has a mass of 50 kg per meter of length. Determine the reactions at the supports for the beam as shown in below fig no. 16.1

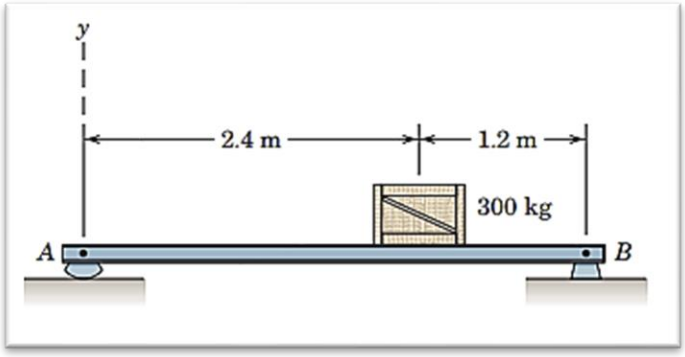

Fig.No. 16.1

17. Calculate the force and moment reactions at the bolted base O of the overhead traffic-signal assembly as shown below in fig no.17.1. Each traffic signal has a mass of 36 kg, while the masses of members OC and AC are 50 kg and 55 kg, respectively. The mass center of member AC is at G.

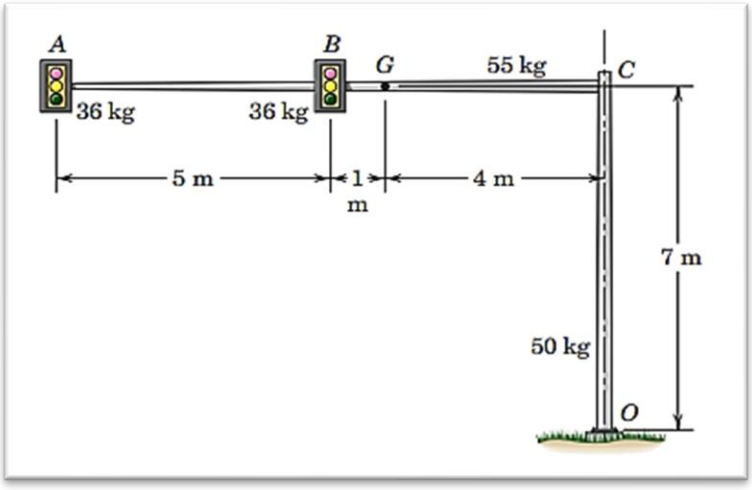

Fig. No. 17.1

18. Find the centre of gravity of an inverted T-section with flange 60 mm × 10 mm and web 50 mm × 10 mm.
19. A circular hole of 50 mm diameter is cut out from a circular disc of 100 mm diameter as shown in Fig. 19.1. Find the centre of gravity of the section from A.
20. Find the centre of gravity of a semicircular section having outer and inner diameters of 200 mm and 160 mm respectively as shown in Fig. 20.1

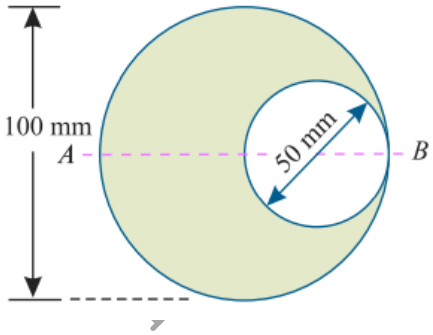

Fig No. 19.1

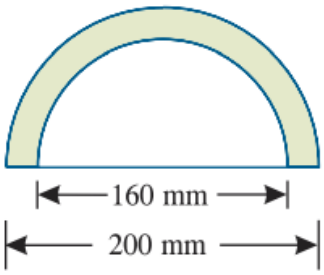

Fig No. 20.1

21. Find the moment of inertia of a triangular section having 50 mm base and 60 mm height about an axis through its centre of gravity and base.
22. Derive an equation for moment of inertia of the following sections about centroidal axis: (a) a rectangular section,
    (b) a hollow rectangular section,
    (c) a circular section, and
    (d) a hollow circular section
23. A circular hole of diameter R is punched out from a circular plate of radius R shown in Fig. 23.1. Find the moment of inertia about both the centroidal axes.

