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GE6253 ENGINEERING MECHANICS

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3 1 0 4

OBJECTIVES:

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I BASICS AND STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces — Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon" s theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton" s laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction – wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to explain the differential principles applies to solve engineering problems dealing with force, displacement, velocity and acceleration.
- Ability to analyze the forces in any structures.
- Ability to solve rigid body subjected to dynamic forces.

TEXT BOOKS:

- Vela Murali, "Engineering Mechanics", Oxford University Press (2010).
- Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).

REFERENCES:

- Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
- Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
- Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
- Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics",3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.
- Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age International (P) Limited Publishers, 1998.
- Kumar, K.L., "Engineering Mechanics", 3rd Revised Edition, Tata McGraw-Hill Publishing company, New Delhi 2008.

What is Engineering Mechanics?

Mechanics is the study of forces that act on bodies and the resultant motion that those bodies experience. With roots in physics and mathematics, Engineering Mechanics is the basis of all the mechanical sciences: civil engineering, materials science and engineering, mechanical engineering and aeronautical and aerospace engineering. Engineering Mechanics provides the "building blocks" of statics, dynamics, strength of materials, and fluid dynamics. Engineering mechanics is the the discipline devoted to the solution of mechanics problems through the integrated application of mathematical, scientific, and engineering principles. Special emphasis is placed on the physical principles underlying modern engineering design.

Engineering Mechanics students are also encouraged to engage in undergraduate research with a faculty member. As a result, Engineering Mechanics students are prepared for careers at the forefront of a wide variety of fields, including the aerospace, electronics, automotive, manufacturing, software, and computer industries. The curriculum also provides excellent preparation for graduate school in many different engineering disciplines.

UNIT I BASICS AND STATICS OF PARTICLES

1.1. Introduction to Mechanics

Continuum mechanics is concerned with motion and deformation of material objects, called bodies, under the action of forces. If these objects are solid bodies, the respective subject area is termed solid mechanics, if they are fluids, it is fluid mechanics or fluid dynamics. The mathematical equations describing the fundamental physical laws for both solids and fluids are alike, so the different characteristics of solids and fluids have to be expressed by constitutive equations. Obviously, the number of different constitutive equations is huge considering the large number of materials. All of this can be written using a unified mathematical framework and common tools. In the following we concentrate on solids. Continuum mechanics is a phenomenological field theory based on a fundamental hypothesis called continuum hypothesis. The governing equations comprise material independent principles namely,

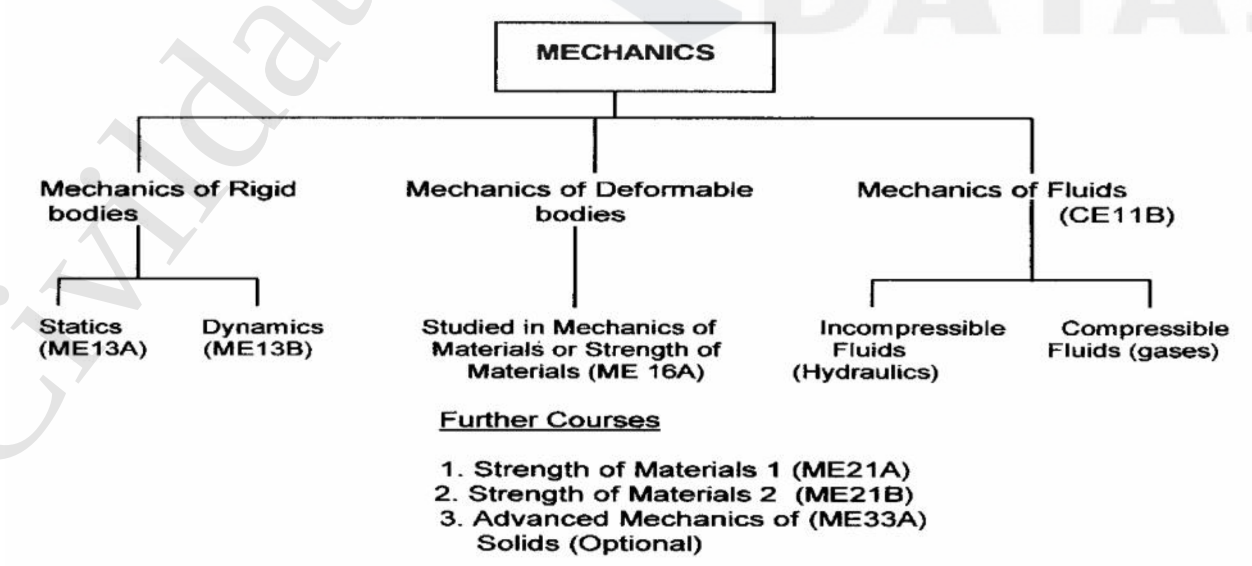
1.1.1 Mechanics

- Body of Knowledge which Deals with the Study and Prediction of the State of Rest or Motion of articles and Bodies under the action of Forces

- **Kinematics**, being a purely geometrical description of motion and deformation of material bodies;
- **Kinetics**, addressing forces as external actions and stresses as internal reactions;

- **Balance equations** for conservation of mass, momentum and energy; and material dependent laws, the

- **Constitutive equations**.
  Altogether, these equations form an initial boundary value problem.



1.2 Laws of Mechanics

1.2.1 Newton's law

Law I

Each body remains in its state of rest or motion uniform in direction until it is made to change this state by imposed forces.

Law II

The change of motion is proportional to the imposed driving force and occurs along a straight line in which the force acts.

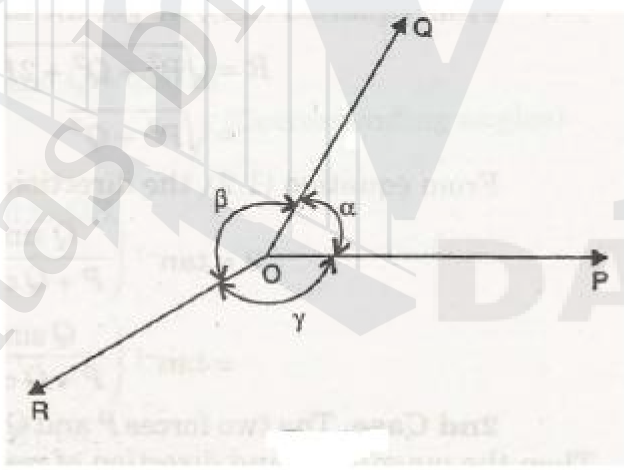
Law III

To every action there is always an equal reaction: or the mutual interactions of two bodies are always equal but directed contrary.

1.2.2 Lami's theorem

It states that, "If there forces acting at a point are in equilibrium, each force will be proportional to the sine of the angle between the other two forces."

Suppose the three forces P, Q and Rare acting at a point 0 and they are in equilibrium as shown in Fig.



Let a = Angle between force P and Q.

β =Angle between force Q and R.

y = Angle between force R and P.

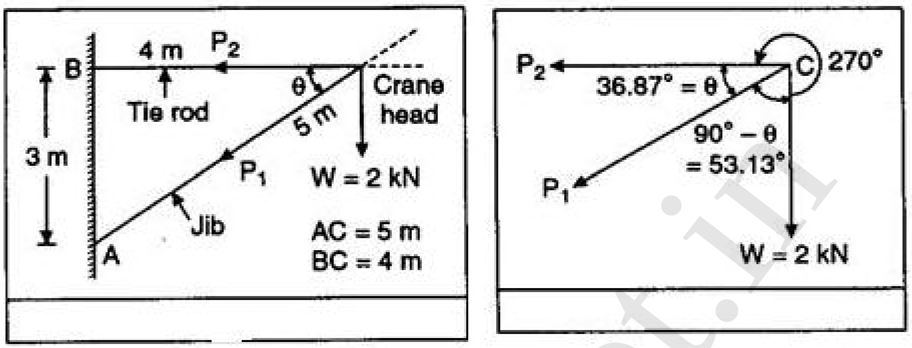
Then according to Lame's theorem, P is proportional sine of angle between Q and R a sin β.

$P / \sin \beta$ = constant.

Similarly $Q / \sin \gamma$ = constant, $R / \sin a$ = constant

$$P / \sin \beta = Q / \sin \gamma = R / \sin a$$

Example-1: In a jib crane, the jib and the tie rod are 5 m and 4 m long respectively. the height of crane post in 3 m and the ties red remains horizontal. Determine the forces produced in jib and tie rod when a load of 2 kn in suspended at the crane head.



Solution: From figure

sin q = 3/5 = 0.6

q = 36.87^o

Let P_1 and P_2 be the forces developed in jib and tie rod respectively. the three forces P_1, P_2 and W are shown in figure with the angle between the forces calculated from the given directions. The line of action of forces P_1, P_2 and weigh W meet at the point C, and therefore Lami's theorem is applicable. That gives:

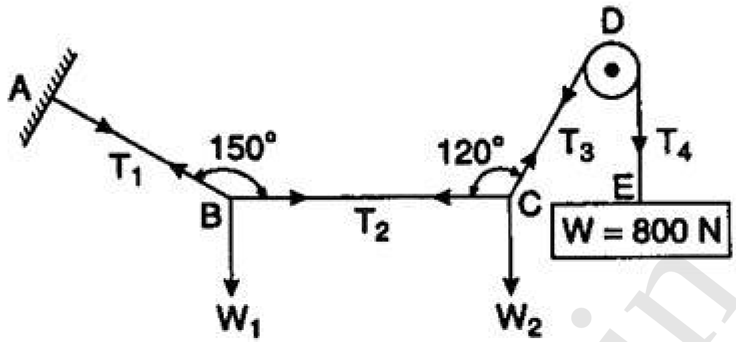
$P_1/\sin 270^o = P_2/\sin 53.13^o = 2/\sin 36.87^o$

$\therefore P_1 = 2 \times \sin 270^o / \sin 36.87^o = 2 \times 1/0. = -3.33$ kN

$P_2 = 2 \times \sin 53.13^o / \sin 36.87^o = 2 \times 0.8 / 0.6 = 2.667$ kN

The –ve sign indicates that the direction of force P_1 is opposite to that shown in figure obviously the tie rod will be under tension and jib will in compression.

Examples-2: **A string ABCD whose extremity A is fixed has weights W_1 and W_2 attached to it at B and C, and passes round a smooth peg at D carrying a weight of 800 N at the free end E shown in Figure. If in a state of equilibrium, BC is horizontal and AB and CD make angles of 150^o and 120^o respectively with BC, make calculation for (a) The tension in portion AB, BC, CD and DE of the string. (b) the value of weights W_1 and W_2 (c) The load on the peg at D**



Solution: Let T_1, T_2, T_3, T_4 be the tension in segments AB, BC, CD and DE of the string.

Under equilibrium condition, $T_5 = T_4 = 800$ N

Applying Lami's theorem at point B,

$T_1/\sin 90^o = T_2/\sin 120^o = W_1/\sin 150^o$

$T_1 = T_2 \sin 90^o / \sin 120^o = 400 \times 1/0.866 = 461.89$ N

$W_1 = T_2 \sin 150^o / \sin 120^o = 400 \times 0.5 / 0.866 = 230.95$ N

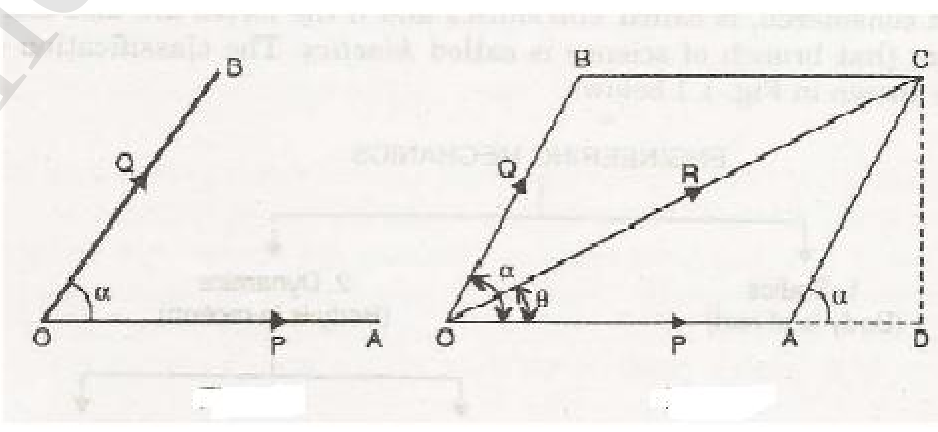
(c) Load on peg at D = $T_3 \sin 60^o + W$

$= 800 \sin 60^o + 800 = 692.82 + 800$

= 1492.82 N

1.2.3 Parallelogram Law of forces

The law of parallelogram of forces is used to determine the resultant* of two forces acting at a point in a plane. It states, "If two forces, acting at a point be represented in magnitude and direction by the two adjacent sides of a parallelogram, then their resultant is represented in magnitude and direction by the diagonal of the parallelogram passing through that point."



Let two forces P and Q act at a point 0 as shown in Fig. 1.3. The force P is represented in magnitude and direction by OA whereas the force Q is presented in magnitude and direction by OB. Let the angle between the two forces be ‘a’. The resultant of these two forces will be obtained in magnitude and direction by the diagonal (passing through O) of the parallelogram of which OA and OB are two adjacent sides. Hence draw the parallelogram with OA and OB as adjacent sides as shown in Fig. The resultant R is represented by OC in magnitude and direction.

Magnitude of Resultant (R)

From C draw CD perpendicular to OA produced.

Let a = Angle between two forces P and Q = LAOB

Now < DAC = < LAOB (Corresponding angles)

In parallelogram OACB, AC is parallel and equal to OB .

AC=Q.

In triangle ACD,

AD = AC cos a = Q cos a and CD =AC sin a= Q sin a.

In triangle OCD,

$OC^2 = OD^2 + DC^2$.

But OC = R, OD = OA +AD = P + Q cos a and DC =Q sin a

$R^2 = (P + Q \cos a)^2 + (Q \sin a)^2 = p^2 + Q^2 \cos^2 a + 2PQ \cos < X + Q^2 \sin^2 a$

$= p^2 + Q^2 (\cos^2 a + \sin^2 a) + 2PQ \cos a$

$= P^2 + Q^2 + 2PQ \cos a$

$R = \sqrt{p^2 + Q^2 + 2PQ \cos a}$

Direction of Resultant

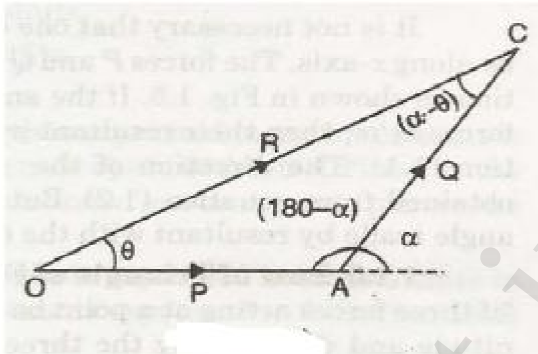
Let θ = Angle made by resultant with OA.

Then from triangle OCD,

$\tan \theta = CD / OD = Q \sin a / P + Q \cos a$

$\theta = \tan^{-1} (Q \sin a / P + Q \cos a)$

The direction of resultant can also be obtained by using sine rule [In triangle OAC, OA = P, AC = Q, OC = R, angle OAC = (180 - a), angle ACO = 180- [θ + 180 - a] = (a- θ)]



sin θ / AC = sin (180 –a) OC = sin (a – θ) / OA

sin θ / Q = sin (180 – a) / R = sin (a – θ) / P

Two cases are important.

1st Case. If the two forces P and Q act at right angles, then a = 90° we get the magnitude of resultant as

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\alpha} = \sqrt{P^2 + Q^2 + 2PQ\cos 90^\circ}$$
$$= \sqrt{P^2 + Q^2} \qquad (\because \cos 90^\circ = 0)$$

the direction of resultant is obtained as

$\theta = \tan^{-1}$ (Q sin a / P + Q sin a)

$= \tan^{-1}$ (Q sin 90^0 / P + Q cos 90^0) = $\tan^{-1}$ Q /P

2nd Case. The two forces P and Q are equal and are acting at an angle a between them. Then the magnitude and direction of resultant is given as

$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\alpha} = \sqrt{P^2 + P^2 + 2P \times P \times \cos\alpha}$$

$$= \sqrt{2P^2 + 2P^2\cos\alpha} = \sqrt{2P^2(1+\cos\alpha)}$$

$$= \sqrt{2P^2 \times 2\cos^2\frac{\alpha}{2}}$$

$$= \sqrt{4P^2\cos^2\frac{\alpha}{2}} = 2P\cos\frac{\alpha}{2}$$

$$\theta = \tan^{-1}\left(\frac{Q\sin\alpha}{P+Q\cos\alpha}\right) = \tan^{-1}\frac{P\sin\alpha}{P+P\cos\alpha}$$

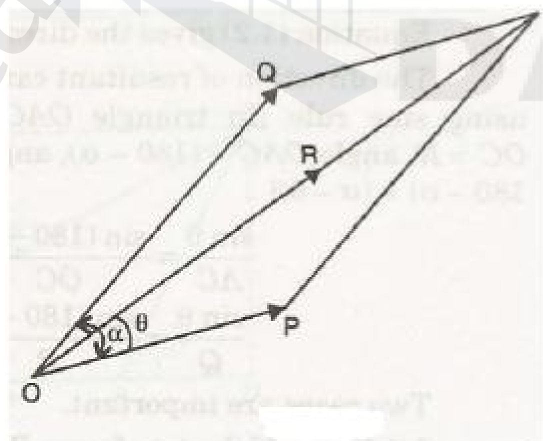
$$= \tan^{-1}\frac{P\sin\alpha}{P(1+\cos\alpha)} = \tan^{-1}\frac{\sin\alpha}{1+\cos\alpha}$$

$$= \tan^{-1}\frac{2\sin\frac{\alpha}{2}\cos\frac{\alpha}{2}}{2\cos^2\frac{\alpha}{2}}$$

$$= \tan^{-1}\frac{\sin\frac{\alpha}{2}}{\cos\frac{\alpha}{2}} = \tan^{-1}\left(\tan\frac{\alpha}{2}\right) = \frac{\alpha}{2}$$

1.2.4 Law of Triangle of Forces

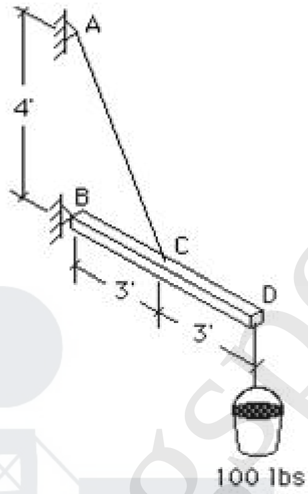
It states that, "if three forces acting at a point be represented in magnitude and direction by the three sides of a triangle, taken in order, they will be in equilibrium."



1.2.5 Vectorial representation of forces

A force can be represented as a vector. Forces and vectors share three major characteristics:

- Magnitude
- Direction
- Location



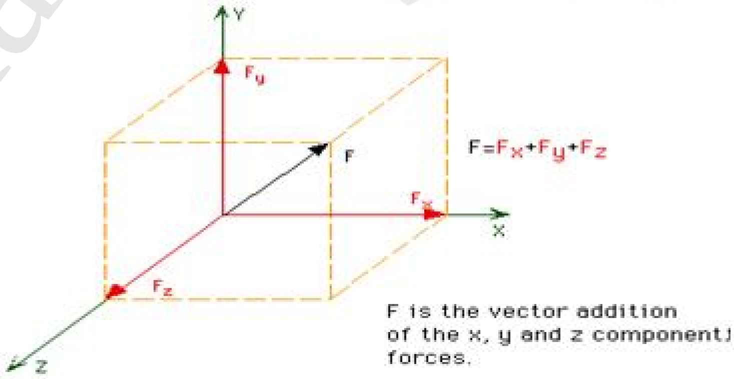
The simple support structure in Figure can be used to illustrate the three characteristics that make a force equivalent to a vector.

