Shri. Gopinath Mahadeo Vedak Pratishthan's
G. M. VEDAK INSTITUTE OF TECHNOLOGY, TALA
Department of Applied Science and Humanities
Academic Year 2020-21 (Second Half 2020)
(F.E. All Branches,Sem I,R-2019,C Scheme)

Engineering Mechanics

(Question Bank)

Siddhesh Kamat

Asst.Prof.in Mechanical Engineering

GMVIT, Tala

Course Code	Course Name	Teaching Scheme (Contact Hours)			Credits Assigned			
		Theory	Pract.	Tut.	Theory	Tut.	Pract.	Total
FEC104	Engineering Mechanics	3	--	--	3	--	--	3

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Pract. /oral	Total
		Internal Assessment			End Sem. Exam.	Exam. Duration (in Hrs)			
		Test1	Test 2	Avg.					
FEC104	Engineering Mechanics	20	20	20	80	3	--	--	100

Objectives

1. To familiarize the concept of equilibrium and friction
2. To study and analyze motion of moving particles/bodies.

Outcomes: Learners will be able to…

1. Illustrate the concept of force, moment and apply the same along with the concept of equilibrium in two and three dimensional systems with the help of FBD.
2. Demonstrate the understanding of Centroid and its significance and locate the same.
3. Correlate real life application to specific type of friction and estimate required force to overcome friction.
4. Establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation
5. Illustrate different types of motions and establish Kinematic relations for a rigid body
6. Analyze particles in motion using force and acceleration, work-energy and impulse-momentum principles

Self-Study/pre-requisites Topics:

Resolution of a forces. Use of trigonometry functions. Parallelogram law of forces. Law of triangle. Polygon law of forces, Lami's theorem. Concepts of Vector Algebra.

Uniformly accelerated motion along straight line, motion under gravity, projectile motion, Time of flight, Horizontal range, Maximum height of a projectile.

Law of conservation of Energy, Law of conservation of Momentum, Collision of Elastic Bodies.

Module	Detailed Contents	Hrs.
01	**1.1 System of Coplanar Forces:** Classification of force systems, Principle of transmissibility, composition and resolution of forces. **1.2 Resultant:** Resultant of coplanar and Non Coplanar (Space Force) force system (Concurrent forces, parallel forces and non-concurrent Non-parallel system of forces). Moment of force about a point, Couples, Varignon's Theorem. Force couple system. Distributed Forces in plane.	06
	Centroid: First moment of Area, Centroid of composite plane Laminas	03

02	**2.1 Equilibrium of System of Coplanar Forces:** Conditions of equilibrium for concurrent forces, parallel forces and non-concurrent non- parallel general forces and Couples. Equilibrium of rigid bodies-free body diagrams. **2.2 Equilibrium of Beams:** Types of beams, simple and compound beams, type of supports and reaction: Determination of reactions at supports for various types of loads on beams. (Excluding problems on internal hinges)	04 03
03	**Friction:** Revision of Static Friction, Dynamic/ Kinetic Friction, Coefficient of Friction, Angle of Friction, Laws of friction. Concept of Cone of friction. Equilibrium of bodies on inclined plane. Application to problems involving wedges and ladders.	04
04	**Kinematics of Particle:** Motion of particle with variable acceleration. General curvilinear motion. Tangential& Normal component of acceleration, Motion curves (a-t, v-t, s-t curves). Application of concepts of projectile motion and related numerical.	04
05	**Kinematics of Rigid Body:** Translation, Rotation and General Plane motion of Rigid body. The concept of Instantaneous center of rotation (ICR) for the velocity. Location of ICR for 2 link mechanism. Velocity analysis of rigid body using ICR.	03
06	**6.1 Kinetics of a Particle:** Force and Acceleration: -Introduction to basic concepts, D'Alemberts Principle, concept of Inertia force, Equations of dynamic equilibrium, Newton's second law of motion. (Analysis limited to simple systems only.)	04
	6.2 Kinetics of a Particle: Work and Energy: Work Energy principle for a particle in motion. Application of Work – Energy principle to a system consists of connected masses and Springs.	04
	6.3 Kinetics of a Particle: Impulse and Momentum: Principle of linear impulse and momentum. Impact and collision: Law of conservation of momentum, Coefficient of Restitution. Direct Central Impact and Oblique Central Impact. Loss of Kinetic Energy in collision of inelastic bodies.	03

Assessment:

Internal Assessment Test:

Assessment consists of two class tests of 20 marks each. The first class test is to be conducted when approx. 40% syllabus is completed and second class test when additional 35% syllabus is completed. Duration of each test shall be one hour.

End Semester Theory Examination:

1. Question paper will comprise of total 06 questions, each carrying 20 marks.
2. 10 percentage of marks will be asked from the self-study topics.
3. Total 04 questions need to be solved.
4. Question No: 01 will be compulsory and based on entire syllabus wherein sub-questions of 2 to 5 marks will be asked.
5. Remaining questions will be mixed in nature.(e.g. Suppose Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

6. In question paper weightage of each module will be proportional to number of respective lecture hrs as mentioned in the syllabus.

References:

1. Engineering Mechanics by R. C.Hibbeler.
2. Engineering Mechanics by Beer &Johnston, Tata McGrawHill
3. Engineering Mechanics by F. L. Singer, Harper& RawPublication
4. Engineering Mechanics by Macklin & Nelson, Tata McGrawHill
5. Engineering Mechanics by ShaumSeries
6. Engineering Mechanics by A K Tayal, UmeshPublication.
7. Engineering Mechanics by Kumar, Tata McGrawHill
8. Engineering Mechanics (Statics) by Meriam and Kraige, WileyBools
9. Engineering Mechanics (Dynamics) by Meriam and Kraige, WileyBools

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G. M. VEDAK INSTITUTE OF TECHNOLOGY, TALA

Department of Applied Science and Humanities

Academic Year 2020-21 (First Half 2021)

Year / Sem –FE / I

Subject / Course - Engineering Mechanics (FEC 104)

Self-Study / Pre-requisites Topics

1. Resolution of a forces
2. Use of trigonometry functions.
3. Parallelogram law of forces.
4. Law of triangle.
5. Polygon law of forces,
6. Lami's theorem.
7. Concepts of Vector Algebra.
8. Uniformly accelerated motion along straight line,
9. Motion under gravity
10. Projectile motion
11. Time of flight
12. Horizontal range
13. Maximum height of a projectile.
14. Law of conservation of Energy
15. Law of conservation of Momentum
16. Collision of Elastic Bodies.

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Department of Applied Science and Humanities

Academic Year 2020-21 (Second Half 2020)

Year / Sem –FE / I

Subject / Course - Engineering Mechanics (FEC 104)

Course Outcomes

CO No.	Course Outcome (CO)
CO 1	Student will be able to illustrate the concept of force, moment, resultant force and centroid.
CO 2	Student will be able to apply concept of equilibrium in two and three dimensional system with the help of FBD.
CO 3	Student will be able to correlate real life application to specific type of friction and estimate required force to overcome friction.
CO 4	Student will be able to establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation.
CO 5	Student will be able to illustrate different types of motion and establish kinematic relation for a rigid body.
CO 6	Student will be able to analyse the body in motion using force and acceleration, work energy, and impulse momentum principle.

G.M. Vedak Institute of Technology Tala Raigad

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Department of Applied Science and Humanities

Academic Year 2020-21 (Second Half 2020)

Year / Sem –FE / I

Course - Engineering Mechanics (FEC104)

CO No.	Course Outcome (CO)
CO 1	Student will be able to illustrate the concept of force, moment, resultant force and centroid.