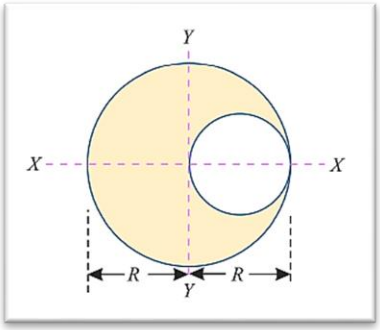

Fig No. 23.1

24. A simply supported beam of span 6 m is carrying a uniformly distributed load of 2 kN/m over a length of 3 m from the right end B. Calculate the support reactions.
25. A beam AB 6 m long rests on two supports 4 m apart, the right hand end is overhanging by 2 m. The beam carries a uniformly distributed load of 1 kN/m over the entire length of the beam. Determine the reactions at the two supports.

Module 3

1. Define the following terms with examples:
   a) Perfect frame
   b) Imperfect frame
   c) Deficient frame
   d) Redundant frame
2. List out the assumptions made, while finding out the forces in the members of a perfect frame?
3. What are the analytical methods to find out the forces in the members of a perfect frames? Explain them in detail?
4. A truss of span 10 meters is loaded as shown in Fig. 4.1. Find the forces in all the members of the truss in terms of magnitude and its nature.

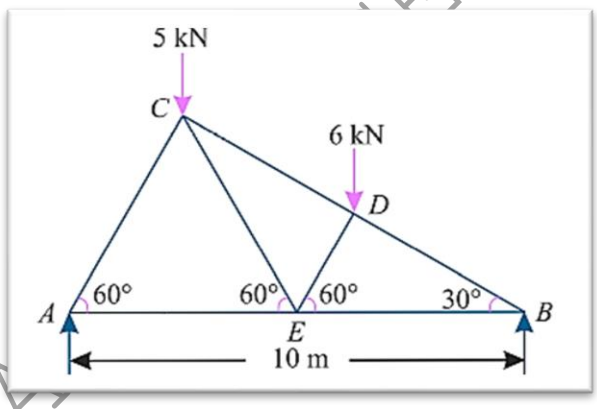

Fig. No.4.1

5. A king post truss of 8 m span is loaded as shown in Fig 5.1. Find the forces in each member of the truss and tabulate the results.