1.2.6 How Forces Are Represented

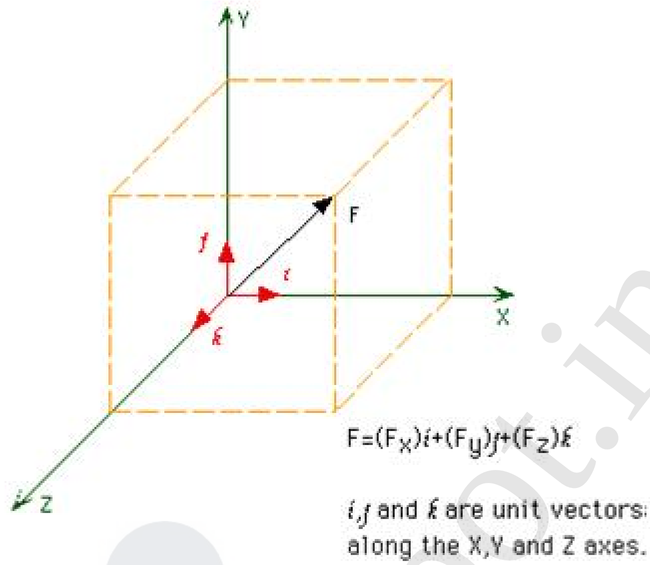
There are two ways in which forces can be represented in written form:

1. Scalar Notation
2. Vector Notation

The method used depends on the type of problem being solved and the easiest approach to finding a solution.



Scalar notation is useful when describing a force as a set of orthogonal force components. For example: $F_x = 15N$, $F_y = 20N$, $F_z = 10N$.



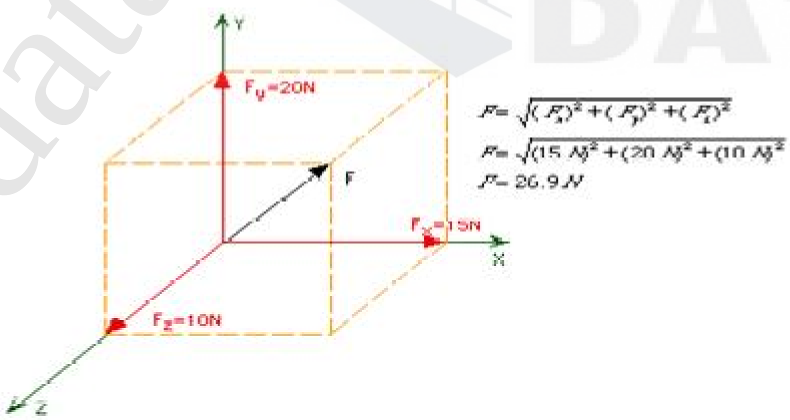
Vector notation is useful when vector mathematics are to be applied to a problem, such as addition or multiplication. Vector notation is somewhat simple in form:

$$F = 15i + 20j + 10k \text{ N.}$$

The N term represents the unit of force, Newtons in this instance.

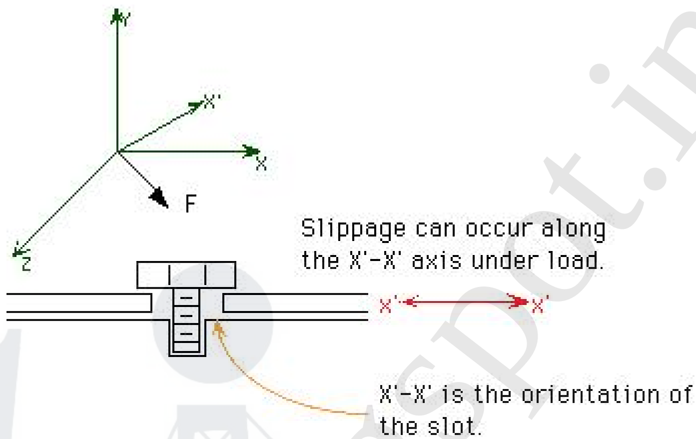
1.2.7 Addition of Forces

Multiple forces can be applied at a point. These forces are known as concurrent forces and can be added together to form a resultant force. If the component forces are orthogonal, then the magnitude of the resultant force can be determined by taking the Square Root of the Sum of the Squares (SRSS). The SRSS method is an extension of the Pythagorean Theorem to three dimensions.



1.2.8 Dot Product

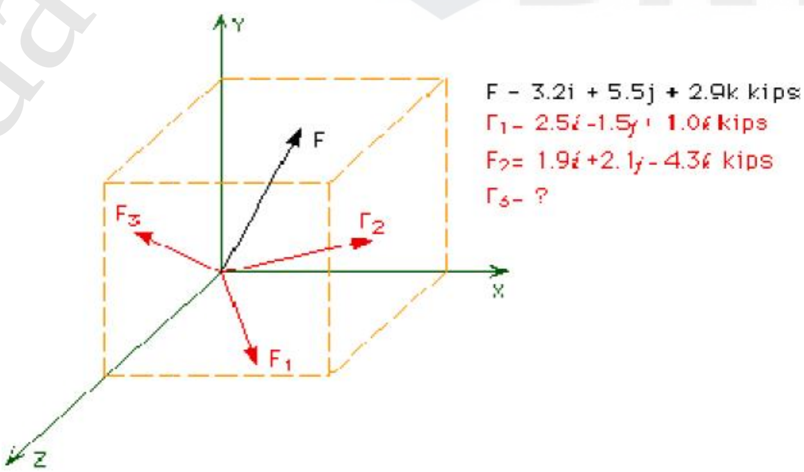
Sometimes it is useful to know how much of a force is acting in a direction other than the X,Y,or Z direction. Such a case might involve a bolted connection with a slotted hole, as shown in Figure.



Suppose that the force in Figure 1.5.1 was F=40i + 10j + 30kNewtons, and that the X' axis was oriented along the unit vector e=0.6i + 0.5j - 0.624k. The projection of F onto X' would be the force component acting in the direction of the slot. Now consider the possibility that the connection would slip if Fx' was greater than 35 N. Will the connection slip? The dot product will help us answer this question.

1.2.9 Resultant of Three Force Vectors

Three force vectors (F1, F2, F3) are simmultaneously applied at point A. The resultant of these three forces is F. Determine F3 such that: F = 3.2*i* + 5.5*j* + 2.9*k*. Write F3 in vector notation.



1.2.10 Equation of equilibrium

A particle is in equilibrium if it is stationary or it moves uniformly relative to an inertial frame of reference. A body is in equilibrium if all the particles that may be considered to comprise the body are in equilibrium. One can study the equilibrium of a part of the body by isolating the part for analysis. Such a body is called a free body. We make a free body diagram and show all the forces from the surrounding that act on the body. Such a diagram is called a free-body diagram. For example, consider a ladder resting against a smooth wall and floor. The free body diagram of ladder is shown in the right. When a body is in equilibrium, the resultant of all forces acting on it is zero. Thus that resultant force ***R*** and the resultant couple ***M R*** are both zero, and we have the equilibrium equations

$$R = \sum F = 0 \quad \text{and} \quad M_R = \sum M = 0 \qquad \text{----------(2.1)}$$

These requirements are necessary and sufficient conditions.

Let us understand equation for different type of force systems.

Types of system of forces

1. Collinear forces :

In this system, line of action of forces act along the same line is called collinear forces. For example consider a rope is being pulled by two players as shown in figure F1 F2

2. Coplanar forces

When all forces acting on the body are in the same plane the forces are coplanar

3. Coplanar Concurrent force system

A concurrent force system contains forces whose lines-of action meet at same one point. Forces may be **tensile (pulling)** or Forces may be **compressive (pushing)**

4. Non Concurrent Co-Planar Forces

A system of forces acting on the same plane but whose line of action does not pass through the same point is known as non concurrent coplanar forces or system for example a ladder resting against a wall and a man is standing on the rung but not on the center of gravity.

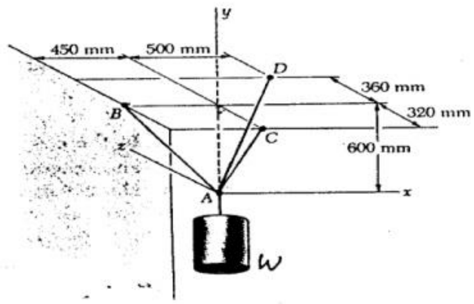
5. Coplanar parallel forces

When the forces acting on the body are in the same plane but their line of actions are parallel to each other known as coplanar parallel forces for example forces acting on the beams and two boys are sitting on the sea saw.

6. Non coplanar parallel forces

In this case all the forces are parallel to each other but not in the same plane,for example the force acting on the table when a book is kept on it.

Example: Problem : A container is supported by three cables which are attached to a ceiling as shown. Determine the weight, W of the container, knowing that the tension in Cable AD is 4.3 kN.



Solution: Position vector, **AC** = 0 **i** + 600 mm **j** - 320 mm **k**

AC = $\sqrt{600^2 + 320^2}$ = 680 mm

$\mathbf{T_{AC}}$ = T_{AC} . λ_{AC} = T_{AC} x **AC**/AC = T_{AC}/680 (600 mm **j** - 320 mm **k**)

$\mathbf{T_{AC}}$ = T_{AC} (0.88 **j** - 0.47 **k**) .... (1)

Position vector **AB** = - 450 mm **i** + 600 mm **j**

AB = $\sqrt{450^2 + 600^2}$ = 750 mm

$\mathbf{T_{AB}}$ = T_{AB} x **AB**/AB = T_{AB}/750 (**AB**) = T_{AB} (- 0.6 **i** + 0.8 **j**) .... (2)

Position vector of **AD**, = 500 mm **i** + 600 mm **j** + 360 mm **k**

AD = $\sqrt{500^2 + 600^2 + 360^2}$ = 860 mm.

$\mathbf{T_{AD}}$ = T_{AD} x **AD**/AD = (4300 N/860 mm) x AD

= 2500 N **i** + 3000 N **j** + 1800 N **k** .... (3)

Load, **W** = - W **j** ....(4)

Using equations 1 to 4:

ΣF_x = 0 i.e. - 0.6 T_{AB} + 2500 = 0

$\mathbf{T_{AB}}$ = 2500/0.6 = 4167 N

ΣF_z = 0 i.e. - 0.47 T_{AC} + 1800 = 0

T_{AC} = 3829.78 N

ΣF_y = 0 i.e. 0.88 T_{AC} + 0.8 T_{AB} - W + 3000 = 0

W = 0.88 T_{AC} + 3333.6 + 3000 i.e. W = (0.88 x 3829.78) + 6333.6 N

W = 9703.8 N = **9.70kN**

Summary

Tensions	x dir	y dir	z dir
AC	0	$0.88 T_{AC}$	$-0.47 T_{AC}$
AB	$-0.6 T_{AB}$	$0.8 T_{AB}$	0
AD	2500 N	3000 N	1800 N
W	0	$-W$	0

1.2.11 Forces in Space

The resultant, **R** of two or more forces in space is obtained by summing their rectangular components i.e.

$$\mathbf{R} = \sum \mathbf{F}$$

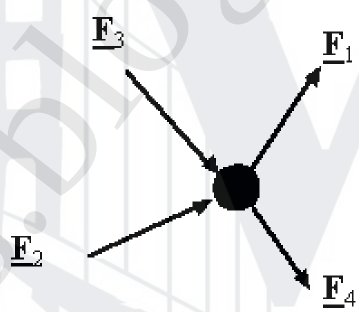
i.e. $R_x\,\mathbf{i} + R_y\,\mathbf{j} + R_z\,\mathbf{k} = \sum\,(F_x\,\mathbf{i} + F_y\,\mathbf{j} + F_z\,\mathbf{k})$

$= (\sum F_x)\,\mathbf{i} + (\sum F_y)\mathbf{j} + (\sum F_z)\mathbf{k}$

$R_x = \sum \mathbf{Fx}$, $\quad R_y = \sum \mathbf{Fy}$, $\quad R_z = \sum \mathbf{Fz}$

1.2.12 Equilibrium of a particle in space

A particle is in equilibrium if the resultant of ALL forces acting on the particle is equal to zero (Newton's first law is that a body at rest is not subjected to any unbalanced forces).



Sum of all forces acting on a particle = $\sum \underline{\mathbf{F}} = 0$

Equilibrium equations in component form: In a rectangular coordinate system the equilibrium equations can be represented by three scalar equations:

$$\sum F_x = 0$$
$$\sum F_y = 0$$
$$\sum F_z = 0$$

To apply equilibrium equations we must account for all known and unknown forces acting on the particle. The best way to do this is to draw a free-body diagram of the particle.

1.2.13 The principle of transmissibility

If a force, acting at a point on a rigid body, is shifted to any other point which is on the line of action of the force, the external effect of the force on the body remains unchanged".

1.2.14 Single Equivalent Force

When a number of forces are acting on a rigid body, then these forces can be replaced by a single force which has. the same effect on the rigid body as that of all the forces acting together, then this single, force is known as 'Single Equivalent Force'. This single equivalent force is also known as resultant of several forces. Hence a single force which can replace a number of forces acting on a rigid body, without causing any change in external effects on the body, is known as single equivalent force (or resultant force)

UNIT II EQUILIBRIUM OF RIGID BODIES

2.1 Free body Diagram

A diagram of a body (or a part of it) which shows all the forces and couples applied on it, and which has all the forces and couples labeled for use in the solution of the problem is called a free-body diagram. Follow these steps to draw a free-body diagram.

1. Select the body (or part of a body) that you want to analyze, and draw it.
2. Identify all the forces and couples that are applied onto the body and draw them on the body. Place each force and couple at the point that it is applied.
3. Label all the forces and couples with unique labels for use during the solution process.
4. Add any relevant dimensions onto your picture.

2.1.1 Forces and couples on a free-body diagram

Each force or couple you put on a free-body diagram represents a model of how the body in the free-body diagram is effected by its surroundings. In selecting the forces and couples that are to be applied on the free-body diagram follow these steps:

1. Identify all the forces which come from the interaction of one body with another. Many of the common supports and their effects are shown in Table 5-1 on page 184. Remember that for each way in which a support restricts the free motion of the body, a force or a moment must be applied to the body to impose the restriction on the motion.
2. Apply the weight of the body to its center of gravity (if it is uniform, then apply it to the centroid).
3. Remember that strings and cables can only pull on an object.
4. Remember that internal loads cancel out and should not be put on the free-body diagram.
5 Remember that if you have selected the direction of forces or couples of interaction on one body, then Newton's 3rd law states that you must apply the forces or couples in the opposite direction on the other body.

2.2 Types of supports and their reactions

Types of reaction and its direction will depend upon the type of support provided.

1.Friction less or smooth surface support

2.Roller support

3.Knife edge support

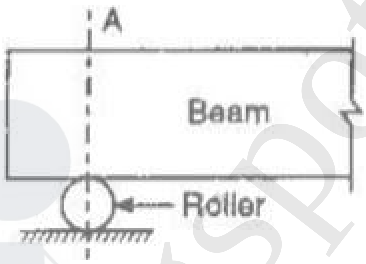
4.Hinged or pinnrd support

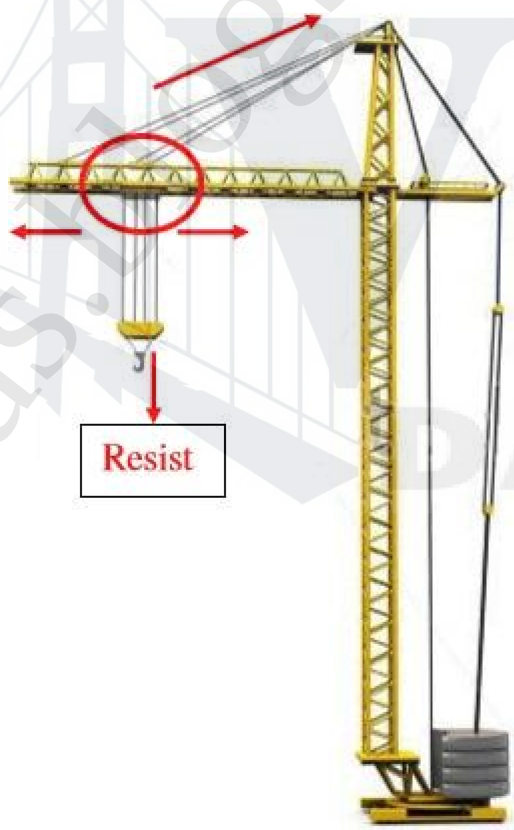
5.Fixed or built in support

2.2.1 Roller Supports

Roller supports are free to rotate and translate along the surface upon which the roller rests. The surface may be horizontal, vertical or slopped at any angle. Roller supports are commonly located at one end of long bridges in the form of bearing pads. This support allows bridge structure to expand and contract with temperature changes and without this expansion the forces can fracture the supports at the banks. This support cannot provide resistance to lateral forces. Roller support is also used in frame cranes in heavy industries as shown in figure, the support can move towards left, right and rotate by resisting vertical loads thus a heavy load can be shifted from one place to another horizontally

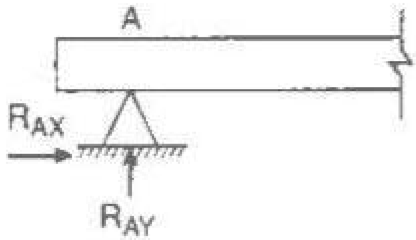
.

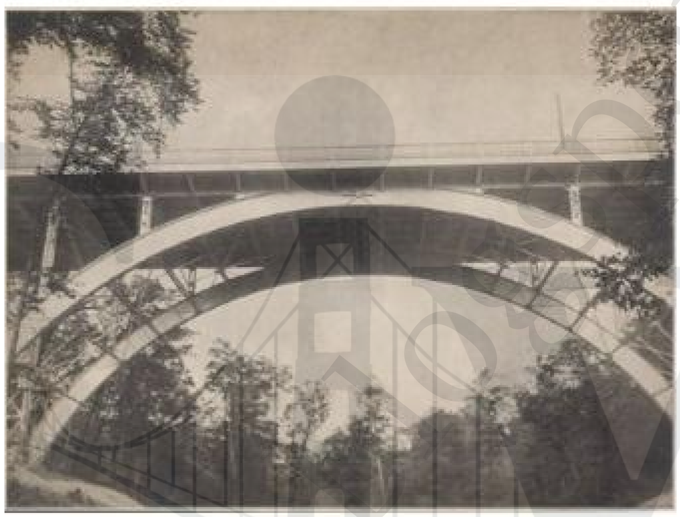


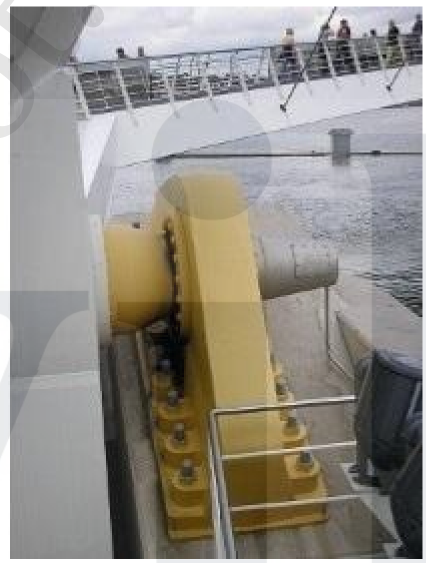


2.2.2 Hinge Supports

The hinge support is capable of resisting forces acting in any direction of the plane. This support does not provide any resistance to rotation. The horizontal and vertical component of reaction can be determined using equation of equilibrium. Hinge support may also be used in three hinged arched bridges at the banks supports while at the center internal hinge is introduced. It is also used in doors to produce only rotation in a door. Hinge support reduces sensitivity to earthquake.