Topics under Module No.01 given in syllabus

1.1 System of Coplanar Forces

- Classification of force systems
- Principle of transmissibility
- Composition and resolution of forces

1.2 Resultant

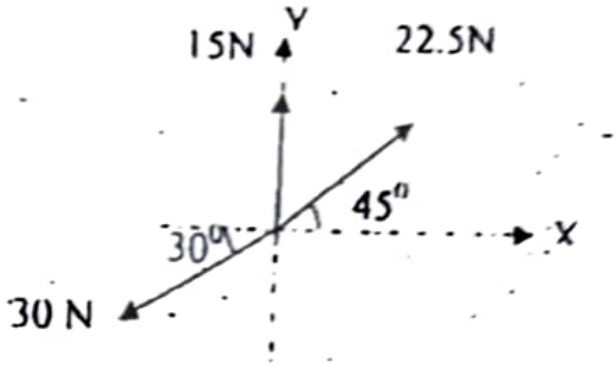
- Resultant of coplanar and Non Coplanar (Space Force) force system (Concurrent forces, parallel forces and non-concurrent Non-parallel system of forces)
- Moment of force about a point
- Couples
- Varignon's Theorem
- Force couple system
- Distributed Forces in plane

1.3Centroid

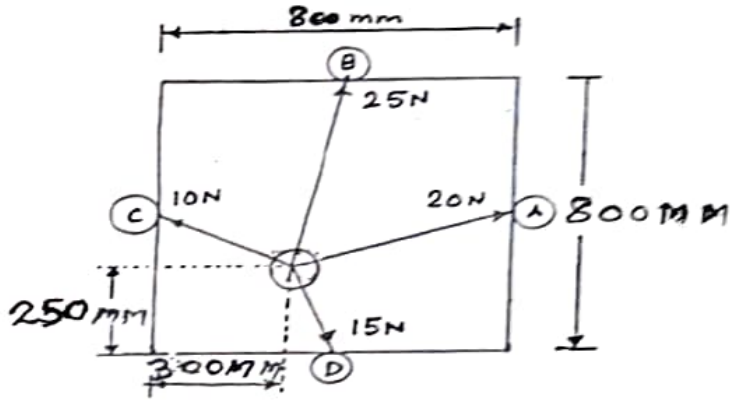
- First moment of Area
- Centroid of composite plane Laminas

Coplanar Force System

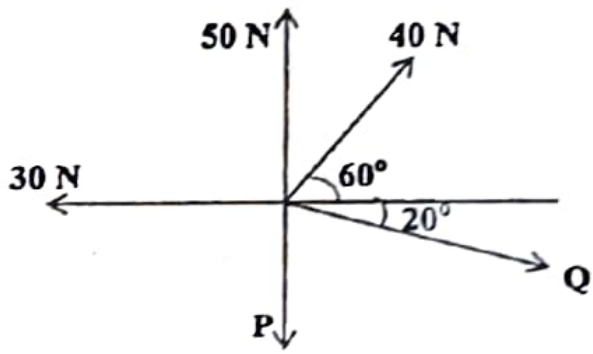
1. **Dec12/ 04 m**
   Find resultant of force system.



2. **May08 / 08 m**
   The striker of carom board lying on the board is being pulled by four players as shown in the figure. The players are sitting exactly at the centre of the four sides. Determine the resultant of forces in magnitude and direction.

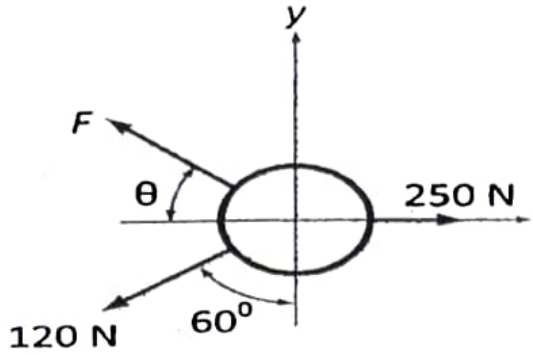


3. **Dec09 / 05m**
   Five concurrent coplanar forces act on a body as shown in the figure. Find the forces P and Q such that the resultant of the five forces is zero.



4. **Dec13 / 04m**

A ring is pulled by three forces as shown in figure. Find the force F and the angle θ if resultant of these three forces is 100 N acting in vertical direction.

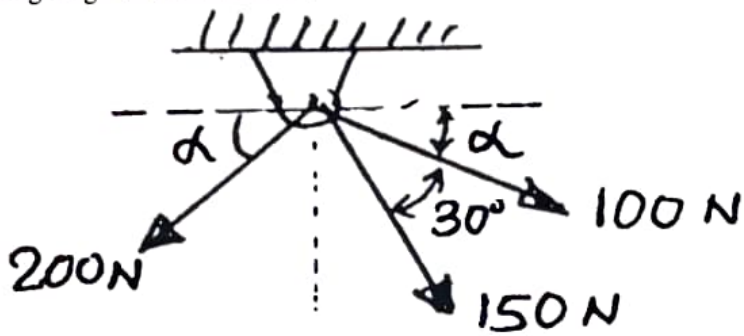


5. **Dec08 / 05m**

For the system shown, determine-

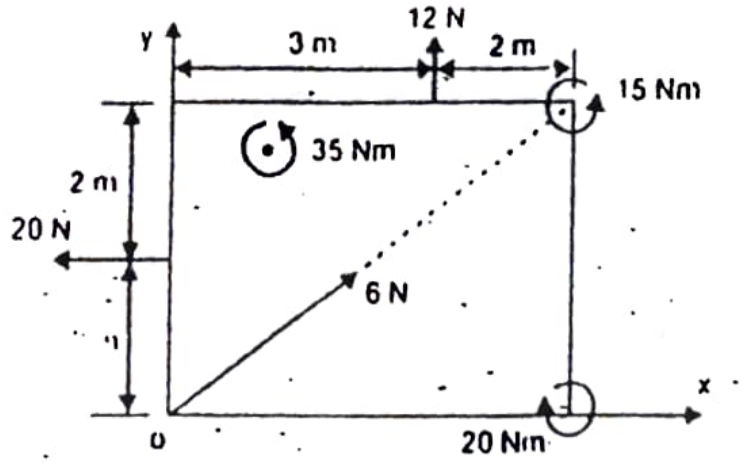
i) The required value of α if the resultant of the three forces is to be vertical.

ii) The corresponding magnitude of resultant.



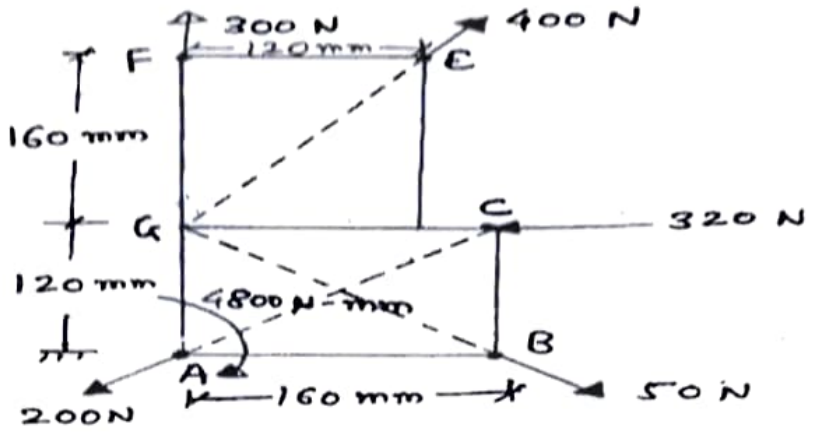
6. **Dec12 / 06 m**

Replace the system of forces and couples by a single force and locate the point on the x-axis through which the line of action of the resultant passes.



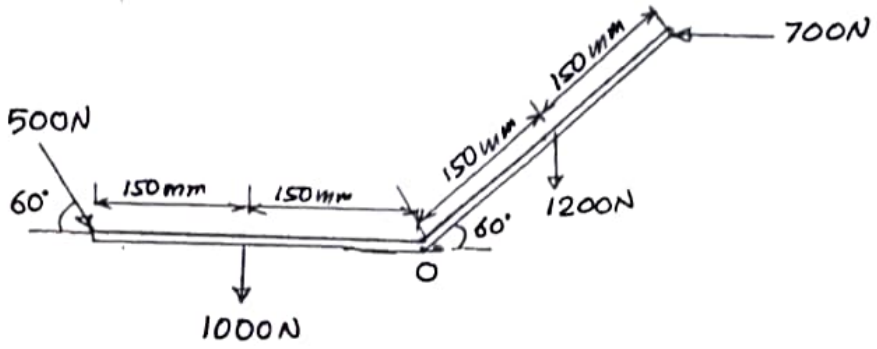
7. **Dec11 / 10 m**

Find the resultant of coplanar force system given below and locate the same on AB with consideration of applied moment of 4800N-mm.



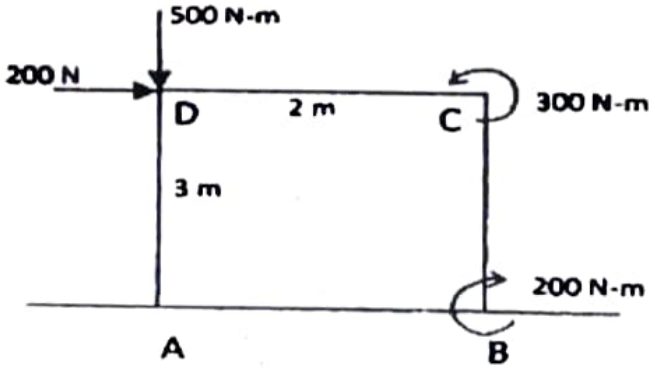
8. **May14 / 6m**

A system of forces acting on a bell crank as shown. Determine the magnitude, direction and the point of application of the resultant w.r.t. O.