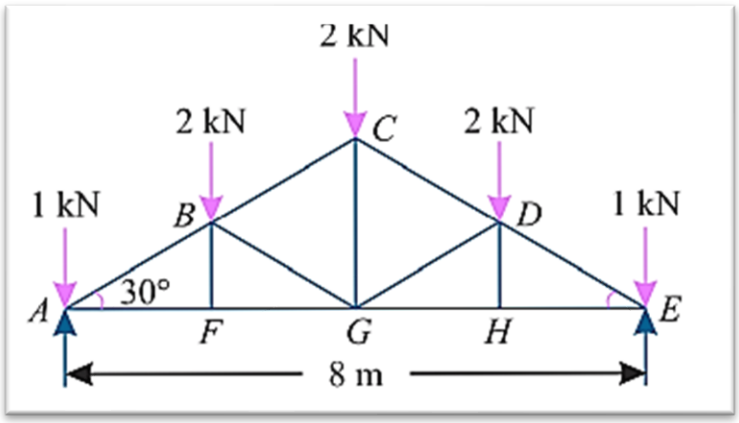

Fig. No. 5.1

6. A 9 m span truss is loaded as shown in Fig 6.1. Find the forces in the members BC, CH and HG of the truss.

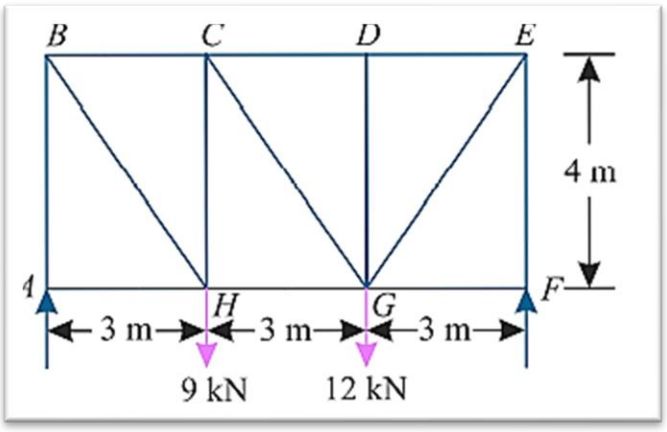

Fig No. 6.1

7. A 4 m ladder weighing 250 N is placed against a smooth vertical wall with its lower end 1.5 m away from the wall. If the coefficient of friction between the ladder and the floor is 0.3, show that the ladder will remain in equilibrium in this position.
8. Define a) Static Friction, b) Dynamic Friction, c) Angle of Friction. What are the laws of dry friction?
9. The coefficient of static friction between block B and the horizontal surface and between the rope and support C is 0.40. Knowing that M_A = 12 kg, determine the smallest mass of block B for which equilibrium is maintained for fig 9.1.
10. Bucket A and block C are connected by a cable that passes over drum B. Knowing that drum B rotates slowly counterclockwise and that the coefficients of static & kinetic friction at all surfaces are μ_s = 0.35 and μ_k =0.25, determine the smallest combined mass **m** of the bucket and its contents for which block C will
    (a) remain at rest,
    (b) start moving up the incline,
    (c) continue moving up the incline at a constant speed

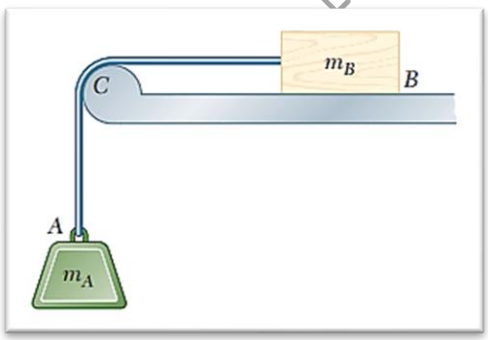

Fig. No. 9.1

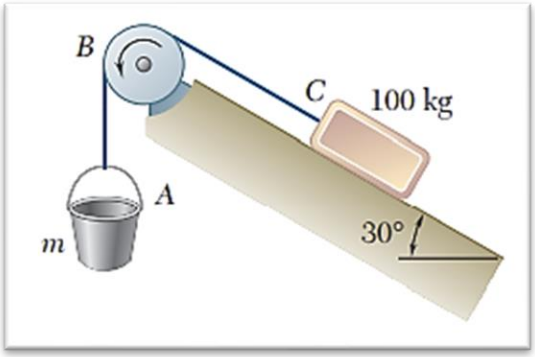

Fig. No. 10.1

11. Define coefficient of friction and limiting friction.
12. How will you distinguish between static friction and dynamic friction?
13. Explain the term angle of friction in detail with neat sketch?
14. Determine the magnitude and direction of the friction force acting on the 100 kg block shown in fig no.14.1 if, a) P = 500 N and b) P = 100 N. The coefficient of static friction is 0.20, and the coefficient of kinetic friction is 0.17. The forces are applied with the block initially at rest.