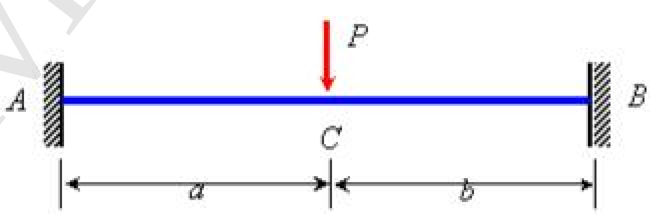


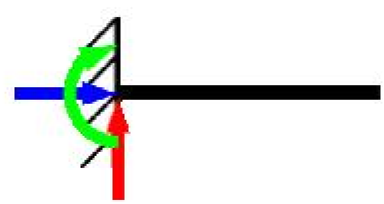




2.2.3 Fixed Support

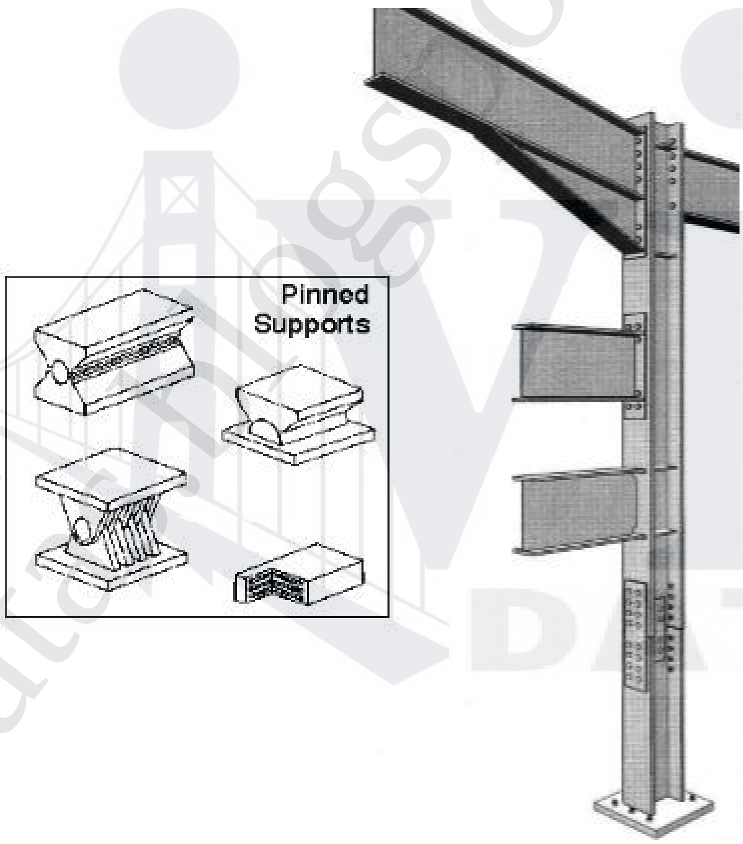
Fixed support can resist vertical and horizontal forces as well as moment since they restrain both rotation and translation. They are also known as rigid support For the stability of a structure there should be one fixed support. A flagpole at concrete base is common example of fixed support In RCC structures the steel reinforcement of a beam is embedded in a column to produce a fixed support as shown in above image. Similarly all the riveted and welded joints in steel structure are the examples of fixed supports Riveted connection are not very much common now a days due to the introduction of bolted joints.





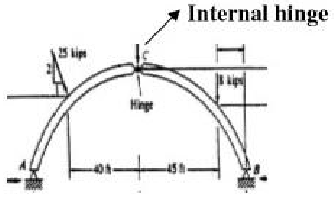
2.2.4 Pinned Supports

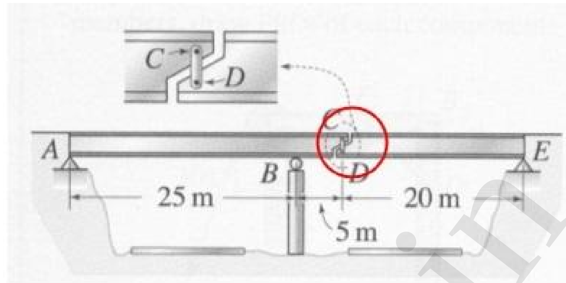
A pinned support is same as hinged support. It can resist both vertical and horizontal forces but not a moment. It allows the structural member to rotate, but not to translate in any direction. Many connections are assumed to be pinned connections even though they might resist a small amount of moment in reality. It is also true that a pinned connection could allow rotation in only one direction; providing resistance to rotation in any other direction. In human body knee is the best example of hinged support as it allows rotation in only one direction and resists lateral movements. Ideal pinned and fixed supports are rarely found in practice, but beams supported on walls or simply connected to other steel beams are regarded as pinned. The distribution of moments and shear forces is influenced by the support condition.



2.2.5 Internal Hinge

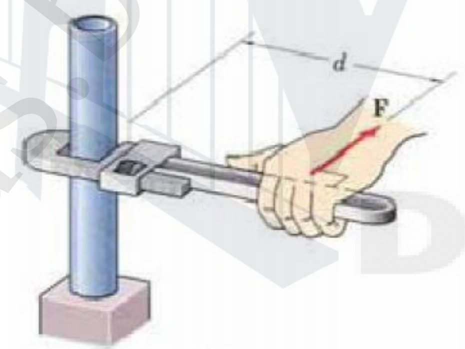
Interior hinges are often used to join flexural members at points other than supports. For example in above fig two halves of an arch is joined with the help of internal hinge.In some cases it is intentionally introduced so that excess load breaks this weak zone rather than damaging other structural elements as shown in above image.





2.3 Moments

The tendency of a force to move the body in the direction of its application a force can tend to rotate a body about an axis. This axis may be any line which is neither intersects nor parallel to the line of the action of the force. This rational tendency of force is know as the moment of force. As a familiar example of the concept of moment, consider the pipe wrench as shown in figure (a). One effect of the force applied perpendicular to the handle of the wrench is the tendency to rotate the pipe about its vertical axis. The magnitude of this tendency depends on both the magnitude of the force and the effective length d of the wrench handle.Common experience shown that a pull which is not perpendicular to the wrench handle is less effective than the right angle pull. Mathematically this tendency of force (moment) is calculated by multiplying force to the moment



(a)

2.3.1 Moment about a point

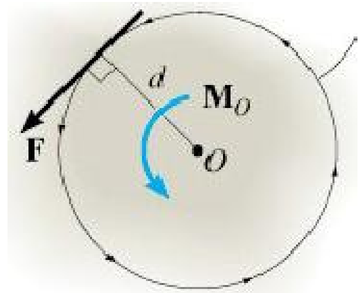
Consider following body (two dimensional) acted by a force F in its plane. The magnitude of moment or tendency of the force to rotate the body about the axis O_O perpendicular to the plane of the body is proportional both to the magnitude of the force and to the moment arm d, therefore magnitude of the moment is defined as the product of force and moment arm.

Moment = Force x moment arm

M = Fd

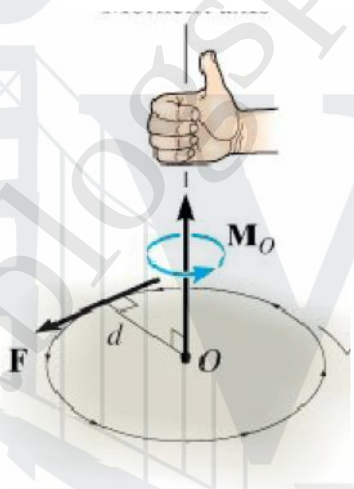
Where d = moment arm and F = magnitude of force

Moment arm is defined as the perpendicular distance between axis of rotation and the line of action of force.



2.3.2 Direction of moment of a force

The direction Mo is specified using the "right-hand rule". To do this the fingers of the right hand are curled such that they follow the sense of rotation, which would occur if the force could rotate about point O. The thumb then point along the moment axis so that it gives the direction and sense of the moment vector, which is upward and perpendicular to the shaded plane containing **F** and **d**.



2.3.3 Clock Wise And Anti Clock Wise Moments

The moment are classified as clockwise and anticlockwise moment according to the direction in which the force tends to rotate the body about a fixed point

Clockwise Moment

When the force tends to rotate the body in the same direction in which the hands of clock move is called clockwise moment the clockwise moment is taken as positive or other wise mentioned.

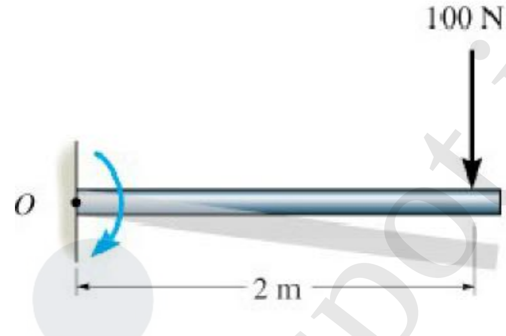
Anticlockwise Moment

When the force tends to rotate the body in the opposite direction in which the hands of clock move is called anti clockwise moment which is taken as negative or otherwise mentioned.

2.3.4 Unit of moment

S.I unit is N.m. (Newton. meter)
F.P.S unit is lb. ft (Pound. foot)
G.G.S unit is dyne.cm (dyne. Centimeter) etc

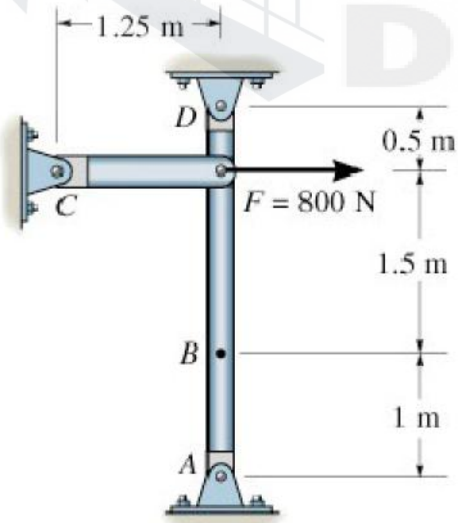
Example 1: Determine the moment of the force about point "O" for following diagram.



(a)

Given Force=100 N
Moment arm=2m
Required Mo=?
Working formula: - MO=Force x Moment arm.
Sol putt the values in first w, f
Mo= F x r = 100 x 2
Mo= 200N.m.
Result: - Moment = 200N.m Direction =Clock wise

Example 2: Determine the moment of the force 800 N acting on the frame about points A, B, C and D.



Given
Force = F = 800 N
Required MA=? MB? MC=? MD=?
Working formula
Moment =force x moment arm.
Sol Solve this question step by step
Now first consider the Point A.
MA = F x r
MA = 800 x (1.5+1)
MA = 2000 N.m clock wise_______ I
Now Moment about B
MB = F x r = 800x 5
MB = 1200 N m clock wise________ (2)
From (1) and (2) it is evidence that when force remain constant then moment varies with moment arm that is moment depends upon moment arm. Similarly it can be proved that moment about any point varies with force when moment arm remain same.
Now consider point C
Moment = Force x distance
Mc = 800 x 0
Mc = 0. _______ (3)
As the line of action of force passes through point C that is point of application it shows that the line of action should be perpendicular to the point i.e. "C"
Now consider the point D.
MD = F x r.
MD = 800 x 0.5
MD= 400 N.m

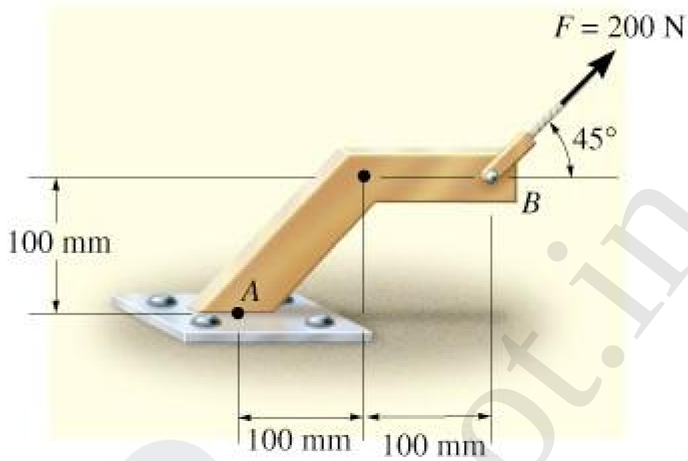
Result
MA =2000 N.m clock wise Or
MA = + 200 N.m
MB = 1200 N.m clock wise Or
MB = + 1200 N.m
MC = O.
Mc = O
MD =. 400 N.m anti clock wise
MD = - 400N.m

2.4 Principle of Moment/ Varignon's Theorem

It is stated that the moment of a force about a point is equal to the sum of the moments of the force components about the point. Or the moment produce by the resultant force is equal to the moment produce by the force components.

Mathematically MFo = Σ Mo

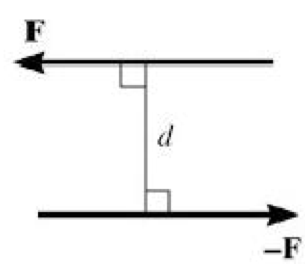
Example 3: A 200 N force acts on the bracket as shown determine the moment of force about "A"



Given F=200N θ = 45º
Required MA =?
Solution Resolve the force into components F1 am F2
F1= F cos θ F1=200 cosine 45º
F1=141.42N.
F2= F sin θ F2 = 200 sin 45º
F2= 2.468N.
We know that MA = 0
MA = moment produce due to component F1+ moment produce due to component F2.
MA =F1 x r1+ F2 x r2.
Let us consider that clock wise moment is + ve.
MA = F1 x r1+ F2 x r2
MA = - 141.42 x 0.1 + 2.468 x (0.1 +0.1)
MA = - 13.648 N
MA = 13 .648 N anti clock wise.

2.5 Couple

When two parallel forces that have the same magnitude but opposite direction is known as couple. The couple is separated by perpendicular distance. As matter of fact a couple is unable to produce any straight-line motion but it produces rotation in the body on which it acts. So couple can be defined as unlike parallel forces of same magnitude but opposite direction which produce rotation about a specific direction and whose resultant is zero



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2.5.1 Application of Couple

1. To open or close the valves or bottle head, tap etc
2. To wind up a clock.
3. To Move the paddles of a bicycle
4. Turning a key in lock for open and closing.

2.5.2 Couple Arm

The perpendicular distance between the lines of action of the two and opposite parallel forces is known as arm of the couple.

2.5.3 Moment of couple or couple moment

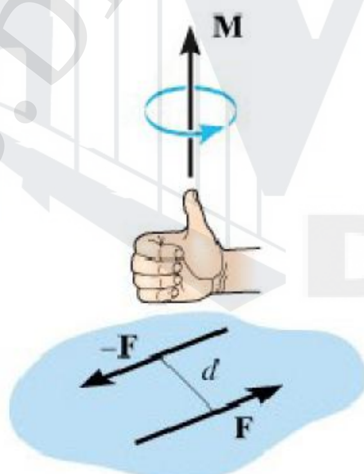
The moment of the couple is the product of the force (one of the force of the two equal and opposite parallel forces) and the arm of the couple. Mathematically

Moment of couple = force x arm of couple

Moment of couple = F x r

2.5.4 Direction of couple

The direction and sense of a couple moment is determined using the right hand rule, here the thumb indicates the direction when the fingers are curled with the sense of rotation caused by the two forces.



2.5.5 Classification of Couple

The couplet are classified as clockwise couple and anticlockwise couple

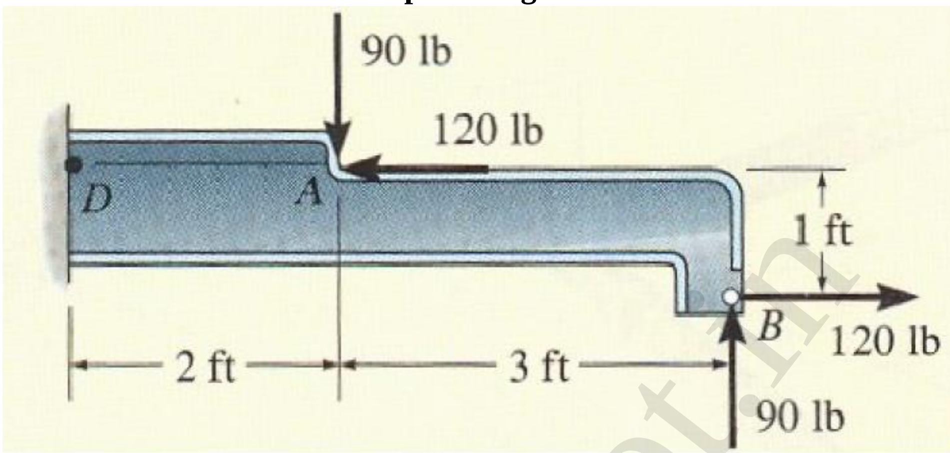
1. Clockwise couple

A couple whose tendency is to rotate the body in a clockwise direction is known as clockwise couple

2. Anticlockwise couple

A couple whose tendency is to rotate the body in anticlockwise direction is known as anticlockwise couple

Example 4: Determine the moment of couple acting on the moment shown.



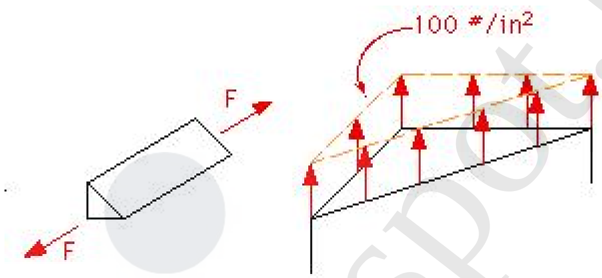
GivenF1=F2 =90lb F3 = F4 = 120lb.

Required Moment of couple = M=?
Solution The moment of couple can be determined at any point for example at A, B or D.
Let us take the moment about point B
MB = Σ F R.
MB = -F1 x r1 – F2 x r2 .
MB = - 90(3) – 120 (1)
MB = - 390 lb ft
Result MB = MA=MD =390 lb .ft counter clock wise.
Moment of couple = 390 lb.ft count clock wise

UNIT III PROPERTIES OF SURFACES AND SOLIDS

3.1 Centroid and Areas

The equivalent force and centroid problem has many guises. In some instances, it is not force that is being integrated, but volume or area. For instance, suppose that we have bar with a triangular cross section that is under tension. If the bar is long (>> 4 times the width), we can assume that the tension is uniform throughout the cross section, mid-length along the member.This is known as a uniform stress distribution



Uniform tension stress in a triangular bar

3.2 Centre of Gravity

The center of gravity is a point where whole the weight of the body act is called center of gravity. As we know that every particle of a body is attracted by the earth towards its center with a magnitude of the weight of the body. As the distance between the different particles of a body and the center of the earth is the same, therefore these forces may be taken to act along parallel lines. A point may be found out in a body, through which the resultant of all such parallel forces acts. This point, through which the whole resultant (weight of the body acts, irrespective of its position, is known as center of gravity (briefly written as C.G). It may be noted that every body has one and only one center of gravity.

3.2.1 Centroid

The plane figures (like triangle, quadrilateral, circle etc.) have only areas, but no mass. The center of area of such figures is known as Centroid. The method of finding out the Centroid of a figure is the same as that of finding out the center of gravity of a body.

3.2.2 Axis of Reference

The center of gravity of a body is always calculated with referrer to some assumed axis known as axis of reference. The axis of reference, of plane figures, is generally taken as the lowest line of the figure for calculating y and the left line of the figure for calculating x.