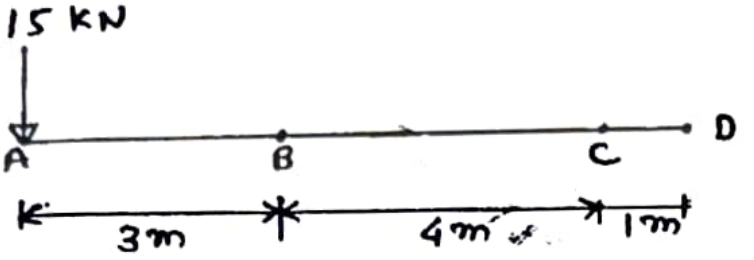
9. **May10/05m**

For the figure shown, find resultant force and moment at point A.



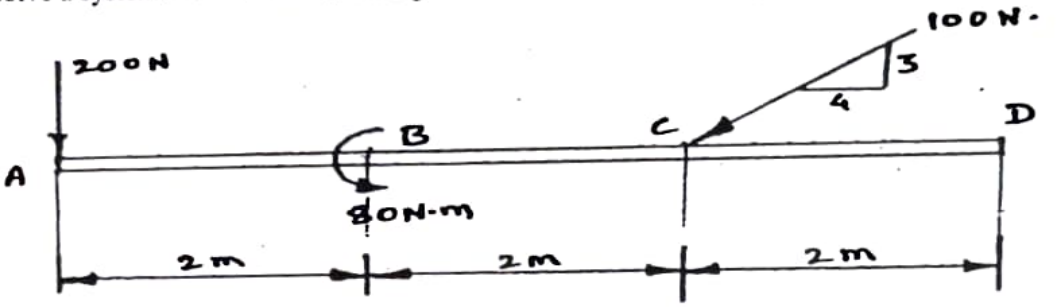
10. Dec11/05m

Resolve 15kN force acting at A into two parallel components at B and C.



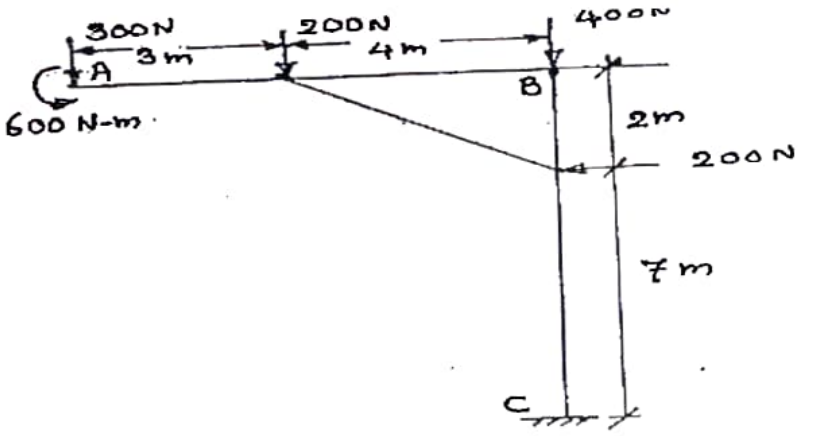
11. Dec07 / 05 m

Resolve a system of forces shown in figure into single force and couple at point A.



12. May09 / 05m

Replace the loading on the frame by a force and moment at point A.

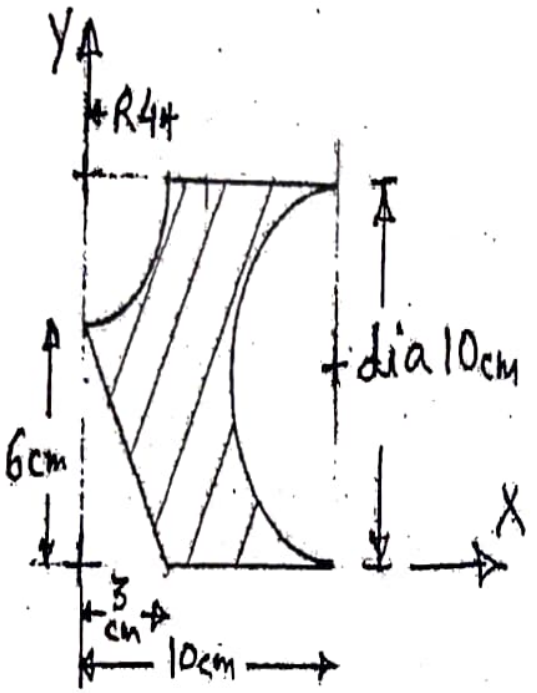


13. Dec15 / 4m

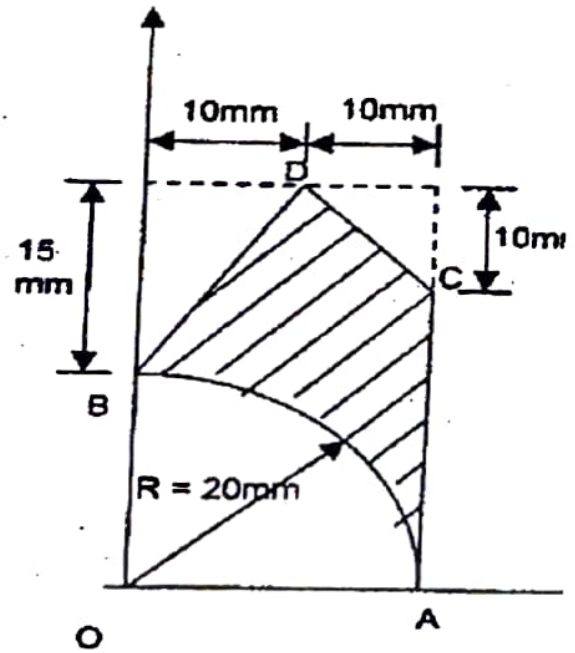
Three concurrent forces P=150 N, Q=250 N and S=300 N are acting at 120^0 with each other. Determine their resultant force magnitude and direction with respect to P. What is their equilibrant?

Centroid

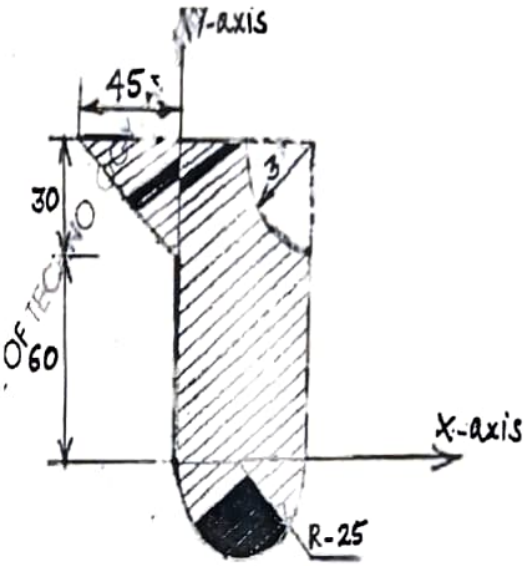
1. **May13 / 08 m**
   Find the centroid of the shaded area.



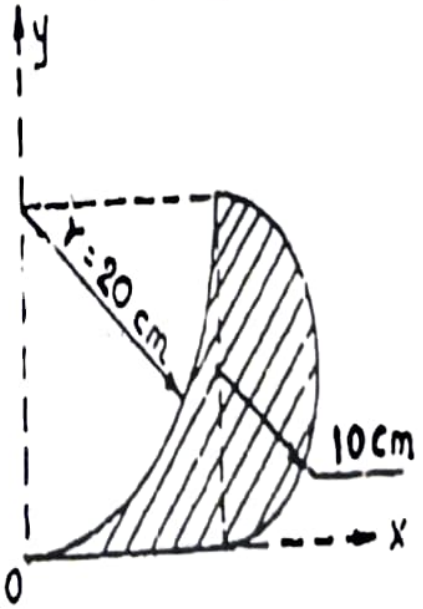
2. **Dec10 / 08 m**
   Find the centroid of the plane area.



3. **Dec 15 / 08m**
   Determine the centroid of the shaded area. All dimensions are in mm.



4. **May16 / 08m**
   Find centroid of shaded area with reference to X and Y axes.



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Academic Year 2020-21 (Second Half 2020)

Year / Sem –FE / I

Course - Engineering Mechanics (FEC 104)

CO No.	Course Outcome (CO)
CO 2	Student will be able to apply concept of equilibrium in two and three dimensional system with the help of FBD.