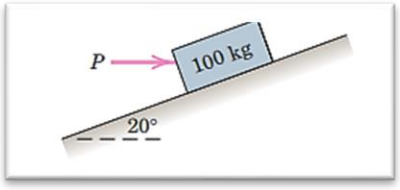

Fig. No. 14.1

Module 4

1. A body starts with a velocity of 3 m/s and moves in a straight line with a constant acceleration. If its velocity at the end of 5 seconds is 5.5 m/s, find (i) the uniform acceleration, and (ii) distance travelled in 10 seconds.
2. A car starts from rest and accelerates uniformly to a speed of 72 kmph. over a distance of 500 m. Find acceleration of the car and time taken to attain this speed. If a further acceleration rises the speed to 90 kmph. in 10 seconds, find the new acceleration and the further distance moved.
3. A bullet moving at the rate of 300 m/s is fired into a thick target and penetrates up to 500 mm. If it is fired into a 250 mm thick target, find the velocity of emergence. Take the resistance to be uniform in both the cases.
4. A stone is dropped from the top of a cliff 120 meters high. After one second, another stone is thrown down and strikes the first stone when it has just reached the foot of the cliff. Find the velocity with which the second stone was thrown.
5. A body is projected upwards with a velocity of 30 m/s. Find the time
   (a) when its velocity will be 5 m/s;
   (b) when it will be 20 meters above the point of projection and
   (c) when it will return to the point of projection.
6. A car starts from rest with an acceleration of 4 m/s2. What is the distance travelled in 8^{th} second?
7. What is the difference between uniform acceleration and variable acceleration?
8. Distinguish clearly between speed and velocity. Give examples.
9. The equation of motion of an engine is given by s = 2t3 – 6t2 – 5, where (s) is in meters and (t) in seconds. Calculate (i) displacement and acceleration when velocity is zero; and (ii) displacement and velocity when acceleration is zero.
10. A body starting from rest, moves in such a way that its acceleration is given by: $\mathbf{a = 3 - 0.15\ t^2}$. Find the time when the body comes to stop and distance travelled during this time.
11. A train moving at 30 kmph is struck by a stone moving at right angles to the train with a velocity of 22.5 kmph Find the velocity and direction which the stone appears to strike the train, to a person sitting in it.
12. What do you understand by the term ‘relative velocity’?
13. A bomber, flying horizontally at a height of 500 m with a velocity of 450 kmph, has aimed to hit a target. Find at what distance from the target, he should release the bomb in order to hit the target.
14. A cricket ball, shot by a batsman from a height of 1.8 m at an angle of 30° with horizontal with a velocity of 18 m/s is caught by a fields man at a height of 0.6 m from the ground. How far apart were the two players?
15. A bird is sitting on the top of a tree 10 m high. With what velocity should a person, standing at a distance of 25 m from the tree, throws a stone at an angle of 30° with the horizontal so as to hit the bird?
16. A player can throw a cricket ball 100 m on a level ground. Find the distance through which he can throw the same ball from the top of hill at angle of 52° 30’, if slope of the hill is 15°.
17. A shot is fired with a velocity of 100 m/s at an angle of 45° with the horizontal on a plane inclined at an angle of 30° with the horizontal. Find the maximum range of the shot.

Module 5

18. Find the force required to give an acceleration of 1.5 m/s^2 to a body of mass 40 kg.
19. A body of mass 40 kg is moving with a constant velocity of 2.5 m/s. Now a force of 100 N is applied on the body in its direction of motion. What will be its velocity after 2 second?
20. A railway coach of mass 50 tons can exert a tractive force of 20 kN Find the acceleration of the coach on a level track if the resistance is 150 N per ton?
21. In an office, a lift is moving upwards with an acceleration of 1.5 m/s^2. Find the pressure exerted by a body of mass 30 kg on the floor of the lift.
22. An elevator of mass 2 t is to be lifted and lowered by means of a rope. Find the tension in the rope, when the elevator is moving (i) upward with an acceleration of 2 m/s^2 and (ii) downward with an acceleration of 1.5 m/s^2.
23. A bullet of 10 gm mass is fired horizontally with a velocity of 1000 m/s from a gun of mass 50 kg. Find (a) velocity with which the gun will recoil, and (b) force necessary to be ring the gun to rest in 250 mm.
24. Derive an expression for the tension in the cable supporting a lift when (i) it is going up, and (ii) it is coming down.
25. Explain clearly the term '**recoil of gun'**. How will you find the velocity of the bullet?
26. A mass of 9 kg, while descending vertically down, drags up a mass of 6 kg by means of a string passing over a smooth pulley. Find the acceleration of the system and tension in the string.
27. Two bodies of mass 3 kg and 2.5 kg are hung to the ends of a string passing over a smooth pulley. At the end of 5 seconds, the string breaks. How much higher the 2 kg mass will go?
28. Explain the reason for the tension in both the strings to be equal, when two masses are attached to its ends, and the inextensible string is made to pass over a smooth pulley.
29. Derive an equation for the tension in the string, when one body is free and the other is lying on a rough horizontal plane.
30. Two bodies of masses 45 and 30 kg are hung to the ends of a rope, passing over a frictionless pulley. With what acceleration the heavier mass comes down? What is the tension in the string?

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