3.3 Methods For Centre of Gravity of Simple Figures

The center of gravity (or Centroid) may be found out by any one of the following methods

I. By geometrical considerations

2. By moments method
3. By graphical method

3.4 Center of Gravity by Geometrical Considerations

The center of gravity of simple figures may be found out from the geometry of the figure

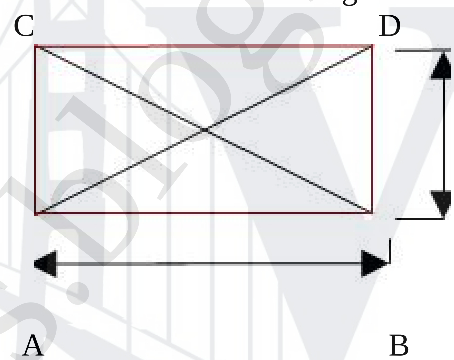
The center of gravity of plane figure

1. The center of g of uniform rod is at its middle point

A L B

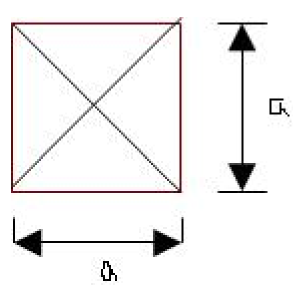
Center of gravity = L / 2 from point A or B

2. The center of gravity of a rectangle is at a point, where its diagonals meet each other. It is also a mid point of the length as well as the breadth of the rectangle as shown in fig



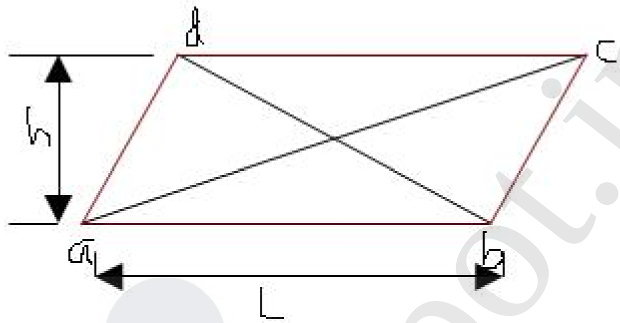
G = L/2
from AD or BC
G = h/2
from AB or DC
Area = L x

3. The center of gravity of a square is a point, where its diagonals meet each other. It is a mid point of its side as shown in fig



G = a/2 from any Area = 2x a

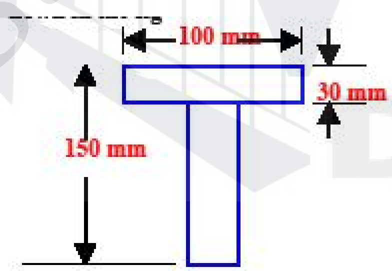
4. The center of gravity of a parallelogram is at a point, where its diagonals meet each other. It is also a mid point of the length as well as the height of the parallelogram as shown in fig



3.5 Centre of Gravity By Moments

The center of gravity of a body may also be found out by moments as discussed below. Consider a body of mass M whose center of gravity is required to be found out. Now divide the body into small strips of masses whose centers of gravity are known as shown in fig

Example1: Find the center of gravity of a 100 mm x 150 mm x 30 mm T-section. As shown in the fig



Given Height = 150 mm width = 100 mm
thick ness = 30 mm
Required center of gravity = y =?
Working formulae y = Σa y or **y = a1 y1 + a2y2 + a3 y 3 +………**

_	Body	Area mm²	Distance (y) mm	Area x y
1	Rectangular ABCD	a1 = 100 x 30 = 3000	30/2 = 15	3000 x 15 =
2	Rectangular EFGH	a2 = (150 – 30) x 30 = 3600	150-30/2 = 135	3600 x135=
		∑ = 9600		∑ = 531000

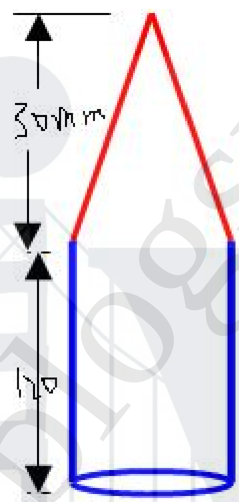
Put in the working formula
y = Σa y = 531000 Y = 94.09 mm

Result center of gravity = 94.09 mm

3.6 Centre Of Gravity Of Solid Bodies

The center of gravity of solid bodies (such as hemisphere, cylinder, right circular solid cone etc) is found out in the same way as that of the plane figures. The only difference between the plane and solid bodies is that in the case of solid bodies we calculate volumes instead of areas

Problem 2: solid body formed by joining the base of a right circular cone of height H to the equal base of right circular cylinder of height h. calculate the distance of the center of gravity of the solid from its plane face when H = 120 mm and h = 30 mm



Given cylinder height = h = 30 mm
Right circular cone = H = 120 mm
Required center of gravity =?
Working formula
$y = v_1 y_1 + v_2 \ / v_1 + v_2$
Solution
Consider the cylinder
Volume of cylinder = $\pi \times r^2 \times 30 = 94.286\ r^2$
C.G of cylinder = $y_1 = 30/2 = 15$mm
Now consider the right circular cone
Volume of cone = $\pi/3 \times r^2 \times 120 = 377.143\ r^2$
C.G of cone = $y_2 = 30 + 120/4 = 60$ mm
Put the values in the formula
$y = v_1 y_1 + v_2 y_2 = 94.286\ r^2 \times 15 + 377.143\ r^2 \times 60$
$v_1 + v_2 \ 94.286\ r^2 + 377.143\ r^2$
$y = 40.7$ mm
Result center of gravity = 40.7 mm

3.7 Centre of Gravity of Sections with Cut Out Holes

The center of gravity of such a section is found out by considering the main section; first as a complete one and then deducting the area of the cut out hole that is taking the area of the cut out hole as negative. Now substituting the area of the cut out hole as negative, in the general equation for the center of gravity, so the equation will become

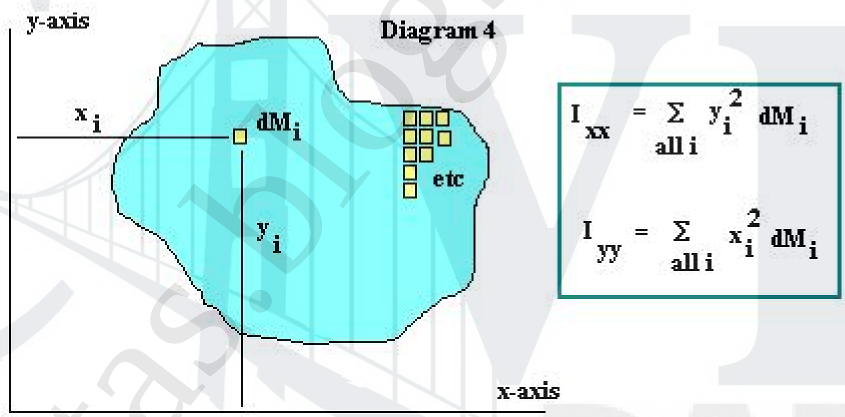
$$x = a1\ x1 - a2\ x\ 2/\ a1 - a2$$

Or

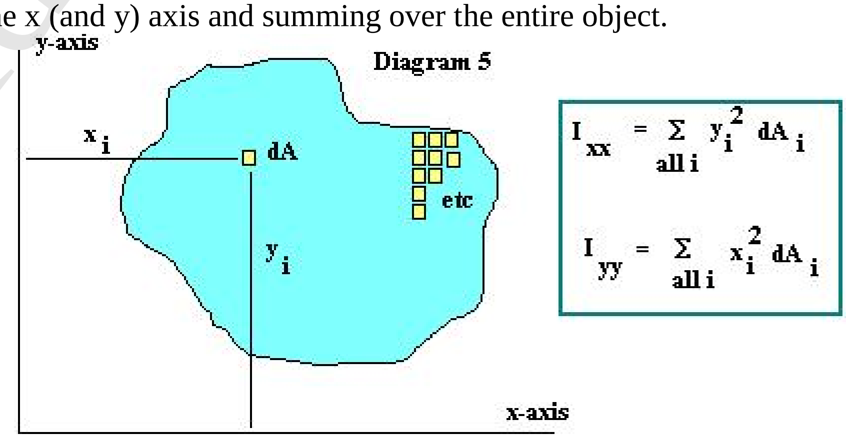
$$y = a1\ y1 - a2\ y\ 2/a1 - a2$$

3.8 Moment of Inertia

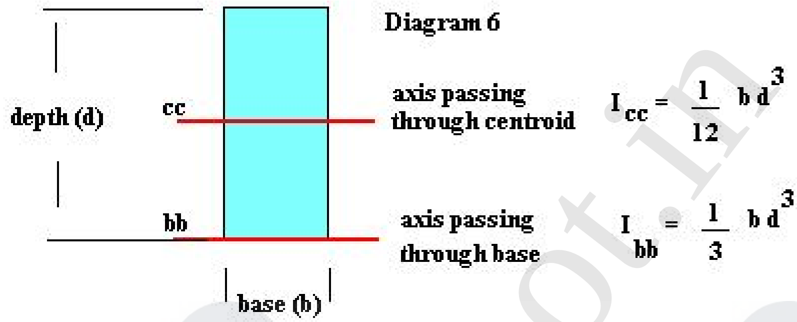
A second quantity which is of importance when considering beam stresses is the Moment of Inertia. Once again, the Moment of Inertia as used in Physics involves the mass of the object. The Moment of Inertia is obtained by breaking the object into very small bits of mass dM, multiplying these bits of mass by the square of the distance to the x (and y) axis and summing over the entire object. See Diagram



For use with beam stresses, rather than using the Moment of Inertia as discussed above, we will once again use an Area Moment of Inertia. This Area Moment of Inertia is obtained by breaking the object into very small bits of area dA, multiplying these bits of area by the square of the distance to the x (and y) axis and summing over the entire object.



The actual value of the moment of inertia depends on the axis chosen to calculate the moment of the inertia with respect to. That is, for a rectangular object, the moment of inertia about an axis passing through the centroid of the rectangle is: I = 1/12 (base * depth^3) with units of inches^4., while the moment of inertia with respect to an axis through the base of the rectangle is: I = 1/3 (base * depth^3) in^4. See Diagram 6. Note that the moment of inertia of any object has its smallest value when calculated with respect to an axis passing through the centroid of the object.



3.9 Parallel Axis Theorem

Moments of inertia about different axis may calculated using the **Parallel Axis Theorem**, which may be written: $\mathbf{I_{xx} = I_{cc} + Ad_{c\text{-}x}^2}$ This says that the moment of inertia about any axis ($\mathbf{I_{xx}}$) parallel to an axis through the centroid of the object is equal to the moment of inertia about the axis passing through the centroid ($\mathbf{I_{cc}}$) plus the product of the area of the object and the distance between the two parallel axis ($\mathbf{Ad_{c\text{-}x}^2}$).We lastly take a moment to define several other concepts related to the Moment of Inertia.

Radius of Gyration: $\mathbf{r_{xx} = (I_{xx}/A)^{1/2}}$ The radius of gyration is the distance from an axis which, if the entire area of the object were located at that distance, it would result in the same moment of inertia about the axis that the object has.

Polar Moment of Inertia $\mathbf{J = \Sigma\, r^2\, dA}$ The polar moment of inertia is the sum of the produce of each bit of area dA and the radial distance to an origin squared. In a case as shown in belowthe polar moment of inertia in related to the x & y moments of inertia by: $\mathbf{J = I_{xx} + I_{yy}}$.

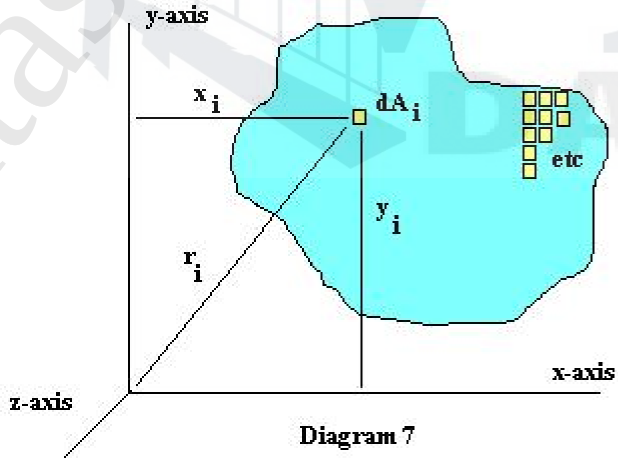


Diagram 7

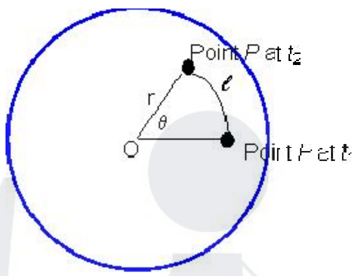
One final comment - all the summations shown above become integrations as we let the dM's and dA's approach zero. And, while this is important and useful when calculating Centroids and Moments of Inertia, the summation method is just as useful for understanding the concepts involved.

UNIT IV DYNAMICS OF PARTICLES

4.1 Displacement

Change in position, that is, where an object is in relation to some reference point. It is measured in metres (m), and its symbol is usually, **x**, or **s** or sometimes **d.**

4.2 Angular Displacement



When an object moves along a straight path, we describe how far it has moved by its displacement. When an object rotates we describe how far it has rotated by its angular displacement .The mathematics of circular motion is much simpler if we measure the angle in radians rather than degrees. One radian as defined as an angle whose arc length is equal to its radius, or in general:

$$\theta = \frac{\ell}{r}$$

4.3 Angular Velocity

The angular velocity is defined in relationship to the angular displacement in the same way that the linear velocity was defined in relationship to the linear displacement. The average angular velocity is given by the Greek letter omega (w), and is defined as the rate of change of the angular displacement.

$$\omega = \frac{\Delta\theta}{\Delta t}$$

4.4 Angular Acceleration

Likewise, the average angular acceleration is defined as the rate of change of the angular velocity, and is given by the Greek letter alpha ( ).

$$\alpha = \frac{\Delta\omega}{\Delta t}$$

and the instantaneous angular acceleration is given by;

$$\alpha = \lim_{\Delta t \to 0} \frac{\Delta \omega}{\Delta t} = \frac{d\omega}{dt}$$

4.5 Rectilinear motion

The particle is classically represented as a point placed somewhere in space. A rectilinear motion is a straight-line motion.

4.6 Curvilinear motion

The particle is classically represented as a point placed somewhere in space. A curvilinear motion is a motion along a curved path.

4.7 Impulse and momentum

Impulse

The impulse of the force is equal to the change of the momentum of the object.

Momentum

The total momentum before the collision is equal to the total momentum after the collision

4.8 Newton's law of motion

LAW	**DEFINTION**	**SPORTING EXAMPLE**
1ST **Law of inertia**	A body remains at rest or in motion unless acted upon by a force Inertia: a body's tendency to remain at rest or in motion	Sumo Sky diving Rugby

2ND **Law of acceleration** **[F = M x A]**	The acceleration of an object is proportional to the force causing it, is in the same direction as the force and relates to the mass of the object	Cricket drive Shot put Volleyball spike
3RD **Law of reaction**	For every action there is an equal/opposite reaction	High jump take off Sprint start

4.9 work energy Equvation

Energy in its different forms is a useful means of analysing Mechanics problems. The forms of energy include:

Kinetic Energy is the energy an object has due its motion. It is calculated from the definition:

$$KE = ½ mv^2.$$

The mass must be in kilograms, and the velocity in metres per second, and KE is measured in joules.Gravitational Potential Energy is the energy an object has due to its position, as with all forms of potential energy. In this case, the position is the position in a gravitational field, which can be measured from any reference point, but usually the surface of the earth. It is calculated from the definition:

Grav Pot'l E = mgh

The mass must be in kilograms, the value of 'g' is the acceleration due to gravity, 10 or 9.8 m/s^2, and 'h' is the height above the reference point. Again the unit of energy is joules.

Elastic Potential Energy is the energy stored in a compressed or stretched material.

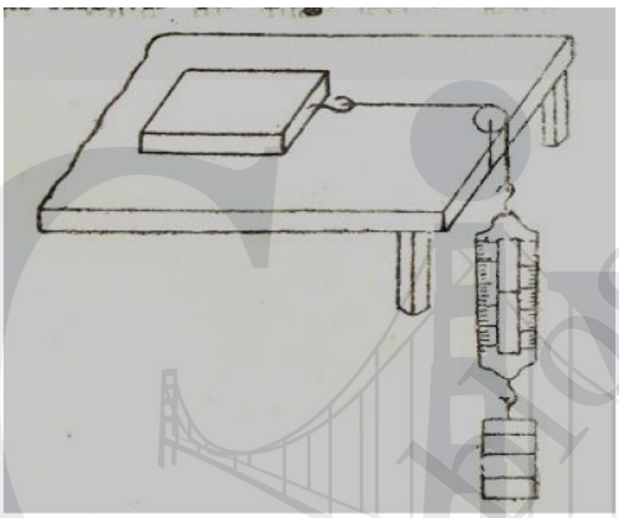
Energy cannot be created or destroyed; it is just converted from one form to another. Other forms of energy include Light, Sound and Thermal energy. This means that the total amount of energy is constant or that Energy is conserved.

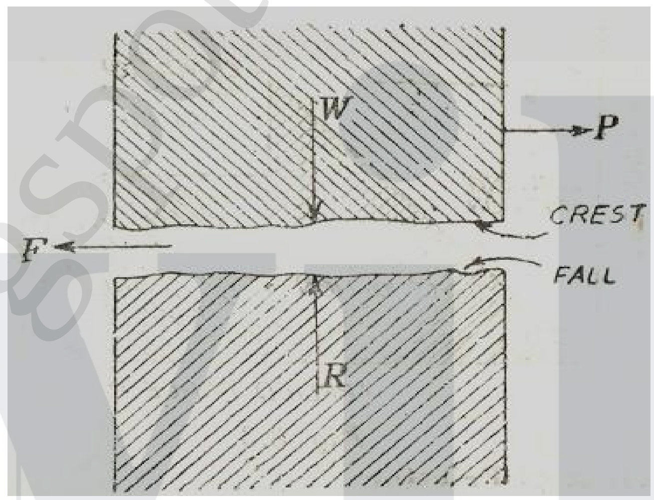
UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS

5.1 Friction

A force which prevents the motion or movement of the body is called friction or force of friction and its direction is opposite to the applied external force or motion of the body. Friction is a force of resistance acting on a body which prevents or retards motion of the body. Or When a body slides upon another body, the property due to which the motion of one relative to the other is retarded is called friction. This force always acts tangent to the surface at points of contact with other body and is directed opposite to the motion of the body.

5.1.1 Explanation





The other end of the string is connected to the spring balance. Apply an external force on the balance. Gradually increase the magnitude of the external force. Initially the body will not move and the effect of the applied force is nullified. This is because there acts a force on the block which opposes the motion or movement of the block. The nature of this opposing force is called friction. It depends upon many factors. The major cause of friction is the microscopic roughness of the contact surfaces. No surface is perfectly smooth. Every surface is composed of crests and falls as shown in fig b. It is the interlockingof the crests of one surface into the falls of the other surface which produces the resistance against the movement of one body over the other body. When the force exerted is sufficient to overcome the friction, the movement ensures and the crests are being sheared off. This gives rise to heat and raises the local temperature. This is also the reason of the wear of the contact surfaces. This phenomenon of friction necessitates the presence o fluid film between the two surfaces to avoid wear of surfaces. The process of creating the fluid film is called lubrication

5.2 Types of Friction

Friction is of the following two types.

5.2.1 Static Friction

It is the friction acting on the body when the body is at the state of rest or the friction called into play before the body tends to move on the surface is called static friction. The magnitude of the static friction is equal to the applied force. It varies from zero to maximum until the movement ensures.

5.2.2 Dynamic Friction

It is the friction acting on the body when body is in motion is called dynamic friction. Dynamic friction is also known as kinetic friction. The magnitude of the dynamic friction is constant.

The dynamic friction has two types

i. Sliding Friction
ii. ii. Rolling Friction

i. Sliding friction

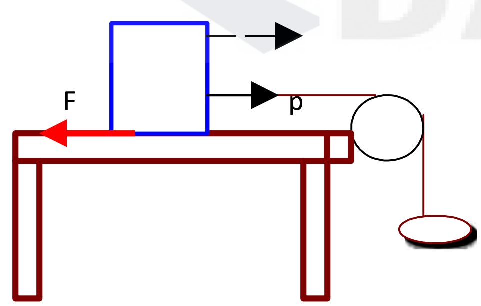
The sliding friction acts on those bodies, which slide over each other for example the friction between piston, and cylinder will slide friction because the motion of the motion of the piston in cylinder is sliding and there is surface contact between piston and cylinder.

ii. Rolling Friction

The rolling friction acts on those bodies which have point contact with each other for example the motion of the wheel on the railway track is the example of rolling motion and the friction between the wheel and railway track is rolling friction. It is experimentally found that the magnitude of the sliding friction is more than the rolling friction because in the rolling friction there is a point contact rather than surface contact.

5.3 Limiting Friction

The maximum friction (before the movement of body) which can be produced by the surfaces in contact is known as limiting friction .It is experimentally found that friction directly varies as the applied force until the movement produces in the body.