Topics under Module No.02 given in syllabus

2.1 Equilibrium of System of Coplanar Forces

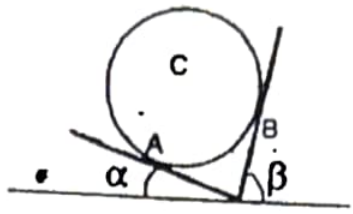
- Conditions of equilibrium for concurrent forces
- Conditions of equilibrium for Parallel forces
- Conditions of equilibrium for Non concurrent non-parallel general forces
- Conditions of equilibrium for Couples
- Equilibrium of rigid bodies - free body diagrams

2.2 Equilibrium of Beams

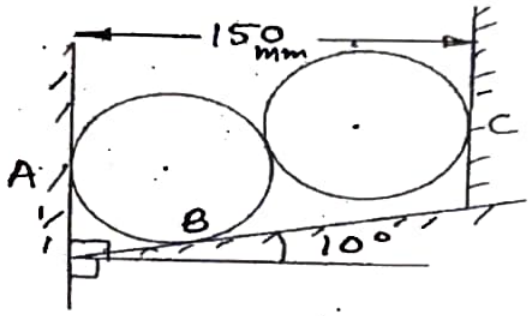
- Types of beams
- Simple and compound beams
- Type of supports and reaction
- Determination of reactions at supports for various types of loads on beams.

Equilibrium

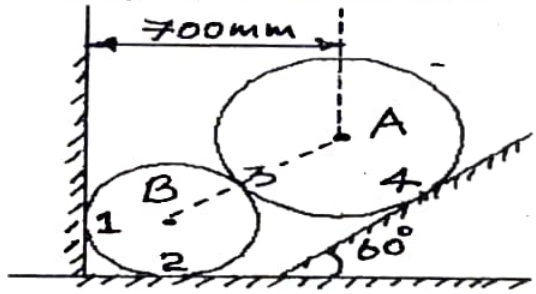
1. **Dec 12 / 04 m**
   A smooth circular cylinder of weight W and radius R rests in a V shape groove whosesides are inclined at angles α and β tothe horizontal. Find the reactions R_A and R_B at the points of contact. $\alpha=20^0,\beta=60^0$



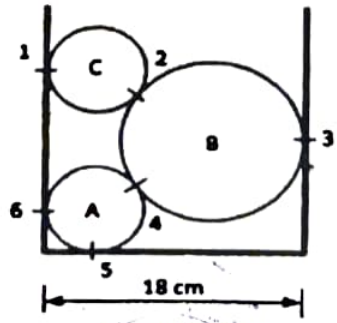
2. **May13 / 08m**
   Two identical cylinders diameter 100mm weight 200N are placed as shown. All contacts are smooth. Find out reactions at A, B and C.



3. **May11 / 10 m**
   Two spheres A and B of weight 1000N and 750 N respectively are kept as shown in the figure. Determine the reactions at all contact points 1, 2, 3 and 4. Radius of A=400mm and radius of B=300mm

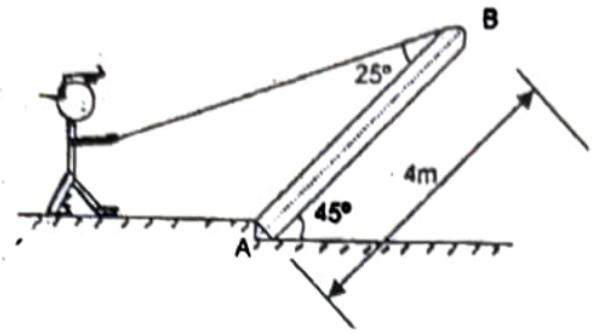


4. **Dec 15 / 08m and May10 / 12 m**
   Three cylinders are piled up in a rectangular channel as shown in figure. Determine the reactions at point 6 between the cylinder A and the vertical wall of the channel. (CylinderA: radius=4cm, m=15 kg, cylinder B: radius=6cm, m=40kg, cylinder C: radius=5cm, m=20kg)



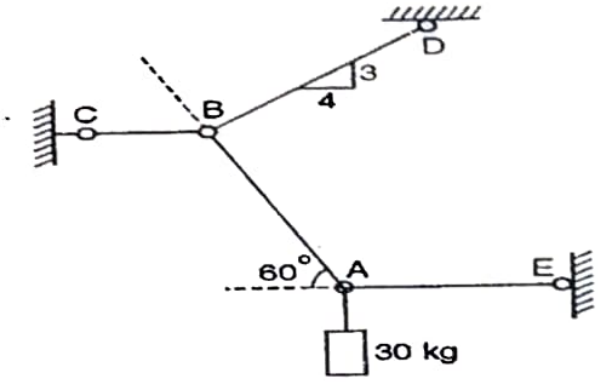
5. **Dec 10 / 08m**

A man raises a 12 kg joist of length 4m by pulling the rope.Find the tension in the rope and the reaction at A.



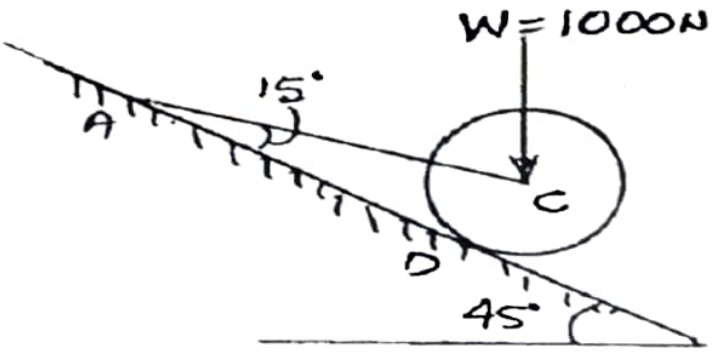
6. **May09 / 05 m**

A 30 kg pipe is supported at A by a system of five chords. Determine the force in each chord for equilibrium.



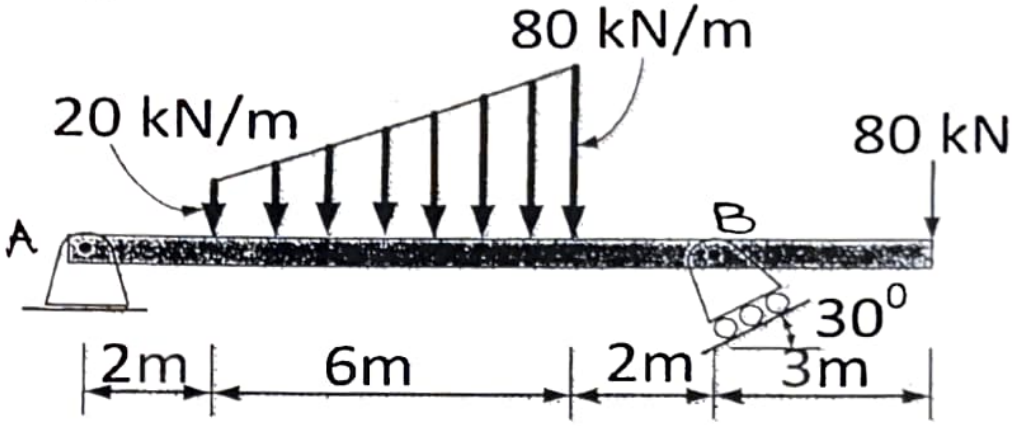
7. **Dec 08 / 05m**

A roller of weight W=1000N rests on a smooth inclined plane. It is kept from rolling down the plane by a string AC. Find the tension in the string and reaction at the point of contact D.

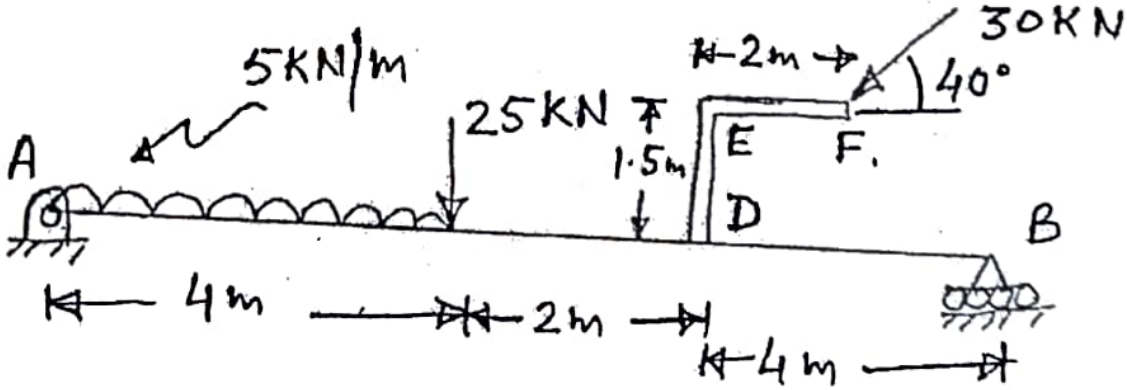


Beam

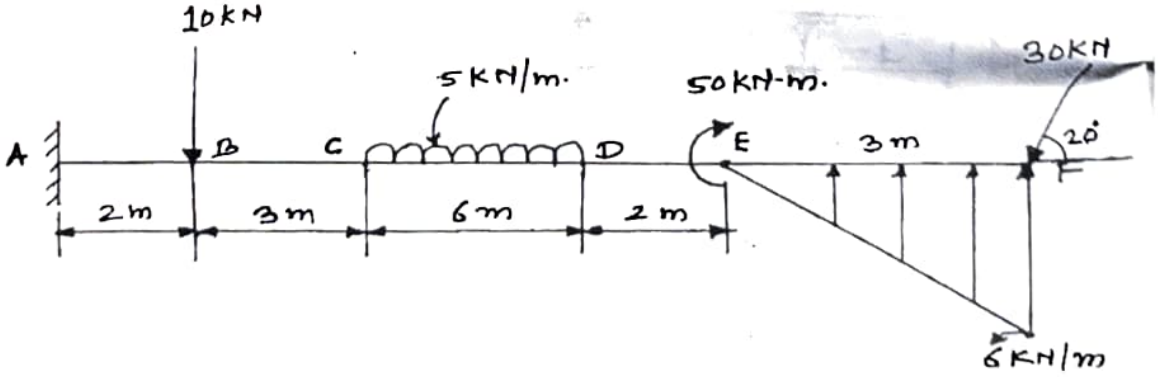
1. **Dec13 / 08m**
   Find the support reactions at A and B for the beam shown in the figure.