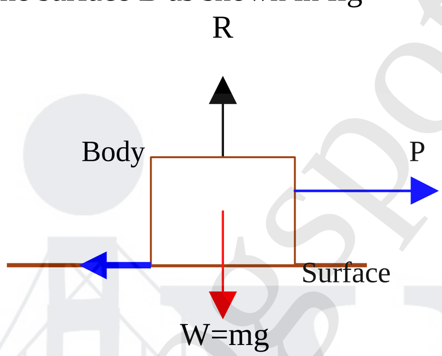


Let us try to slide a body of weight w over another body by a force P as shown in fig

A little consideration will show that the body will not move because the friction F which prevents the motion. It shows that the applied force P is exactly balanced by the force of friction acting in the opposite direction of applied force P. if we increase the force P by increasing the weight in the pan, the friction F will adjust itself according to applied force P and the body will not move. Thus the force of friction has a property of adjusting its magnitude to become exactly equal and opposite to the applied force which tends to produce the motion.There is however a limit beyond which the friction cannot increase. If the applied force increases this limit the force of friction cannot balance applied force and body begins to move in the direction of applied force. This maximum value of friction, which acts on body just begin to move, is known as limiting friction. It may be noted that when the applied force is less than the limiting friction the body remains at rest, and the friction is called static friction, which may have any values zero to limiting friction.

5.4 Normal Reaction

Let us consider a body A of weight "W" rest over another surface B and a force P acting on the body to slide the body on the surface B as shown in fig



A little concentration will show that the body A presses the surface B downward equal to weight of the body and in reaction surface B lift the body in upward direction of the same magnitude but in opposite direction therefore the body in equilibrium this upward reaction is termed as normal reaction and it is denoted by R or N.

Note

It is noted the weight W is not always perpendicular to the surface of contact and hence normal reaction R is not equal to the weight W of body in such a case the normal reaction is equal to the component of weight perpendicular to surface.

5.5 Co Efficient of Friction

The ratio of limiting friction and normal reaction is called coefficient of friction and is denoted by μ.

Let R = normal reaction

And F = force of friction (limiting friction)

μ = Co efficient of friction

$F/R = \mu$

$\mathbf{F = \mu R}$

5.6 Laws of Friction

These laws are listed below:

5.6.1 Laws of Static Friction

- The force of friction always acts in a direction opposite to that in which the body tends to move.

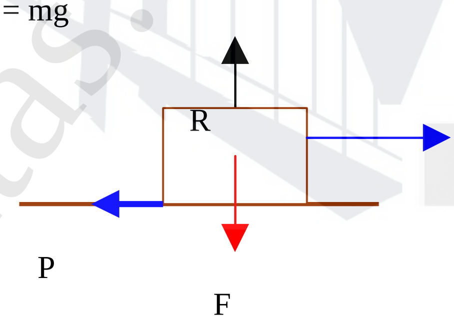
- The magnitude of force of static friction is just sufficient to prevent a body from moving and it is equal to the applied force.
- The force of static friction does not depend upon, shape, area, volume, size etc. as long as normal reaction remains the same.
- The limiting force of friction bears a constant ratio to normal reaction and this constant ratio is called coefficient of static friction.

5.6.2 Laws of Dynamic Friction

- When a body is moving with certain velocity, it is opposed by a force called force of dynamic friction.
- The force of dynamic friction comes into play during the motion of the body and as soon as the body stops, the force of friction disappears.
- The force of dynamic friction is independent of area, volume, shape, size etc. of the body so long the normal reaction remains the same. However, to some extent it varies with the magnitude of
- velocity of the body. Force of dynamic friction is high for low speeds and low for very high speeds.
- The ratio of force of dynamic friction and normal reaction on the body is called coefficient of dynamic friction.

Example 1: A horse exerts a pull of 3 KN just to move a carriage having a mass of 800 kg. Determine the co efficient of friction between the wheel and the ground. Take g = 10 m/sec²

Given P = 3 KN Mass = m = 800 Kg g = 10 m/sec²
Required co efficient of friction = μ =?
Working formula F = μ R
Solution we know that W = mg
W = 800 x 10 = 8000 N

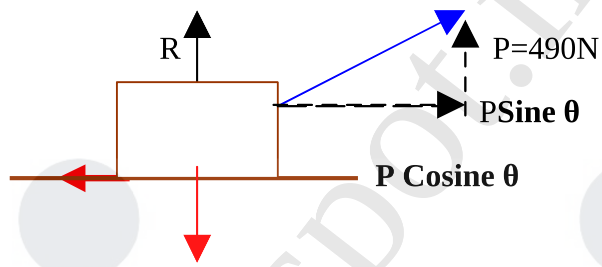


A little consideration will show that the weight of the carriage is equal to the normal reaction because that the body is horizontal to the plane as shown in fig
Therefore W = R and P = F
put the values in working formula we get
300 = μ 8000
μ =0.375
Result co efficient of friction = 0.375

Example 2: A pull of 490 N inclined at 30º to the horizontal is necessary to move a block of wood on a horizontal table. If the coefficient of friction between to bodies in contact is 0.2 what is the mass of the block.

Given P = 490 N θ = 30º μ = 0.2
Required mass of block =?
Solution

Now consider the following diagram and also resolve the force P into horizontal and vertical components.



F = μ R
w = mg
Now apply the condition of equilibrium the forces acting in x axis is positive
Σ Fx = 0
P Cosine θ – F = 0
P Cosine θ – μ R = 0
490 Cosine 30– 0.2 x R = 0 Therefore
R = 2121.762
Now consider the forces acting in y axis is positive
Σ Fy= 0
R + P Sine θ – W = 0
R + P Sine θ – mg = 0
2121.762 + 490 Sine 30– m x 9.81 = 0
m = 241.260 Kg
Result mass of the wooden block = 241.260 Kg

Example 3: A body of mass 100 Kg rests on horizontal plane the co efficient of friction between body and the plane 0.40. Find the work done in moving the body through a distance of 20 m along the plane.
Given m = 100 Kg μ = 0.40 d = 20 m
Required work done =?
Working formula 1 W = F x d
2 Fs = μ R
Solution we know that R = W = mg
R = W = 10 x 9.81 = 98.1 N
Put the values in 2nd working formula we get
Fs = 0.40 x 98.1
Fs = 39.24 N
Now put the values in 1st working formula
W = 39.24 x 20
W = 748.8 N
Resultant weight = 748.8 N

GE6253: ENGINEERING MECHANICS

UNIT -1(BASICS & STATICS OF PARTICLES)

1. **Define force?**

Force is a physical quantity that changes or tires to change the state of rest or of uniform motion of an object

2. **Differenciate between particles and rigid body?**

Particle is a body which has mass but no dimension where as rigid body as both mass and dimensions.Particle can have only translational motion where as rigid body can have translational as well as rotational motion.

3. **State newton's first law of motion?**

Everybody tries to be in it's state of rest or of uniform motion along a straight line unless it's acted upon by an external unbalanced force .

4. **State newton's second law of motion?**

The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction of the force .

5. **State newton's third law of motion?**

Every action has an equal and opposite reaction .

6. **State law of parallelogram of vectors?**

If two vectors are represented in magnitude and direction by two adjacent sides of a parallelogram,their resultant is represented in magnitude and direction by the diagonal of the parallelogram drawn from the common point.

7. **State the principle of transmissibility of force with simple sketch?**

According to principle of transmissibility of force,the force can be transmitted from one point to another on it is line of action without causing by any change in the motion of the object. EG:force F can be transmitted from A to B.

8. **Define unit vector?**

A vector having magnitude one unit is known as a unit vector .

9. **Define the following terms?**

(a)coplanar forces

(b)concurrent forces

(a)If all forces act in one plane,they are known as coplanar forces.

(b)If lines of action of all forces intersected at a single point,the forces are known as concurrent forces.

10. **Defferentiate between collinear and concurrent forces?**

Collinear forces act along the same line where as concurrent forces have lines of action intersecting at one point.

11 **.Define resultant of coplanar concurrent force system?**

A system of coplanar concurrent forces can be reduced to a single force which is known as resultant force.

12. **what is the difference between a resultant force and equilibrant force?**

Resultant force makes the object move whereas equilibrant force keeps it in equilibrium.

13. **state triangle law of forces?**

If two forces are represented in magnitude and direction by two sides of a triangle taken in order,their resultant is represented in magnitude and direction by the third side of the triangle drawn from starting point of first force to end point of the second force.

14. **State parallelogram law of forces?**

If two forces are represented in magnitude and direction by two adjacent sides of a parallelogram,their resultant is represented in magnitude and direction by the diagonal of the parallelogram drawn from the common point.

15. **Statelami's theorem?**

If three concurrent forces are in equilibrium,magnitude of any force is proportional to the sine of angle between the other two forces.

16. **State the necessary and sufficient condition for static equilibrium of a particle in two dimensions?**

For static equilibrium of a particle in two dimensions,

i)The algebraic sum of horizontal components of all forces acting the particle must be zero.

ii) The algebraic sum of vertical components of all forces acting the particle must be zero.

17 **.State triangle law of equilibrium?**

If three forces acting on a particle are represented by the three sides of a triangle in magnitude and direction when taken in order,the particle will remain in equilibrium.

18.**What is a free body diagram?**

A force system,in a plane,in which the lines of action all forces intersect at a single point is called coplanar concurrent force system.

UNIT- 2(EQUILIBRIUM OF RIGID BODIES)

1.State varignon's theorem?

The algebraic sum of moments due to all forces acting on the object about any point is equal to the moment of their resultant about the same point.

2.Define couple?

Twonon collinear parallel forces having same magnitude but opposite direction from a couple.

3.**Why the couple moment is said to be a free vector?**

Couple moment is said to be a free vector as it can be transferred to any point in the plane without causing any change in its effect on the body.

4.Distinguish between couple and moment?

Moment represents the turning effect of a force where as couple consists of two equal and opposite forces separate by some distance.moment of force various from point to point but moment of a couple is same about any point in the plane.

5.What is meant by force-couple system?

A system of coplanar non concurrent force system acting in a rigid body can be replaced by a single resultant force and couple moment at a point known as force couple system.

6.Can a coplanar non concurrent system with zero resultant force necessarily be in equilibrium?

A coplanar non concurrent system with zero resultant force is not necessarily In equilibrium as it can have a non zero resultant moment.

7.When is moment of force zero about a point?

The moment of force about a point is zero its line of action passes through that point.

8.When is moment of force maximum about a point ?

Moment of force is maximum about a point when,

i)Its applied at maximum result from the point and,

ii)It is applied perpendicular to the line joining the point to the point of application of force.

9.When is moment of force zero about a line?

Moment of force about a line is zero when,

i)Force is parallel to that line or,

ii)Line of action of force intersects that line.

10.Explain free body diagram with one example?

Free body diagram is the isolated diagram of an object\system of objects\any point in the system in which all forces at couple moment acting on it are shown including support reactions example:consider a ladder of weight W having rollers at it's end's as shown in figure.

11.Statethe necessary and sufficient conditions for equilibrium of rigid bodies in two dimensions?

The necessary and sufficient conditions for equilibrium of rigid bodies in two dimensions are:

1)algebraic sum of horizontal components of all forces acting on the body is must be zero,

2)Algebraic sum of vertical components all forces acting on the body is must be zero,

3)Algebraic sum of moments due to all forces and couple moments acting the body is in must be zero.

12.Write the equation of equilibrium of a rigid body?

The three equations of a rigid body are:

$\sum F_x=0$,;

$\sum F_y=0$,;

$\sum M=0$.

13.Write the conditions equilibrium of a system of parallel force acting in a plane ?

The two conditions of equilibrium of a system of parallel forces acting in a plane are :

1)Algebraic sum of all forces must be zero,

2)Algebraic sum of moments due to all forces about any point must be zero.

14.What are the reactions at a fixed support of a plane beam that are possible?

The reaction at fixed support of a plane beam consist of ,

1)A reaction force in the plane which can be represented by it's two components(Generally taken to be horizontal and vertical)&,

2)Areaction moment.

15.How many scalar equations can be obtained for equilibrium of rigid body in three dimensions?

Six scalar equations can be obtained for equilibrium of a rigid body in three dimensions.

UNIT- 3(PROPERTIES OF SURFACES AND SOLIDS)

1. **Define centroid of gravity.**
   Centroid is the geometrical center of the body whereas center of gravity is the point through which weight of the body acts.

2. **Difine first moment of an area about of an axis.**

The first moment of an area about of an axis is the product of an area and the perpendicular distance of its centroid from axis.

3. Define line of symmetry.

Line of symmetry is line a about which the area on one side is a mirror image of the area of the side

4. State pappus-guldinus theorem for finding surface area.

The area of surface of revolution is equal to the product of the length of the generating curve and the distance travelled by the centroid of the generating curve while generating that surface.

5.What is uniform motion.

If the velocity of body does not change with time ,then the motion is called as uniform motion.

6.state parallel axis theorem.

Moment of inertia of an area about an axis is equal to the sum of (a) moment of inertia an axis passing through the centroid parallel to the given axis and (b) the product of area and square of the distance between the two parallel axes.

7.Define principal axes and principal moment of inertia.

The axes about which moments or inertia is maximum and minimum are known as principal axes .when these two axes are passing through centroid of aera it is known a centroidal principal axis.now the maximum and minimum moments of inertia are called principal moments of inertia.

8.What is called the coefficient of static friction.

As the force ‘P’ increases, ‘F’ also increases but the body remains at rest and is in equilibrium. If ‘F’ reaches a limiting value friction or from when ‘P’ is increases it loses its balance and hence the body slides to right.

9.state the Coulomb’s laws of dry friction.

(i) when a body kept on another body is subjected to a horizontal force, friction force developed at the surfaces of contact of two bodies has a magnitude equal to that of the horizontal force applied. When one body moves over another,the magnitude of the friction force is less than that of the horizontal force.

(ii) The friction force acts in the direction opposite to that of the moving body.

(iii) The friction force is proportional to the normal reaction developed at the contact surface.

(iv) The friction force does is not depend on the apparent area of the surfaces in contact

10.What is the condition in terms of efficiency for a machine to be self-locking.

When the efficiency of a machine is less than 50%, it is said to be self-locking

[illegible]

1.State D'Alembert's principle

The force system consisting of external forces and inertia force can be considered to keep the particle in equilibrium.since the resultant force externally acting on the particle is not zero ,the particle is said to be in dynamic equilibriums.the principle is known as D'Alembert's principle.

2.what is general plane motion.

Any plane motion which is neither a rotation nor a translation but considered as the sum of translation and rotation.

3.Define the term co-efficient of restitution.

The co-efficient of restitution between two bodies in a collision is defined as the ratio of the relative velocity of their separation after collision to the relative of their approach before collision.

4.Define angle friction.

Angle of friction is the angle between resultant reaction of one body on another and normal to the common tangent between two bodies when the motion is impending.

5.what are motion curves.

The path described by a particle or a rigid body with respect to time is called motion curve.

6.what do you understand by kinematics

Kinematics refers to the study of bodies in motion without considering the force that causes motion.

7.Define Dynamics.

Dynamics is the branch of mechanics.which deals with the analysis of particles bodies in motion.

UNIT- 5(FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS)

1.Define instantaneous centre of rotation.

Instantaneous centre of rotation is a point identified with in a body where the velocity is zero.

2.Define co-efficient of restitution.

It is ratio of magnitudes of impulses corresponding to the period of restitution and to the period of deformation is called coefficient of restitution .

3.Define kinetics.

Study of bodies subjected to forces which are unbalanced is called kinetics.

4. Define kinematics

The study of geometry and time dependent aspects of motion without considering forces causing motion.

5.Define Angular momentum.

Momentum of linear momentum is called angular momentum.

6.what is general plane motion ? give some examples.

When motion of particles and rigid bodies defined in a plane is called plane motion.
Example :All planets revolving around the sun.

7.Define Relative velocity.

Assume particle A moves with a velocity of Va and particle B moves with a velocity Vb.

8.Define Resultant velocity.

Assume particle A moves to x direction Vx and in y direction Vy this resultant velocity.

9.How will you calculate the linear restoring force of an elastic material.

Linear restoring force of an elastic material.
F=kx
Where k is the stiffness of the material and x is the displacement.

10.state the principle of work and energy.

The principle of work and energy or work energy equation is written as
Work done =final kinetis energy - initial kinetis energy

11.Define instantaneous centre of rotation.

A rigid body in plane motion can be considered to rotate about a point that remains at a particular instant. This point having zero instantaneous velocity is called the instantaneous centre of rotation.

ENGINEERING MECHANICS – QUESTION BANK

Sub. Name: Engg. Mechanics

UNIT I - PART-A

1.Distinguish the following system of forces with a suitable sketch. a) Coplanar b) Collinear

2.Define Kinetics and Kinematics

3.State Lami's theorem with a sketch.

4.State parallelogram law and triangle law of forces.

5.What are fundamental and derived units? Give examples

6.Distiguish between units and dimensions. Give examples.

7.Define principle of transmissibility.

8.A force vector F= 700i + 1500j is applied to a bolt. Determine the magnitude of the force and angle it forms with the horizontal.

9.A force of magnitude 50 KN is acting along the line joining A(2,0,6) and B(3,-2,0)m. Write the vector form of the force.

10.Two forces of magnitude 50 KN and 80 KN are acting on a particle, such that the angle between the two is 135°. If both the force are acting away from the particle, calculate the resultant and find its direction.

11.A 100N force acts at the origin in a direction defined by the angles $\theta x = 75°$ and $\theta y = 45°$.Determine θz and the component of the force in the Z-direction.

12.Write the equations of equilibrium of a coplanar system of forces.

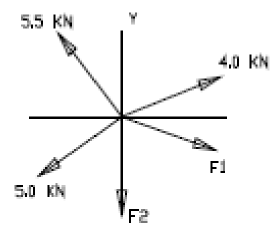
13.Differentiate between 'Resultant' and 'Equilibrant'

14.Find the resultant of an 800N force acting towards eastern direction and a 500N force acting towards north eastern direction.

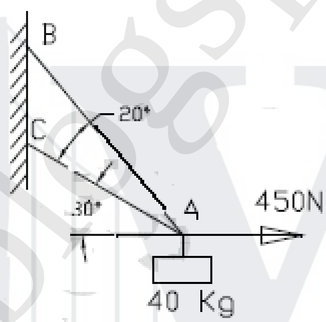
15.Find the magnitude of the two forces such that if they act at right angles, their resultant isÖ10 N. But if they act at 60° their resultant is Ö13 N.

UNIT I - PART-B

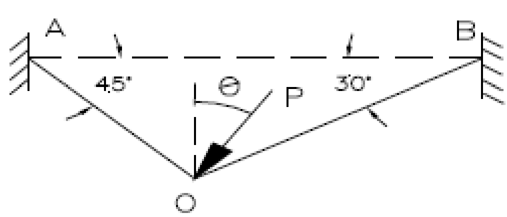
1. The forces shown in the figure below are in equilibrium. Determine the forces F1 and F2



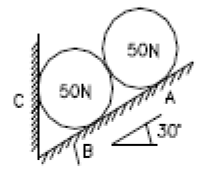
2. Determine the tension in cables AB & AC to hold 40 Kg load shown in fig.



3. A force P is applied at 'O' to the string AOB as shown in fig. If the tension in each part of string is 50 N, find the direction an magnitude of force P for equilibrium conditions.



4. Two identical rollers each of weight 50N are supported by an inclined plane and a vertical wall as shown in fig. Find the reactions at the points of supports A, B, and C.

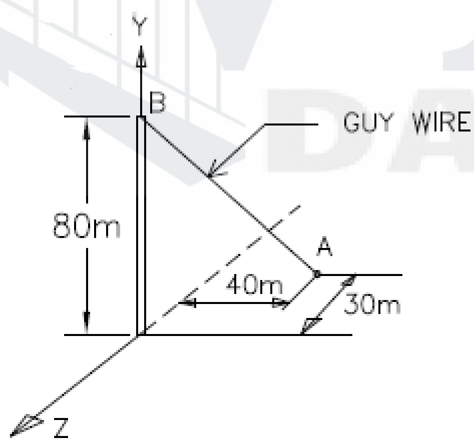


5. A tower guy wire shown below is anchored by means of a bolt at A as shown. The tension in the wire is 2500kN.

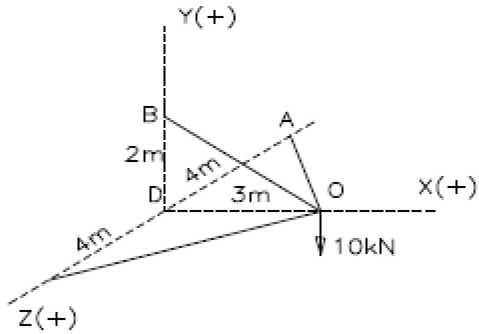
Determine

a) the components F_x,F_y & F_z of the force acting on the bolt

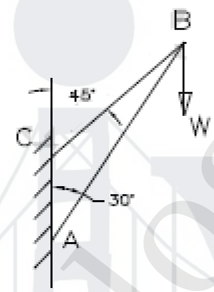
b) the angles _x, _y, _z defining the direction of the force.



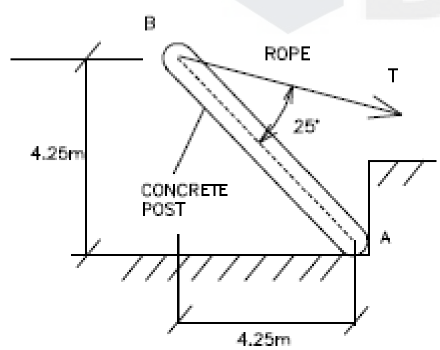
6. Members OA, OB and OC form a three member space truss. A weight of 10 KN is suspended at the joint 'O' as shown in fig. Determine the magnitude and nature of forces in each of the three members of the truss



7. A crane shown in figure is required to lift a load of W=10 KN. Find the forces in the members AB and CB

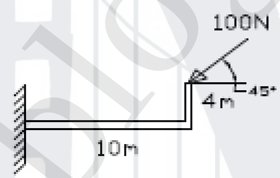


8. A precast concrete post weighing 50 Kg and of length 6m shown in fig. is raised for placing it in position by pulling the rope attached to it. Determine the tension in the rope and the reaction at A.



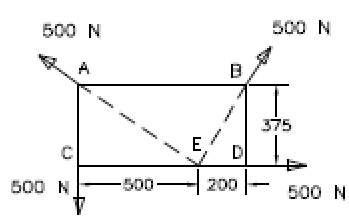
UNIT II - PART-A

1. State Varignon's theorem
2. What is a couple? what is a moment of a couple?
3. A force vector F has the components Fx = 150N, Fy= -200N and Fx = 300N. Determine the magnitude F and the angle made by the force with coordinate axes.
4. Sketch the different types of supports.
5. Write down the conditions of equilibrium of a particle in space
6. A force vector of magnitude 100N is represented by a line of coordinates A (1, 2, 3) and B (5, 8, 12). Determine components of the force along X, Y and Z axes.
7. Explain will you reduce a force into an equivalent force-couple system with an example.
9. Draw Compute the moment of the 100 N force about point A and B

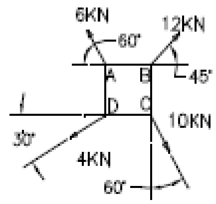


UNIT II - PART-B

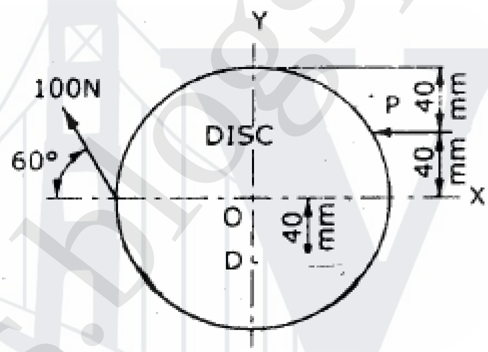
1. Four forces act on a 700mm X 375mm plate as shown in fig. a) Find the resultant of these forces b) Locate the two points where the line of action of the resultant intersects the edge of the plate.



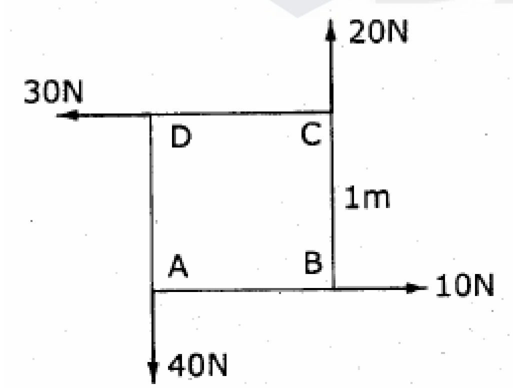
2. Four coplanar non concurrent non parallel forces act on a square plate of side 2m as shown in fig. Locate the resultant force.



3. In figure below, two forces act on a circular disc as shown. If the resultant moment of all these forces about point D on the disc is zero, determine: a) Magnitude of force P (b) Magnitude of the resultant of two forces (c) The point on the Y-axis through which the line of action of the resultant passes through.



4. Four forces act on a square of side 1 m as shown in fig. Reduce the force system into an equivalent force – couple system at A.



5. Reduce the system of forces shown in fig.5 to a force – couple system at A.

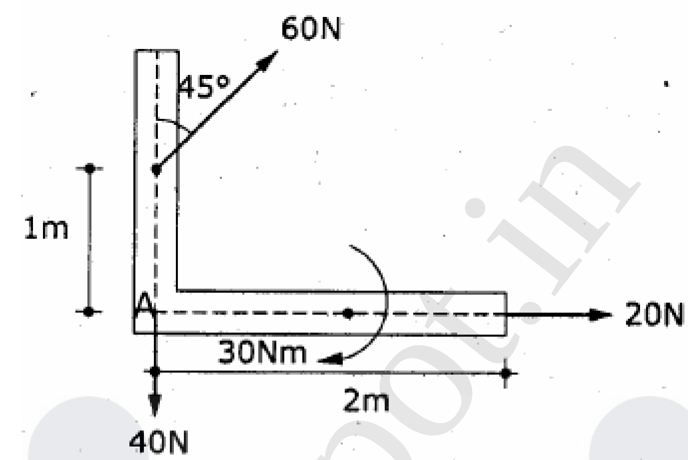
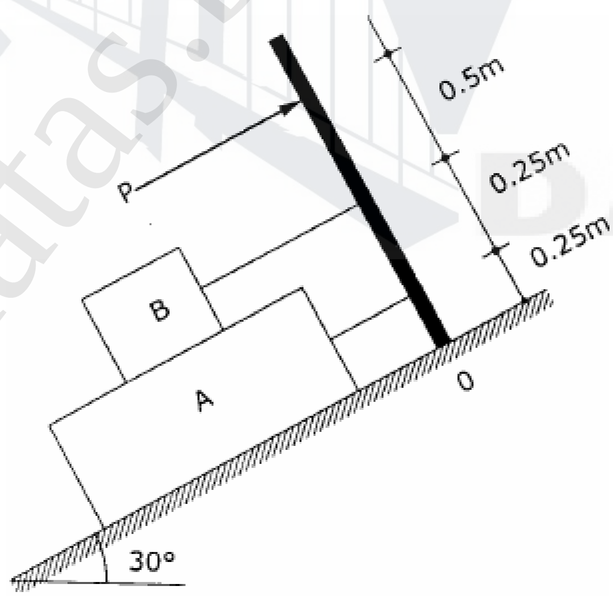
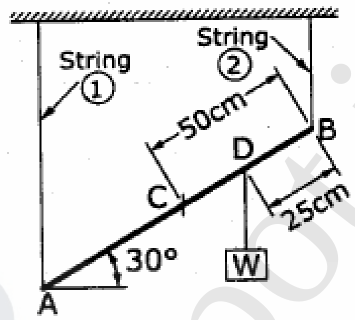


Fig.5

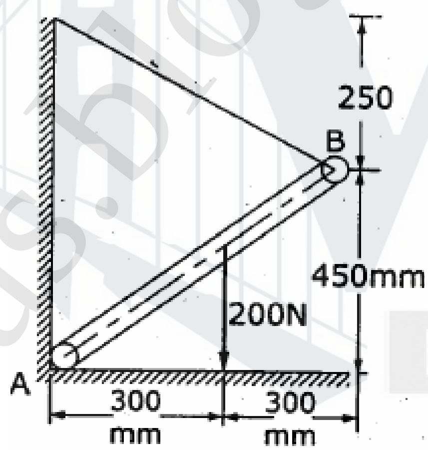
6. Blocks A and B of weight 200N and 100N respectively, rest on a 30 inclined plane and are attached to the post which is held perpendicular to the plane by force P, parallel to the plane, as shown in fig. Assume that all surfaces are smooth and that the cords are parallel to the plane. Determine the value of P. Also find the Normal reaction of Blocks A and B.



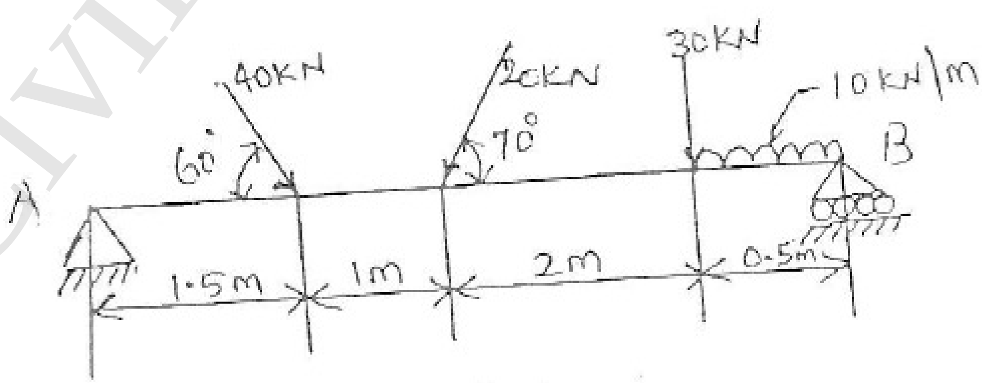
8. A Uniform meter rod AB, assumed rigid of mass 0.5 kg is suspended from its ends in an inclined position and a mass of 1 kg is suspended from a point D, as shown in fig. Determine the tension in each string. Where should the suspended mass be placed in order to get equal tension in the strings.



9. A rod AB of weight 200 N is supported by a cable BD and the corner of wall and floor surface as shown in fig. Find the reaction at A and tension in the cord.



10. Find reactions at points A & B

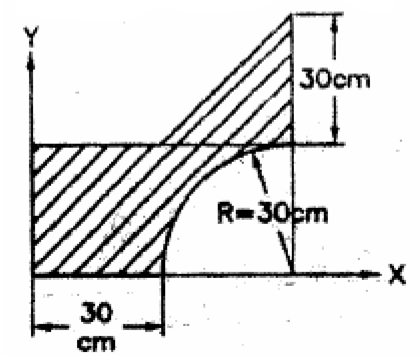


UNIT III - PART-A

1. State parallel axis theorem
2.State perpendicular axis theorem
3.Find the polar moment of inertia of a hollow circular section of external diameter ‘D’ and internal diameter ‘d’
4.Define principal axes and principal moment of inertia
5.Locate the centroid and calculate the moment of inertia about centroidal axes of a semicircular lamina of radius 2m.
6.A semicircular area having a radius of 100 mm is located in the XY-plane such that its diameter
coincides with Y-axis.Determine the X-coordinate of the center.
7.Distiguish between centroid and center of gravity.
8.Define polar moment of inertia.
9.Differentiate between ‘Mass moment of inertia’ and ‘Area moment of inertia’
10.Write down the expression for finding mass moment of inertia of a cylinder of radius ‘R’ and height ‘h’ about its base.

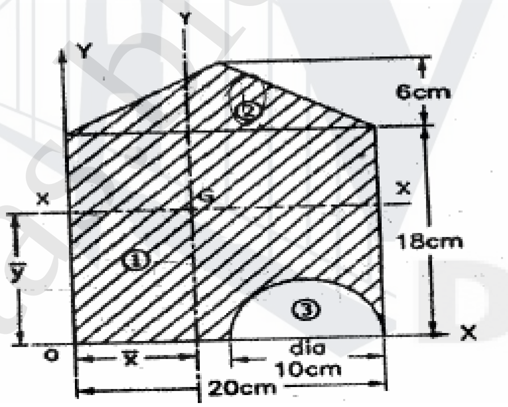
UNIT III - PART-B

1. Determine the co-odinates of centroid of the shaded area shown in figure.

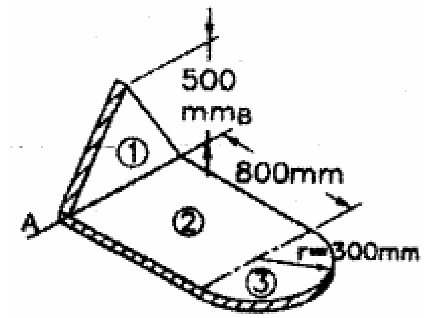


2. A Cylinder of height of 10 cm and radius of base 4 cm is placed under sphere of radius 4 cm such that they have a common vertical axis. If both of them are made of the same material, locate the centre of gravity of the combined unit.

3. Find the moment of inertia of the section shown in the figure about its horizontal centroidal axis.



4. Calculate the mass moment of inertial of the plate shown in figure with respect to the axis AB. Thickness of the plate is 5 mm and density of the material is 6500 Kg/m3.



5. Derive expression form mass moment of inertia of prism along three axes.

UNIT IV - PART-A

1. Define D'Alembert's principle

2.Write down the equations of motion of a particle under gravitation

3.A car accelerates uniformly from a sped of 30 Km/Hr to a speed of 75 Km/Hr in 5 secs. Determine the acceleration of the car and the distance traveled by the car during 5 secs.

4.Explain dynamic equilibrium

5.State the law of conservation of momentum

6.A car starts from rest with a constant acceleration of 4m/sec2. Determine the distance traveled in the 7th second.

7.A point P moves along a straight line according to the equation x= 4t3+2t+5, where x is in meters and t is in secs. Determine the velocity and acceleration at t=3 secs.

8.A stone is projected in space at an angle of 45° to horizontal at an initial velocity of 10 m/sec. Find the range of the projectile.

9.What is work energy principle

10.Write the impulse momentum equation.

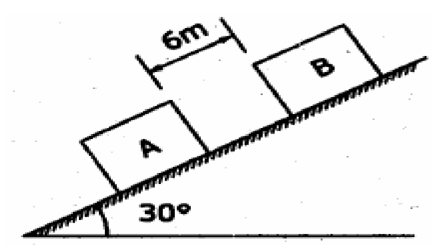
UNIT IV - PART-B

1. A train is traveling from A to D along the track shown in fig. Its initial velocity at A is zero. The train takes 5 min to cover the distance AB, 2250 m length and 2.5 minutes to cover, the distance BC, 3000 m in length, on reaching the station C, the brakes are applied and the train stops 2250 m beyond, at D (i) Find the retardation on CD, (ii) the time it takes the train to get from A to D, and (iii) its average speed for the whole distance.

2. The position of the particle is given by the relation $S=1.5t^3-9t^2-22.5t+60$, where S is expressed in meters and t in seconds. Determine (i) the time at which the velocity will be zero (ii) the position and distance traveled by the particle at that time (iii) the acceleration of the particle at that time and (iv) the distance traveled by the particle from t = 5s to t = 7s.

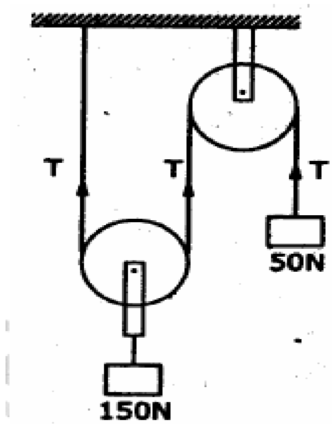
3. A particle is projected with a initial velocity of 12m/s at an angle M with the horizontal. After sometime, the position of the particle is observed by its x and y distances of 6m and 4m respectively from the point of projection. Find the angle of projection.

4. Two Blocks A and B of weight 100 N and 200 N respectively are initially at rest on a 30° inclined plane as shown in figure. The distance between the blocks is 6 m. The co efficient of friction between the block A and the plane is 0.25 and that between the block B and the plane is 0.15. If they are released at the same time, in what time the upper block (B) reaches the Block (A).

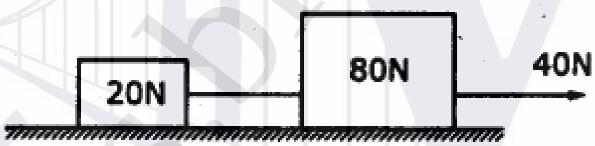


5. Two blocks of weight 150 N and 50 N are connected by a string and passing over a frictionless pulley as shown in figure. Determine the acceleration of blocks A and B and the

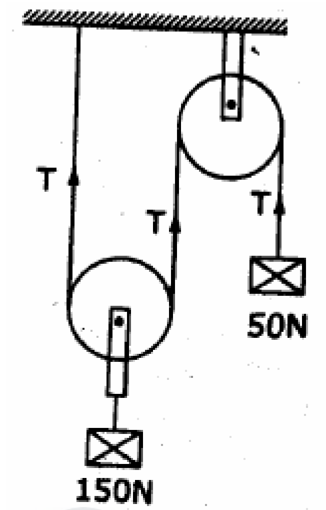
tension in the string.



6. Two weights 80 N and 20 N are connected by a thread and move along a rought horizontal plane under the action of a force 40 N, applied to the first weight of 80 N as shown in figure. The coefficient of friction between the sliding surfaces of the wrights and the plane is 0.3. Determine the acceleration of the weights and the tension in the thread using work-energy equation.

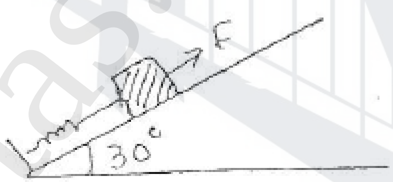


7. Two blocks of weight 150N and 50N are connected by a string, passing over a frictionless pulley as shown in fig. Determine the velocity of 150N block after 4 seconds. Also calculate the tension in the string.



8. Two bodies, one of mass 30kg, moves with a velocity of 9m/s centrally. Find the velocity of each body after impact, if the coefficient of restitution is 0.8.

A force F = 30 N acts parallel to the inclined plane as it accelerates a block of mass m = 2 kg upto the 30° incline with a coefficient of kinetic friction $\mu_K = 0.3$ as shown in fig. 5. A spring whose force constant 'K' is 40 Nm^{-1} is attached to the block which starts from rest at a position $x = 0$, where the spring is unstressed. Find the speed of the block after travelling 0.2 m up the incline? Use work energy method.



UNIT V - PART-A

1.Give mathematical definitions of velocity and acceleration.

2.A Car traverses half of a distance with a velocity of 40 Kmph and the remaining half of distance with a velocity of 60 Kmph. Find the average velocity.

3.Define friction and classify its types.

4.Classify the types of friction.

5.Define Limiting friction.

6.Define coefficient of static friction.

7.Stat coulomb's laws of dry friction.

8.Define rolling resistance.

9.What is coefficient of rolling resistance?

10.Define coefficient of friction and express its relationship with angle of friction.

11.If $x=3.5t^3 - 7t^2$, determine acceleration, velocity and position of the particle, when t = 5 sec.

12.Consider a wheel rolling on a straight track. Illustrate the characteristics of general plane motion.

13.Write work energy equation of rigid body. Mention the meaning for all parameters used in the equation.

14.What us general plane motion? Give some examples.

15.Define Limiting friction.

16.Define Co-efficient of friction and angle of friction

17.Define coulomb's laws of dry friction.

18.Define impending motion.

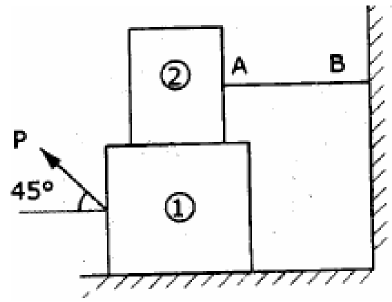
19.Define angle of repose

20.Define cone of friction.