2. **May13 / 08 m**
   Find the support reactions at hinge A and roller B.



3. **May12 / 10 m**
   Find the reactions at A.



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Course - Engineering Mechanics (FEC 104)

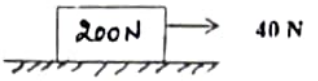
CO No.	Course Outcome (CO)
CO 3	Student will be able to correlate real life application to specific type of friction and estimate required force to overcome friction.

Topics under Module No.03 given in syllabus

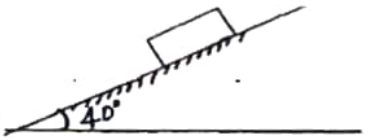
- Revision of StaticFriction
- Dynamic/Kinetic Friction
- Coefficient of Friction
- Angle of Friction
- Laws of friction
- Concept of Cone of friction
- Equilibrium of bodies on inclined plane
- Application to problems involving wedges and ladders.

Friction

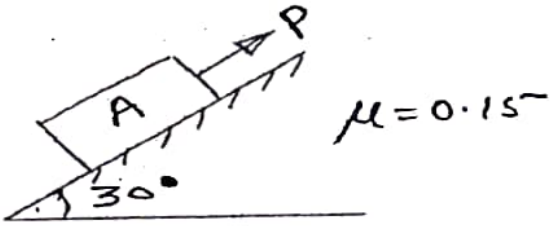
1. **Dec09 / 05m**
   A block of weight 200 N rests on a horizontal surface. The co-efficient of friction between the block and the horizontal surface is 0.4. Find the frictional force acting on the block if a horizontal force of 40 N is applied to the block.



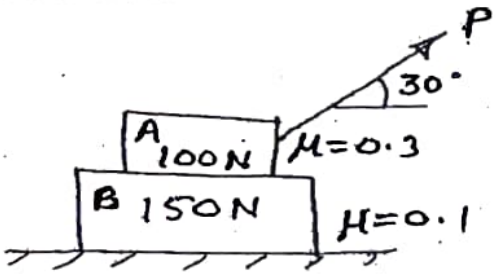
2. **May10 / 04m**
   Block of 100 kg is resting on inclined plane of 40^0.Find whether block in equilibrium. Also find frictional force when motion impends.



3. **May13 / 04m**
   A block of weight 1000 N is kept on rough inclined surface. Find out range of P for which the block will be in equilibrium.

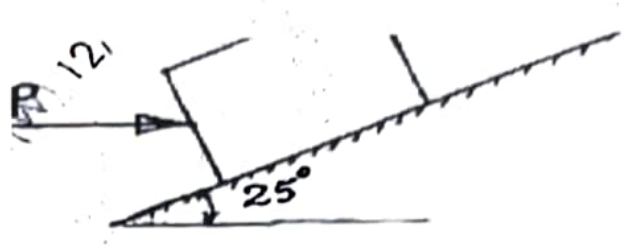


4. **May 13 / 08 m**
   Find out minimum value of P to start the motion.

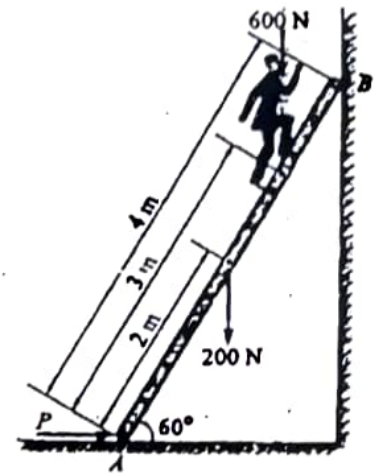


5. **Dec09 / 05m**
   Two blocks A and B of weight 500 N and 750 N respectively are connected by a cord that passes over a frictionless pulley as shown in figure. The coefficient of friction between the block A and the inclined plane is 0.4 and that between the block B and the inclined plane is 0.3. Determine the force P to be applied to block B to produce the impending motion of block B down the plane.

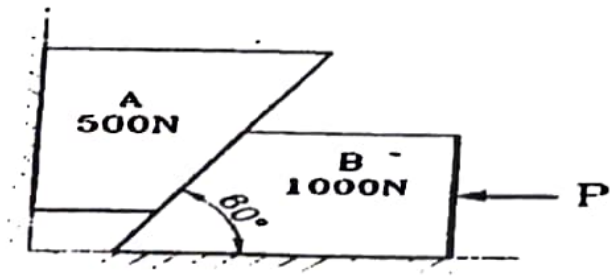
6. **Dec15 / 04m**
A block of weight 800 N is acted upon by a horizontal force P as shown in figure. If the coefficient of friction between the block and incline are μ_s=0.35 and μ_k=0.25, determine the value of P for impending motion up the plane.



7. **May15 / 08m**
A ladder of 4 m length weighing 200 N is placed as shown in figure. μ_B=0.25 & μ_A=0.35. Calculate the minimum horizontal force to be applied at A to prevent slipping.



8. **Dec12 / 08m**
Assuming the values for μ=0.25 at the floor and 0.3 at the wall and 0.2 between the blocks, find the minimum value of horizontal force P applied to the lower block that will hold the system in equilibrium.



9. **May08 / 05m**
A car of 1000 kg mass is to be parked on the same 10^0 incline year round. The static coefficient of friction between the tires and the road varies between the extremes of 0.05 and 0.9. Is it always possible to park the car at this place? Assume that the car can be modeled as a particle.

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Department of Applied Science and Humanities

Academic Year 2020-21 (Second Half 2020)

Year / Sem –FE / I

Course - Engineering Mechanics (FEC 104)

CO No.	Course Outcome (CO)
CO 4	Student will be able to establish relation between velocity and acceleration of a particle and analyze the motion by plotting the relation.

Topics under Module No.04 given in syllabus

- Motion of particle with variable acceleration
- General curvilinear motion
- Tangential & Normal component of acceleration
- Application of concepts of projectile motion and related numerical
- Motion curves (a-t, v-t, and s-t curves)

Variable Acceleration Motion

1. **Dec12 / 04m**
   The car starts from rest and moves in a straight line such that for a short time its velocity is defined by $v=(9t^2 + 2t)$m/s. where t is in seconds. Determine its position and acceleration when t=3sec.

2. **Dec14 / 04m**
   Acceleration of a particle moving along a straight line is represented by the relation $a = 30 - 4.5\ x^2 m/s^2$ It starts with zero initial velocity at x=0. Determine
   a) The velocity when x=3m
   b) The position when the velocity is again zero
   c) The position when the velocity is maximum

3. **Dec 10/05 m**
   The velocity of a particle travelling in a straight line is given by $V=6t-3t^2$ m/s where t is in second. If s=0 when t=0, determine the particle's deceleration and position when t=3sec.

4. **May09 /08 m**
   The motion of a particle moving in a straight line is given by the expression $s=t^3-3t^2+2t+5$ where s is the displacement in meters and t is time in seconds. Determine
   i) Velocity and acceleration after 4 seconds
   ii) Maximum and minimum velocity and corresponding displacement.
   iii) Time at which velocity is zero.

5. **May13/04m**
   For a particle in rectilinear motion $a= -0.05V^2$ m/s^2, at v=20m/s x=0. Find x at v=15 m/s and acceleration at x=50 m.

6. **Dec 12/04 m**
   A particle moving in the +ve X direction has an acceleration $a=100-4v^2$ m/s^2. Determine the time interval and displacement of a particle when speed changes from 1m/s to 3m/s.