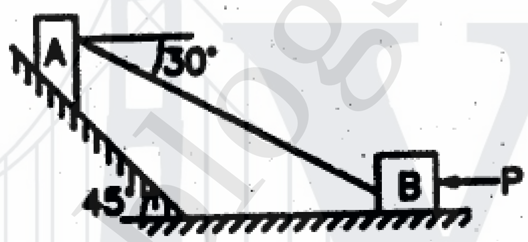
21.Define the following terms i) Ladder friction. ii) Wedge friction iii) Screw friction iv) Belt friction.

UNIT V - PART-B

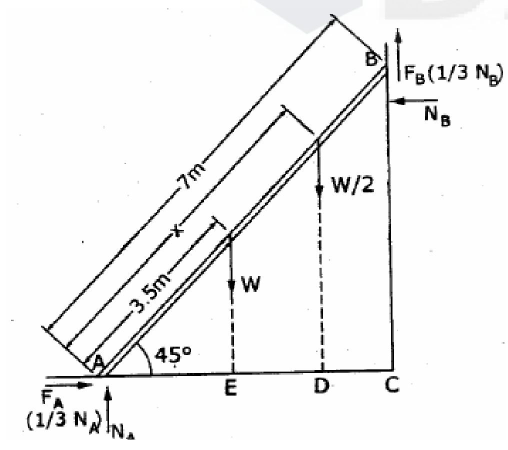
1. Block (2) rests on block (1) and is attached by a horizontal rope AB to the wall as shown in fig. What force P is necessary to cause motion of block (1) to impend? The co-efficient of friction between the blocks is ¼ and between the floor and block (1) is 1/3. Mass of blocks (1)and(2) are 14kg and 9 kg respectively



2. Block A weighing 1000 N rests on a rough inclined plane whose inclination to the horizontal is 45°. It is connected to another block B, weighing 3000 N rests on a rough horizontal plane by a weightless rigid bar inclined at an angle of 30° to the horizontal as shown in fig. Find the horizontal force required to be applied to the block B just to move the block A in upward direction. Assume angle of friction as 15° at all surfaces where there is sliding.



3. A 7m long ladder rests against a vertical wall, with which it makes an angle of 45° and on a floor. If a man whose weight is one half that of the ladder climbs it, at what distance along the ladder will he be, when the ladder is about to slip? Take coefficient of friction between the ladder and the wall is 1/3 and that between the ladder and the floor is ½.



4. In a screw jack, the pitch of the square threaded screw is 5.5 mm and means diameter is 70 mm. The force exerted in turning the screw is applied at the end of lever 210 mm long measured from the axis of the screw. If the co-efficient of friction of the screw jack is 0.07. Calculate the force required at the end of the lever to (i) raise a weight of 30 KN (ii) lower the same weight.

5. An effort of 200 N is required just to move a certain body up an inclined plane of angle 15°, the force is acting parallel to the plane. If the angle of inclination of the plane is made 20°, the effort required being again parallel to the plane, is found to be 230 N. Find the weight of the body and coefficient of friction.

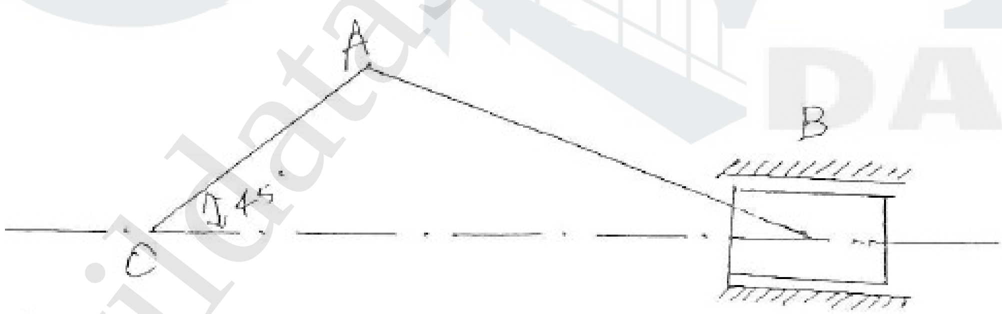
6. Find the force P inclined at an angle of 32° to the inclined plane making an angle of 25 degree with the horizontal plane to slide a block weighing 125 KN (i) up the inclined plane (ii) Down the inclined plane, when P = 0.5.

A reciprocating engine mechanism is shown in fig. 7. The crank OA is of length 150 mm and rotating at 600 rpm. The connecting rod AB is 700 mm long. Find

(i) The angular velocity of the connecting rod. (5)

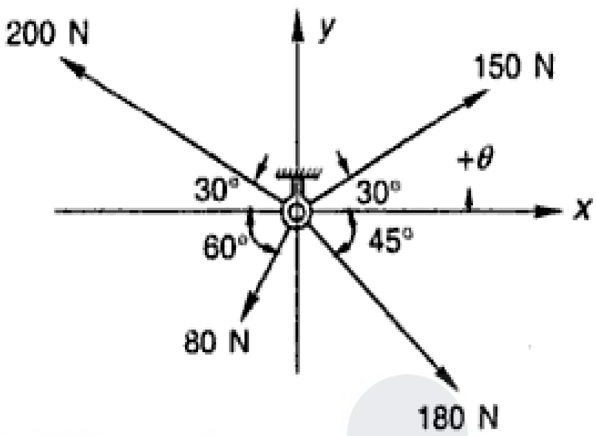
(ii) The velocity of piston B. (5)

(iii) The velocity of point C on the connecting rod at a distance of 200 mm from A when $\theta = 45°$ (6)

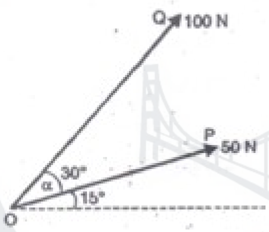


GE6253 Engineering Mechanics Important Questions

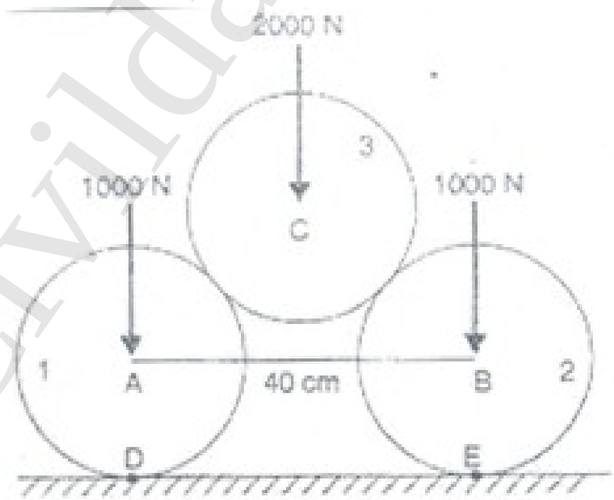
1. Find the resultant force and its direction for the given figure



2. Two forces are acting at a point O as shown in Figure Determine the resultant in magnitude and direction of the force.



3. Two smooth circular cylinders each of weight 1000 N and radius 15 cm are connected at their centers by a string AB of length 40 cm and rest upon a horizontal plane, supporting above them a third cylinder of weight 2000 N and radius 15 cm as shown in Figure. Find the force S in the string AB and reactions on the floor at the points of contact D and E.



4. Find the tension in each cable for the given Figure

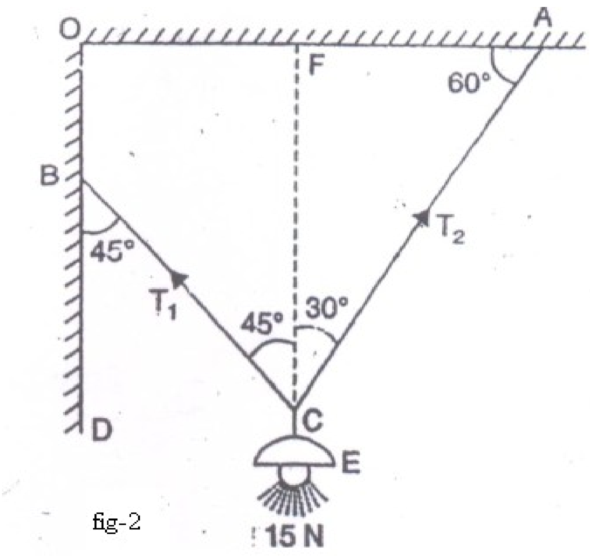
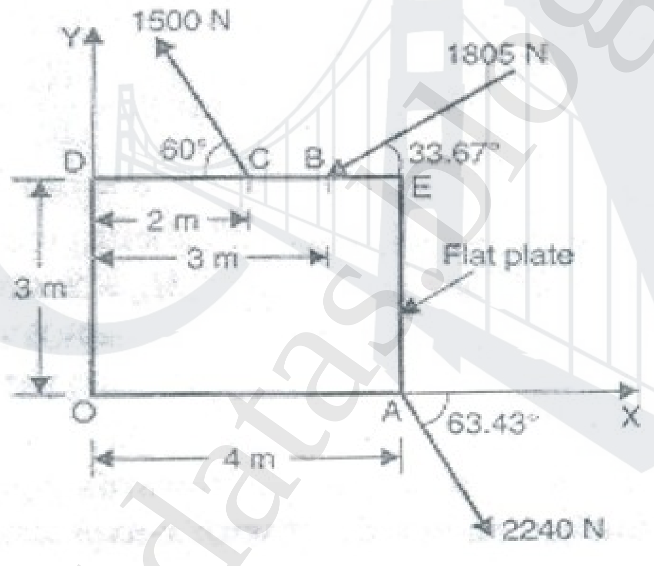
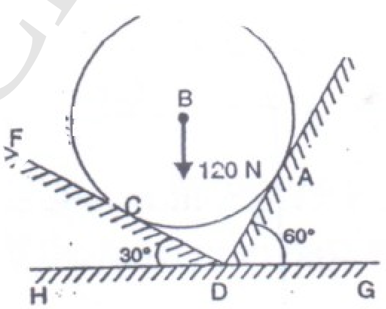


fig-2

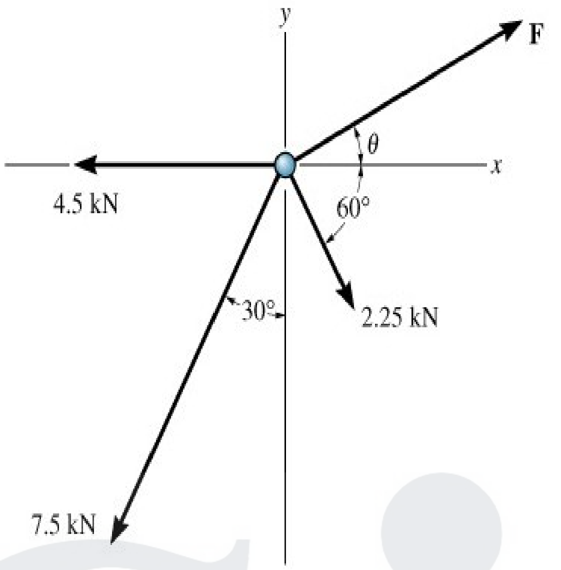
5. The Following figure Shows the coplanar system of forces acting on a flat plate. Determine i) the resultant ii) x and y intercepts of the resultant



6. The magnitude of the resultant of 2 concurrent forces including an angle of 90° between them is √13 KN when the included angle between them is 60° , the magnitude of their resultant is √19 KN. Find the magnitude of the 2 forces.
7. Find the tension in each cable for the given figure

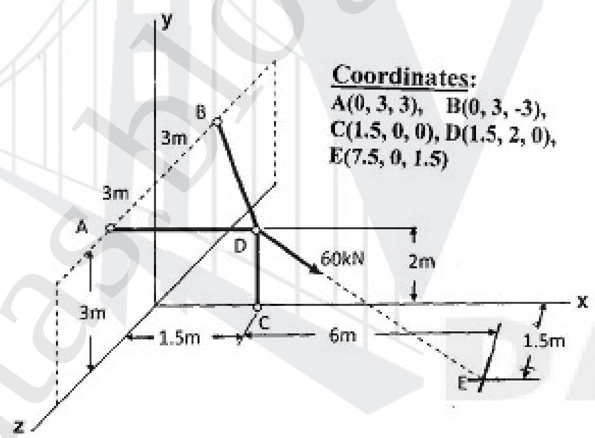


8. Determine the magnitude and angle of F so that the particle is in equilibrium for the given Figure



9.

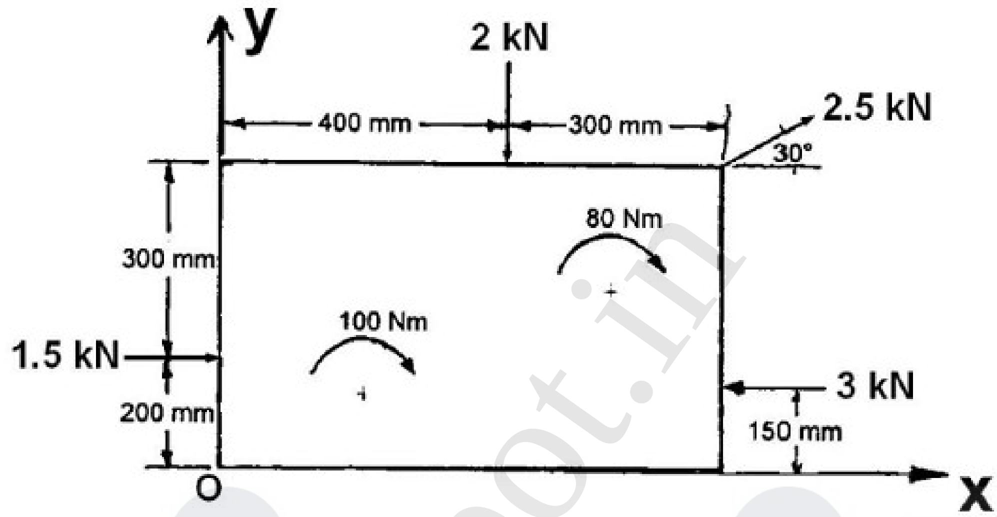
In the figure shown, three wires are joined at D.



Two ends A and B are on the wall and the other end C is on the ground. The wire CD is vertical. A force of 60 kN is applied at 'D' and it passes through a point E on the ground as shown in figure. Find the forces in all the three wires.

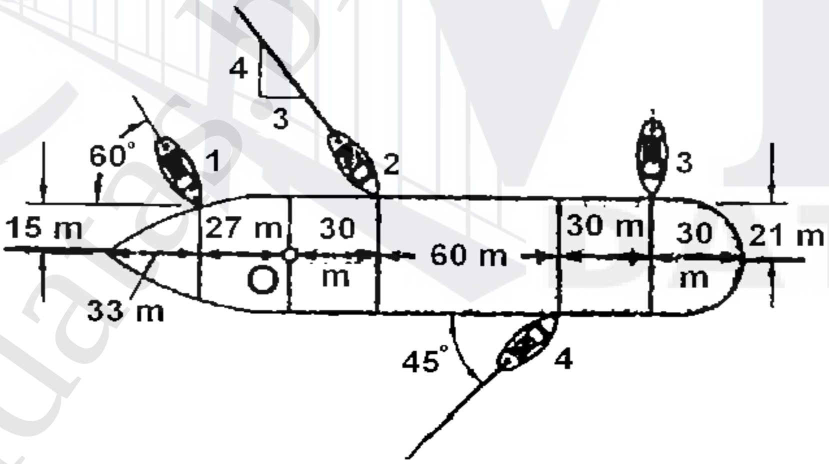
10.

A force couple system acting on a rectangular plate is shown in figure.

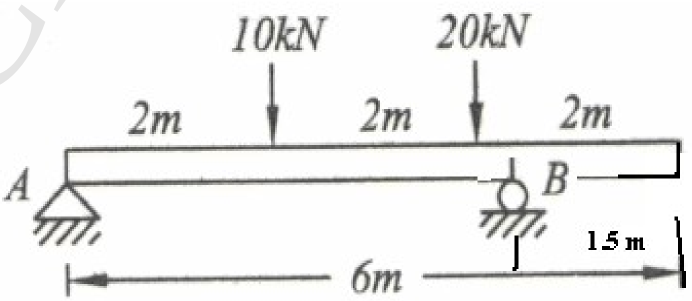


(i) Find the equivalent force-couple system at the origin O.
(ii) Find the single resultant force and its location on the x-axis.

11. Four tugboats are used to bring an ocean large ship to its pier. Each tugboat exerts a 22.5 KN force on the direction as shown in the Figure. i. Determine the equivalent force-couple system at O. ii) Determine a single equivalent force and its location along the longitudinal axis of the ship



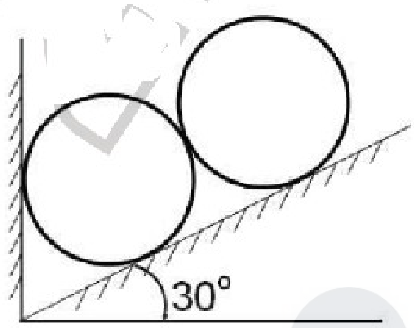
12. Determine the reactions at supports A and B of overhanging beam shown in **Figure**



13. The X,Y, Z components of a force 54kN, -36kN and 36kN respectively. Find the magnitude of the force and angle it makes with X, Y and Z axes. Also find the component of the force along the line joining A (1, 2, - 3) and B (- 1, - 2, 2)

14.

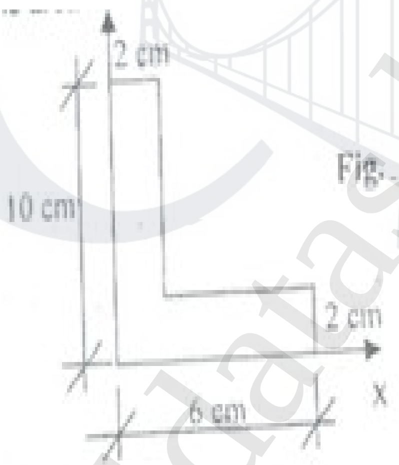
Two identical rollers, each of weight 500 N, are supported by an inclined plane making an angle of 30° to the horizontal and a vertical wall as shown in the figure.



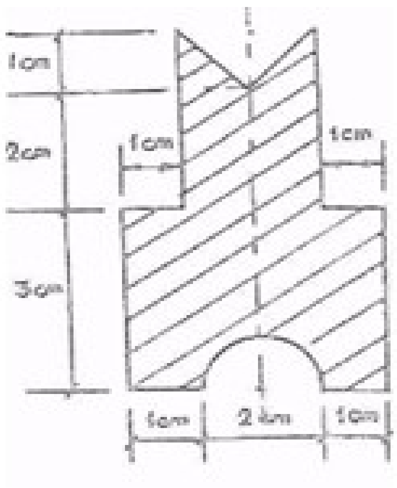
(i) Sketch the free body diagrams of the two rollers.

ii) Assuming smooth surfaces, find the reactions at the support points.