7. **May12/05m**
   During a test, the car moves in a straight line such that its velocity is defined by $v=0.3(9t^2+2t)$ m/s where t is in seconds. Determine the position and acceleration when t=3sec. Take at t=0, x=0

8. **Dec 10/08 m**
   The acceleration of the particle is defined by the relation $a=25-3x^2$ mm/s^2. The particle starts with no initial velocity at the position x=0. Determine
   a) The velocity when x=2mm.
   b) The position when velocity is again zero.
   c) The position where the velocity is maximum and the corresponding maximum velocity.

Curvilinear Motion

1. **May13/ 04m**
   A curvilinear motion of a particle is defined by $v_x=25-8t$ m/s and $y=48-3t^2$ m. At $t=0$, $x=0$ find out position, velocity and acceleration at $t=4$sec.

2. **May15 / 06m**
   The y coordinate of a particle is given by $y= 6t^3 - 5t$. If $a_x=14t$ m/s^2 and $v_x = 4$m/s at $t=0$, determine the velocity and acceleration of a particle when $t=1$ sec.

3. **Dec 14 / 04 m**
   A particle moves along a track which has parabolic shape with constant speed of 10 m/s. The curve is given by $y=5+0.3x^2$. Find the components of velocity and normal acceleration when $x=2$m.

4. **Dec 11/ 05 m**
   A particle moves in X-Y plane and its position is given by $r= (3t)\ i + (4t-3t^2)\ j$ where r is the position vector of the particle measured in meters at time t seconds. Find the radius of curvature of its path and normal and tangent components of acceleration when if crosses X axis again.

5. **May14 / 04m**
   A point moves along a path $y=x^2/3$ with a constant speed of 8m/s. What are the x and y components of its velocity when $x=3$? What is the acceleration of the point at this instant?

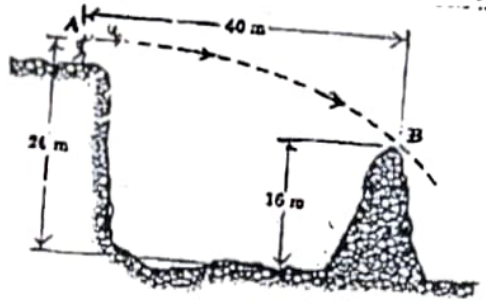
6. **May11 /10 m**
   The motion of a particle is defined by the position vector, $r=6t\ i +4t^2\ j$ where r is in meters and t is in seconds. At the instant when $t=3$ seconds, find i) tangential and normal components of acceleration
   ii) radius of curvature

7. **May10/8m**
   A particle moves in a plane with constant acceleration $a=4i$ m/s^2. At $t=0$the velocity of the particle was $V_0=i+1.732\ j$ m/s. Find velocity of the particle at $t=1$sec.

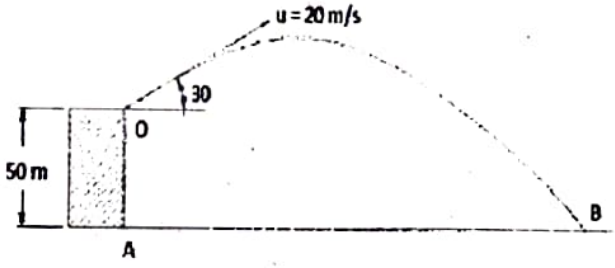
8. **May09 / 05m**
   If $x=1-t$ and $y=t^2$, where x and y are in meters and t is in seconds, determine x and ycomponents of velocity and acceleration. Also write equation of the path.

Projectile Motion

1. **May15 / 04m**
   With what minimum velocity (u) can a boy throw a rock at A and have it just clear the obstruction at B ?

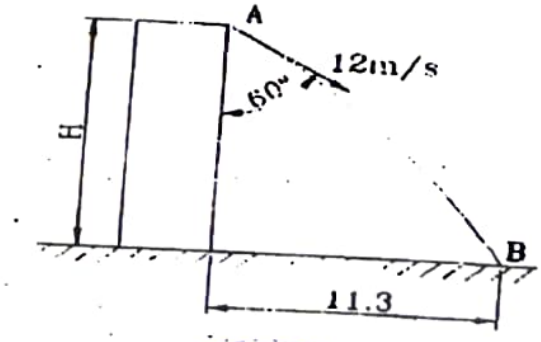


2. **Dec14 / 06m**
   A particle is projected from the top of a tower of height 50m with a velocity of 20 m/s at an angle 30^0 to the horizontal. Determine
   1. Horizontal distance AB it travels from the foot of the tower
   2. The velocity with which it strikes the ground at B.
   3. Total time taken to reach point B.



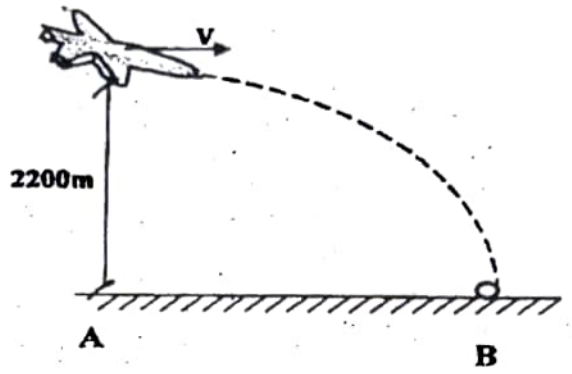
3. **Dec13/ 06m**
   A ball is thrown from horizontal level, such that it clears a wall 6m high, situated at a horizontal distance of 35m. If the angle of projection is 60^0, with respect to the horizontal, what should be the minimum velocity of projection?

4. **Dec 12 /06m**
   A ball thrown with speed of 12m/s at an angle of 60^0 with a building strikes the ground 11.3m horizontally from the foot of the building as shown. Determine the height of the building.



5. **Dec10/08 m**

An airplane is flying in horizontal direction with a velocity of 540km/hr and at a height of 2200meters. When it is vertically above the point A on the ground; a body is dropped from it. The body strikes the ground at point B. Calculate the distance AB. (Ignore air resistance.)Also find velocity at B and time taken to reach B.



6. **May11 /10 m**

A ball is projected from the top of a tower of 110 m height with a velocity of 100m/s and at an angle of elevation 25^0 to the horizontal. Neglecting the air resistance find

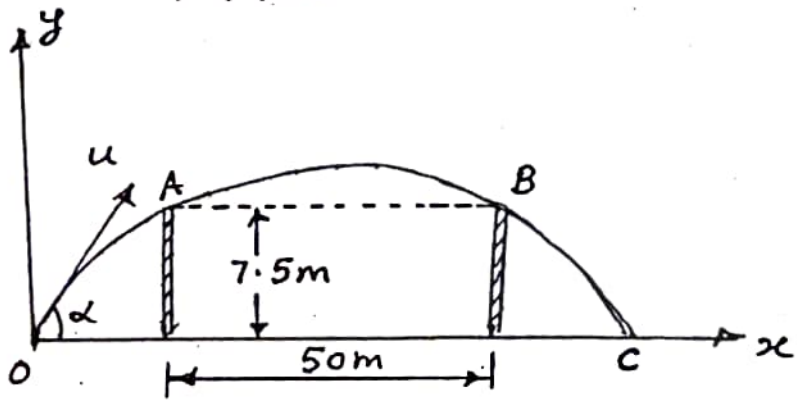
i) The maximum height the ball will rise from the ground.

ii) The horizontal distance it will travel just before it strikes the ground.

iii) The velocity with which it will strike the ground.

7. **May 08 / 10m**

An object is projected so that it just clears two obstacles each 7.5 m high which are situated 50 m from each other. If the time of passing between two obstacles is2.5 seconds, calculate the complete range of projection and initial velocity of projectile.



8. **Dec16 / 04m**

A stone is thrown with a velocity (u) m/sec at an angle of 20^0 with horizontal from a point 2m above the ground. The stone strikes the ground 5m away from the original position. The motion of the stone is subjected to gravitational acceleration and wind resistance of 0.82 m/sec^2 , opposing the horizontal motion. Determine the time of flight of the stone.

Motion Diagram

1. **May 15 / 06m**
   Figure shows the v-t diagram for the motion of train as it moves from station A to station B. Draw a-t graph and find the average speed of the train and the distance between the stations.

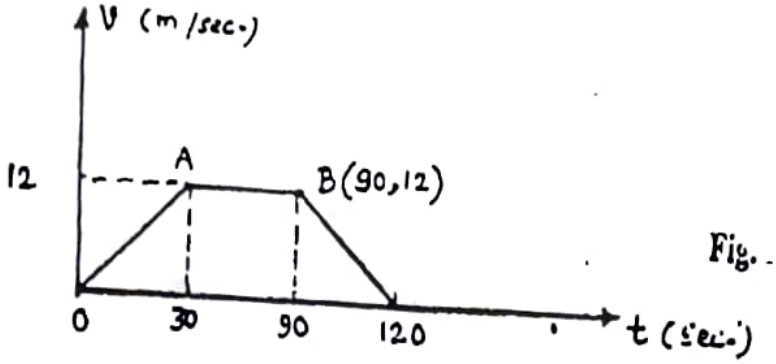
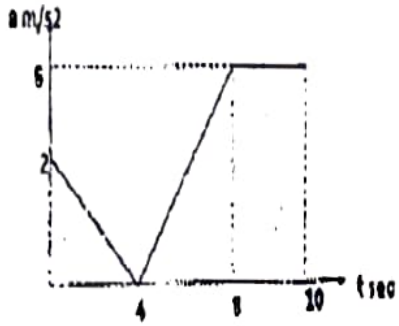
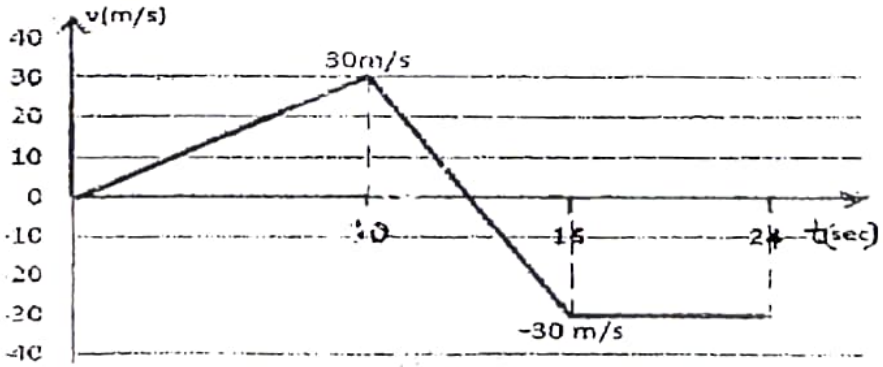


Fig.

2. **Dec14 / 06m**
   A particle is projected with an initial velocity of 2 m/s along a straight line. The relation between acceleration and time is given in the diagram. Draw v-t and s-t diagram.

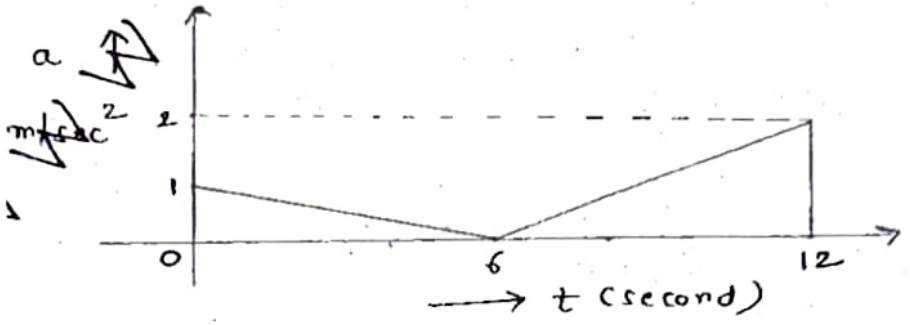


3. **May 14 / 06 m**
   A particle moves in straight line with a velocity time diagram shown in figure.If S= -25 m at t=0,draw displacement time and acceleration time diagrams for 0 to 24 seconds.



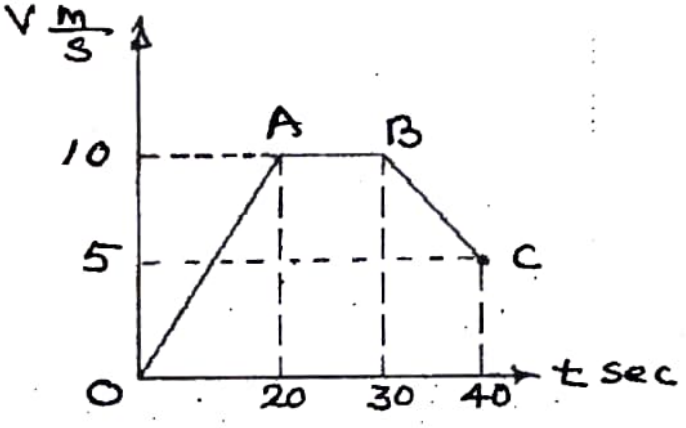
4. **Dec11 / 10m**

Figure shows acceleration-time diagram for rectilinear motion. Construct velocity-time and displacement-time diagrams for the motion assuming that motion starts with initial velocity of 5m/s from starting point.



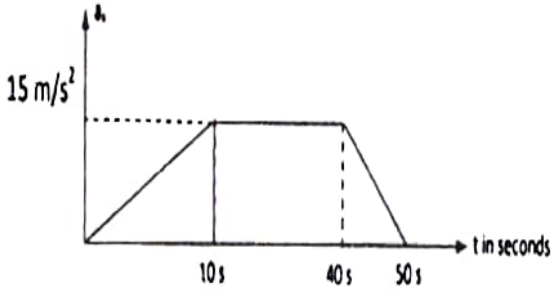
5. **May11/12m**

Velocity-time graph for a particle moving along a straight line is given below. Draw displacement-time and acceleration-time graphs. Also find the maximum displacement of the particle.



6. **May10/ 05m**

Figure shows a plot of a_x versus time for a particle moving along x axis. What is the speed and distance covered by the particle after 50 seconds?



7. **Dec13 / 06m and May11/05m**

In Asian games, for 100m event an athlete accelerates uniformly from the start to his maximum speed in a distance of 4m and runs the remaining distance with that velocity. If the athlete finishes the race in 10.4 sec, determine i) his initial acceleration ii) his maximum velocity.

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G. M. VEDAK INSTITUTE OF TECHNOLOGY, TALA

Department of Applied Science and Humanities

Academic Year 2020-21 (Second Half 2020)

Year / Sem –FE / I

Course - Engineering Mechanics (FEC 104)

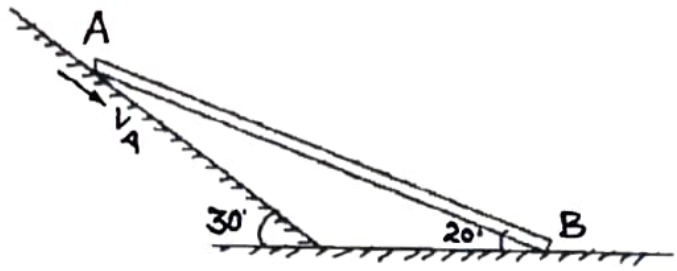
CO No.	Course Outcome (CO)
CO 5	Student will be able to illustrate different types of motion and establish kinematic relation for a rigid body.

Topics under Module No.05 given in syllabus

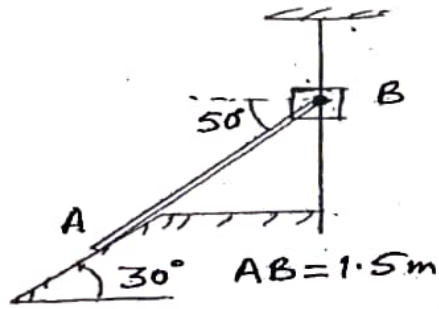
- Translation Rotation and General Plane motion of rigid body
- The concept of Instantaneous center of rotation (ICR) for the velocity
- Location of ICR for 2 link mechanism
- Velocity analysis of rigid body using ICR

Kinematics of Rigid Body

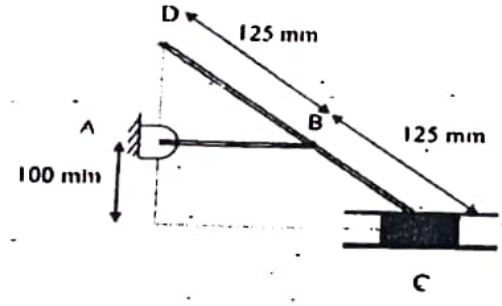
1. **May11 / 08 m**
   Rod AB of length 3m is kept on smooth planes as shown in the figure. The velocity of the end A is 5m/sec along the inclined plane. Locate the ICR and find the velocity of the end B.



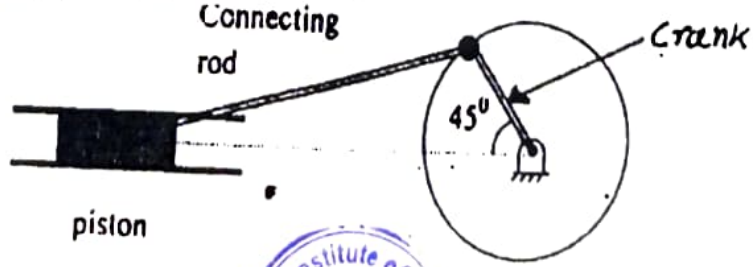
2. **May13 / 06m**
   Collar B moves up with constant velocity V_B=2m/s. Rod AB is pinned at B. Find out angular velocity of AB and velocity of A.



3. **Dec 12 / 06 m**
   At the position shown in the figure, the crank AB has angular velocity of 3 rad/sec clockwise. Find the velocity of the slider C and the point D at the instant shown. AB=100mm

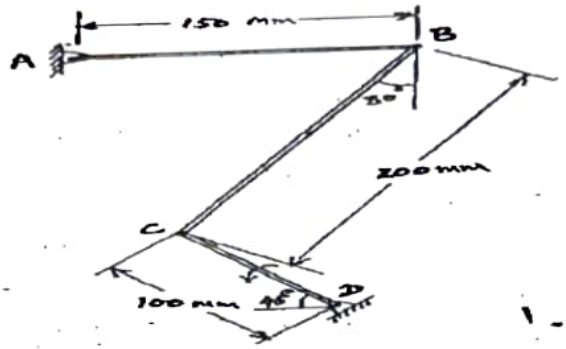


4. **Dec 12 / 06 m**
   In a crank and connecting rod mechanism, the length of crank and connecting rod are 300mm and 1200mm respectively. The crank is rotating at 180 rpm. Find the velocity of the piston, when the crank is at an angle of 45^0 with the horizontal. Direction of rotation of the crank is clockwise.



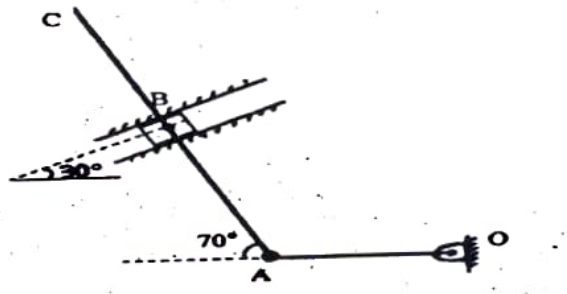
5. Dec11 / 10 m

If the link CD is rotating at 5 rad/sec anticlockwise, determine the angular velocity of link AB at the instant shown.



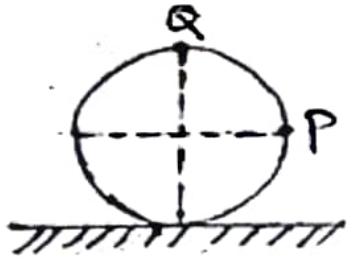
6. Dec 10 / 08 m

Locate the instantaneous center of rotation for the link ABC and determine velocity of points B and C. Angular velocity of rod OA is 15 rad/sec counterclockwise. Length of OA is 200mm, AB is 400mm and BC is 150mm.



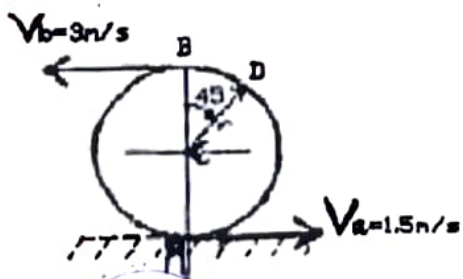
7. Dec 09 / 05 m

A wheel of radius 0.75m rolls without slipping on a horizontal surface to the right. Determine the velocities of the points P and Q shown in figure when the velocity of center of the wheel is 10m/s towards right.



8. Dec15 / 06m

Due to slipping, points A and B on the rim of the disk have the velocities V_a=1.5m/s to the right and V_b=3m/s to the left. Determine the velocities of the centre point C and point D on the rim at this instant. Take radius of disk 0.24m.



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Year / Sem –FE / I

Course - Engineering Mechanics (FEC 104)

CO No.	Course Outcome (CO)
CO 6	Student will be able to analyse the body in motion using force and acceleration, work energy, and impulse momentum principle.

Topics under Module No.06 given in syllabus

6.1 Kinetics of a Particle: Force and Acceleration

- Introduction to basic concepts
- D'Alemberts Principle
- Concept of Inertia force
- Equations of dynamic equilibrium
- Newton's second law of motion

6.2 Kinetics of a Particle: Work and Energy

- Work Energy principle for a particle in motion
- Application of Work–Energy principle to a system consists of connected masses and springs

6.3 Kinetics of a Particle: Impulse and Momentum

- Principle of linear impulse and momentum
- Impact and collision: Law of conservation of momentum, Coefficient of Restitution
- Direct Central Impact and Oblique Central Impact
- Loss of Kinetic Energy in collision of inelastic bodies

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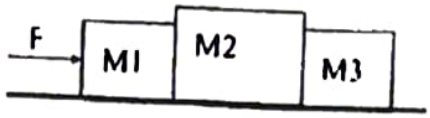
Force and Acceleration

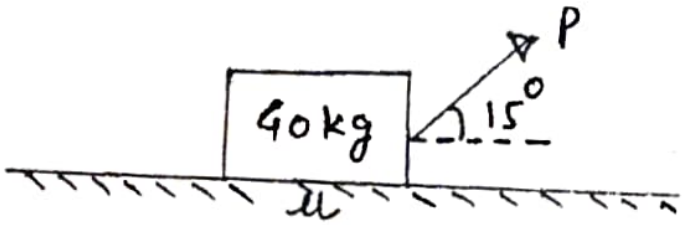
1. **Dec 12 / 04 m**
   Three m_1, m_2 and m_3 of masses 1.5kg,2kg and 1kg respectively are placed on a rough surface with μ=0.20 as shown. If a force F is applied to accelerate the blocks at $3m/s^2$, what will be the force that 1.5kg block exerts on 2kg block?



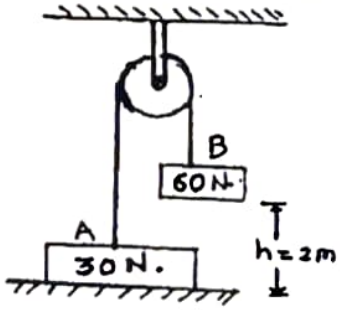
2. **Dec 12 / 04 m**
   A vertical lift of total mass 750 kg acquires an upward velocity of 3m/s over a distance of 4m moving with constant acceleration starting from rest. Calculate the tension in the cable.

3. **Dec 13 / 04 m**
   A 50 kg block kept on a 15^0 inclined plane is pushed down the plane with an initial velocity of 20 m/s. If μ_k = 0.4, determine the distance traveled by the block and the time it will take as it comes to rest.

4. **Dec 11 / 05 m**
   Find P required to accelerate the block shown in the figure below at 2.5 m/s^2. Take μ=0.3



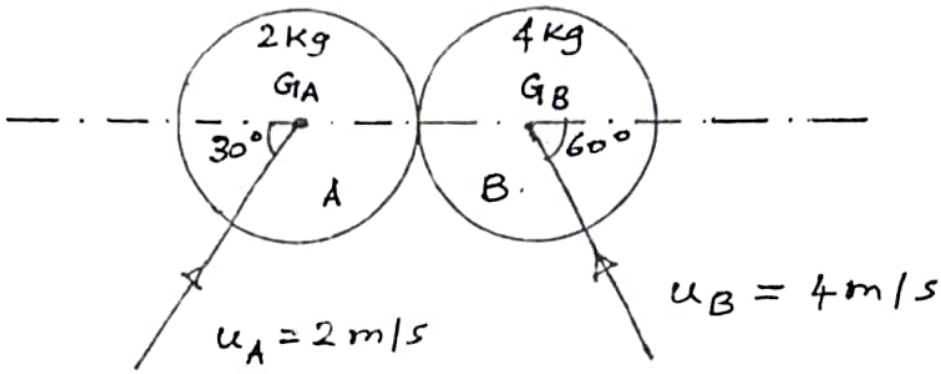
5. **May15 / 04m**
   Two masses of 60 N & 30 N are positioned over frictionless & massless pulley. If the 60 N mass is released from rest, find the speed at which the 60 N mass will hit the ground.



6. **May08 / 05m**
   At a certain instant a body of mass 15 kg is falling freely under gravity was found to be falling at a speed of 25 m/s. What force will stop the body in 2 seconds?

Impact and Collision

1. **May08 / 10 m**
   Two smooth spheres A and B having a mass of 2 kg and 4 kg respectively collide with initial velocities as shown in Figure. If the coefficient of restitution for the spheres is e=0.8, determine the velocities of each sphere after collision.



2. **Dec09 / 08 m**
   A smooth spherical ball A of mass 5 Kg is moving in a horizontal plane from left to right with a velocity of 10m/s. Another ball B of mass 6 Kg traveling in a perpendicular direction with a velocity of 20 m/s collides with A in such a way that the line of impact is in the direction of motion of ball B. Assuming e = 0.7, determine the velocities of balls A and B after impact.

3. **May10 / 08 m**
   Two identical balls of 120 gm collide when they are moving with velocities as shown in figure. Determine the velocities of ball A and B completely after the impact. Take e=0.8