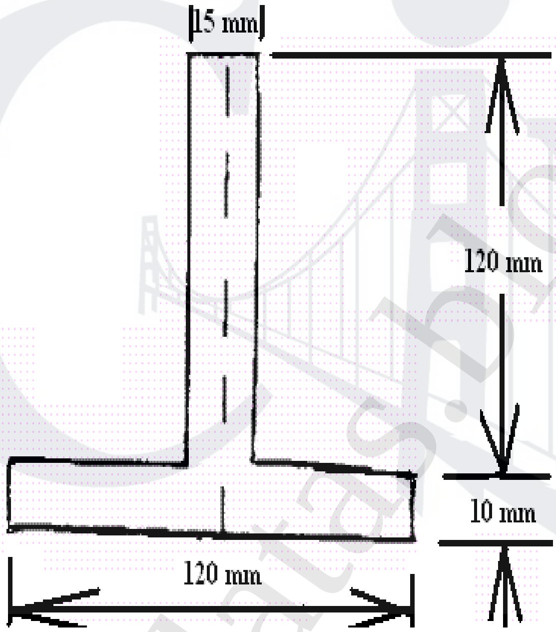
15. Find the area Moment of Inertia about centroidal axes for the given area



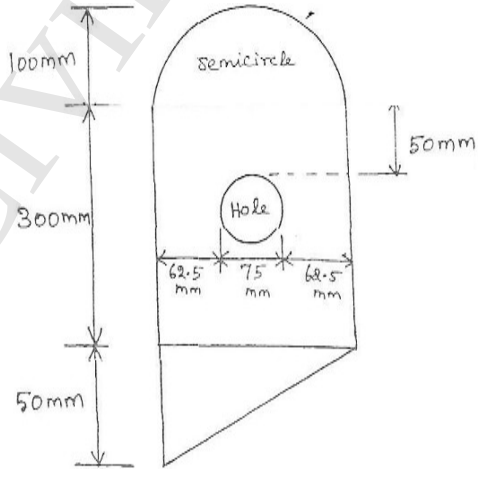
16. Determine the radii of gyration for the plane section shown in Figure about its centroidal axes



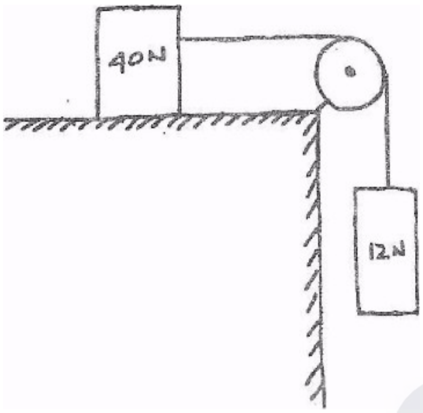
17. An inverted T section is shown in Figure. Calculate the moment of inertia of the section about XX axis parallel to the base and passing through the Centroid. Also calculate radius of gyration



18. Locate the Centroid and find I_{XX}, I_{YY}. about the axes passing through the Centroid of lamina



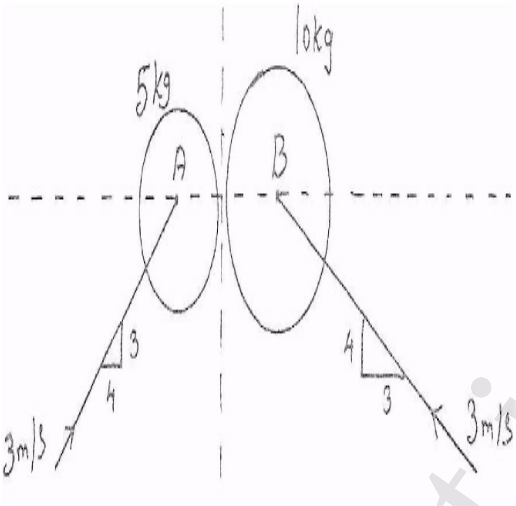
19. A 40 N mass is dragged along the surface of the table by means of a cord which passes over a frictionless pulley at the edge of the table and is attached to a 12 N mass as shown in Figure **.** If the coefficient of Motion between 40 N mass and the table is 0.15, determine the acceleration of the system and tension in the cord



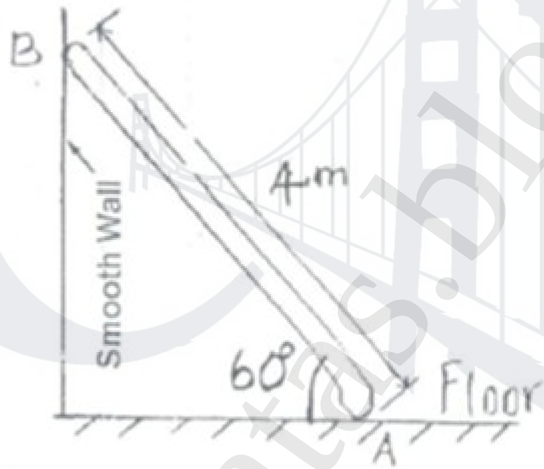
20. A projectile is fired with an initial velocity of 250 m/*s* at a target located at a horizontal distance of 4 km and vertical distance of 700 m above the gun. Determine the value of firing angle to hit the target. Neglect air resistance

21. Two weights 80 N and 20 N are connected by a thread and move along a rough horizontal plane under the action of force 40 N, applied to the first weight of 80 N as shown in Figure. The coefficient of friction between the sliding surfaces of the weight and the plane is 0.3. Determine the velocity of the system after 2 seconds. Also calculate the tension in the string using Impulse - Momentum equation

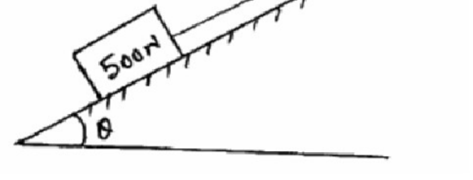
22. In the oblique central impact shown in figure the co-efficient of restitution is 0.8. The flat disks shown, slide on a smooth horizontal surface. Determine the final velocity of each disk directly after impact



23. A ladder of weight 1000 N and length 4 m rests as shown in Figure. If a 750 N weight is applied at a distance of 3 m from the top of ladder , it is at the point of sliding. Find the co-efficient of friction between ladder and the floor.

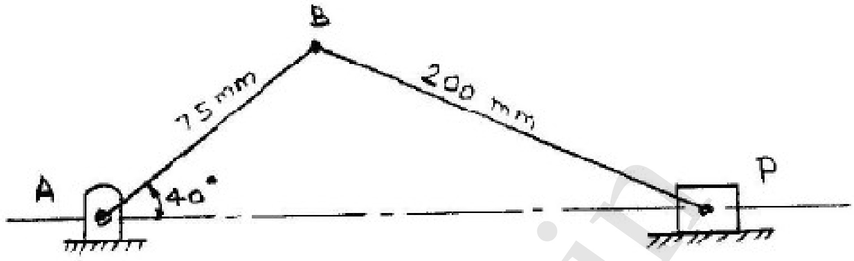


24. Two blocks of weight 500 N and 900 N connected by a rod are kept on an inclined plane as shown in Figure. The rod is parallel to the plane, The co-efficient of friction between 500N block and the plane is 0.4. Find the inclination of the plane with the horizontal and the tension in the rod when the motion down the plane is just about to start



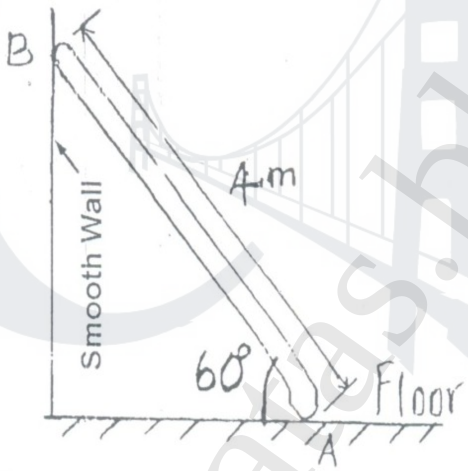
25.

In the engine system shown in figure, the crank AB has a constant clockwise angular speed of 3000 r.p.m.

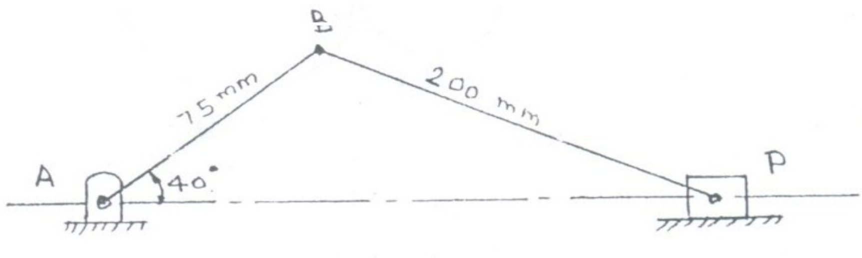


For the crank position indicated, find
(i) the angular velocity of the connecting rod BP
(ii) velocity of piston P.

26. A ladder of weight 1000 N and length 4 m rests as shown in Figure. If a 750 N weight is applied at a distance of 3m from the top of ladder. It is at the point of sliding. Determine the coefficient of friction between ladder and floor.

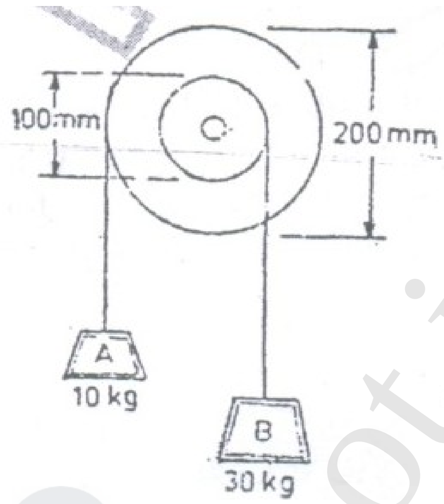


27. In the engine system shown in figure the crank AB has a constant clockwise angular speed of 3000 r.p.m. For the crank position indicated. Find i) The angular velocity of the connecting rod (BP). ii) Velocity of piston P.

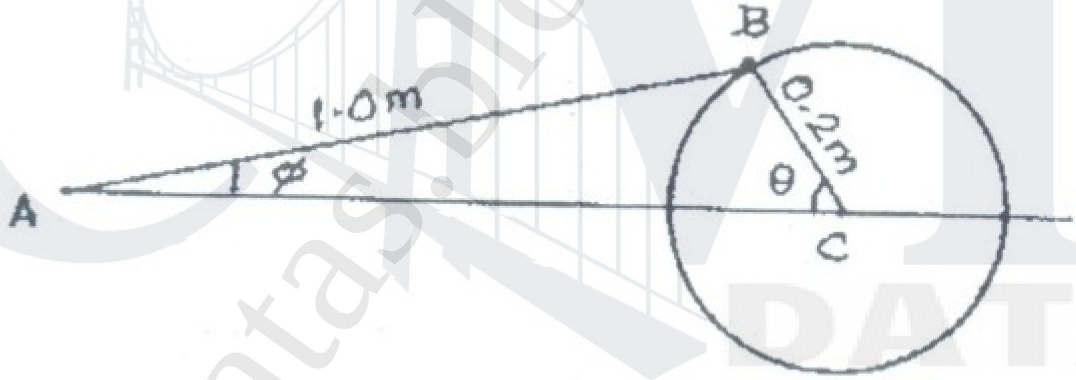


28. Two masses of 30 kg and 10 kg are tied to the two ends of a light string passing over a composite pulley of radius of gyration as 70 mm and mass

4 kg as shown in figure**.** Find the pulls in the two parts of the string and angular acceleration of the pulley

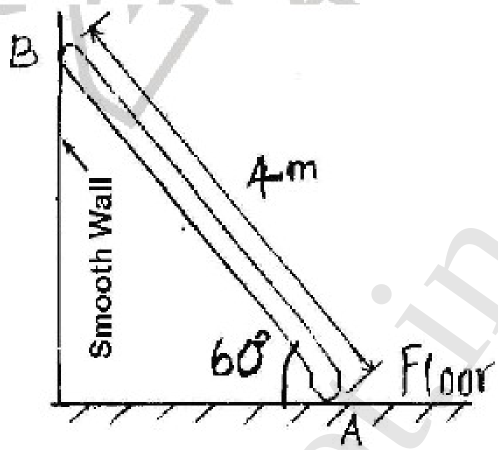


29. The crank of a reciprocating engine is rotating at 210 rpm. The lengths of the crank and connecting rod are 200mm and 1 m respectively. Find the of the point A (Velocity of piston), when the crank has turned through an angle of 45° with the horizontal as shown in figure



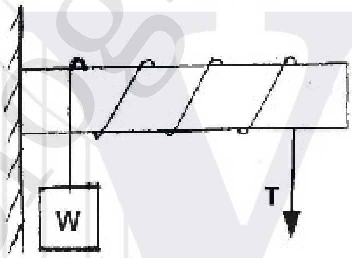
30.

(i) A ladder of weight 1000 N and length 4 m rests as shown in figure.



If a 750 N weight is applied at a distance of 3 m from the top of ladder, it is at the point of sliding. Determine the coefficient of friction between ladder and the floor.

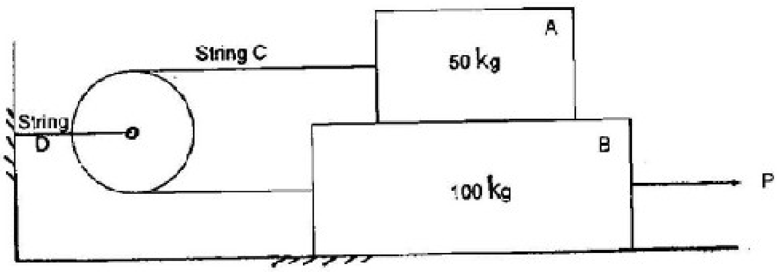
(ii) A rope is wrapped three times around a rod as shown in figure.



Determine the force required on the free end of the rope, to support a load of $W = 20$ kN. Take μ as 0.30.

31.

Two blocks A and B of mass 50 kg and 100 kg respectively are connected by a string C which passes through a frictionless pulley connected with the fixed wall by another string D as shown in figure.

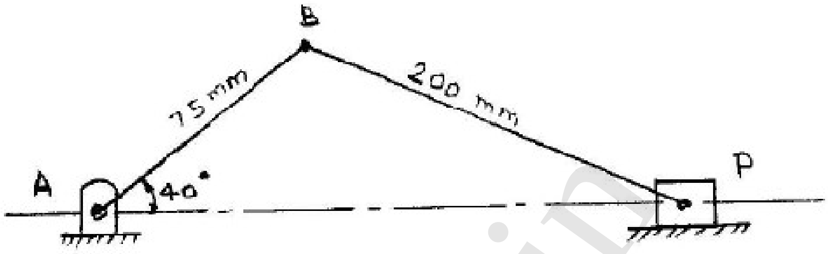


Find the force P required to pull the block B. Also find the tension in the string D. Take coefficient of friction at all contact surfaces as 0.3.

(ii) In a belt drive, the smaller pulley is subjected to a tension T_1 on the tight side and a tension T_2 on the slack side. Derive a relation between these tensions in terms of the coefficient of friction and the angle of wrap.

32.

In the engine system shown in figure, the crank AB has a constant clockwise angular speed of 3000 r.p.m.



For the crank position indicated, find
(i) the angular velocity of the connecting rod BP
(ii) velocity of piston P.

Reg. No. : | | | | | | | | | | | |

Question Paper Code : P 1409

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Third Semester

Mechanical Engineering

ME 1206 — APPLIED ENGINEERING MECHANICS

(Common to Aeronautical Engineering/Automobile Engineering/Mechatronics Engineering/Marine Engineering/Metallurgical Engineering and Production Engineering)

(Regulation 2004)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Two forces 50 kN and 10 kN act at a point 'O'. The included angle between them is 60°. Find the magnitude and the direction of the resultant.

2. State and prove Varignon's theorem.

3. State the general conditions of equilibrium of a rigid body in two dimensions.

4. Distinguish between statically determinate and indeterminate support reactions.

5. A right-angled triangle of base 3 m and height 4 m is revolved about its vertical edge. Compute the volume of the solid generated.

6. State parallel axis theorem as applied to moment of inertia of mass.

7. A rope is wrapped two and a half times around a pulley. Find the force exerted on the free end of the rope (tight side) that is required to support a 1.5 kN weight on the other end (slack side). The radius of the pulley is 200 mm and the coefficient of friction between cylinder and the rope is 0.25.

8. The equation of motion of a particle moving in a straight line is given by $S = 18t + 3t^2 - 2t^3$, where S is in meters and t in seconds. Find the velocity and acceleration at start. Also find time when particle reaches its maximum velocity.

9. A pelton wheel attains its operating speed of 800 rpm within 2 seconds after it is turned on. Determine the constant angular acceleration of the pelton wheel.

10. State D' Alembert's principle.

PART B — (5 × 16 = 80 marks)

11. (a) A force acts at the origin of a coordinate system in a direction defined by the angles $\theta_x = 70.9°$ and $\theta_y = 144.9°$. Knowing that the z - component of the force is – 52.0 N, determine,

(i) The angle θ_z (4)

(ii) The magnitude of the force 'F' (4)

(iii) The component of the force F along x and y directions (4)

(iv) The component of the force F on a line through the origin and the point (1,- 2, 1). (4)

Or

(b) A couple of magnitude M = 300 Nm and three forces shown in Figure 1. are applied to an angle bracket.

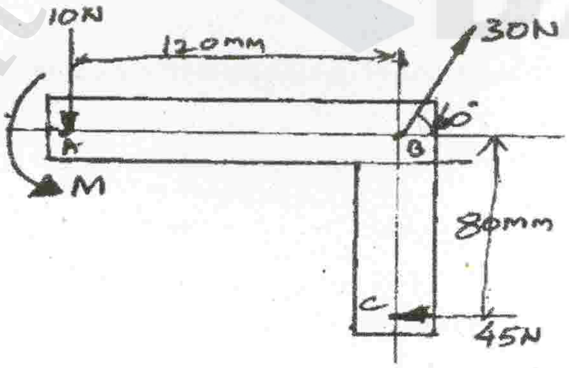


Fig. 1

(i) Find the resultant of the system of forces. (4)

(ii) Locate the points where the line of action of the resultant intersects Line AB and Line BC. (12)

12. (a) A precast concrete post weighing 50 kg and of length 6 m is raised for placing it in position by pulling the rope attached to it as shown in Figure 2. Determine the tension in the rope and the reaction at A.

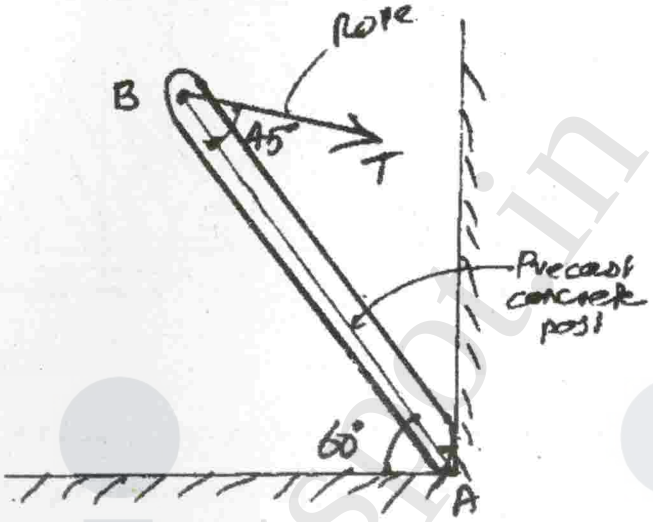


Fig 2.

Or

(b) The 6 m post shown in Figure 3. is acted upon by a 30 kN force at Q and is held by a ball and socket at P. Two cables AB and AC are connected as shown. Determine the tension in each cable and the reaction at support P.

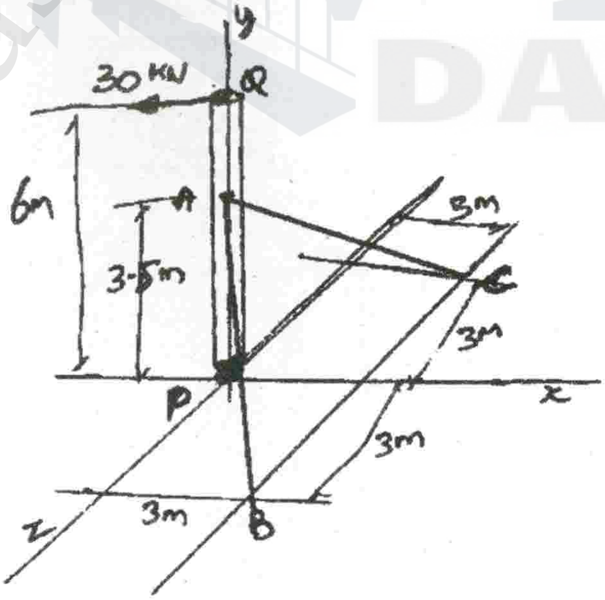


Fig. 3

13. (a) For the shaded area shown in Figure 4.

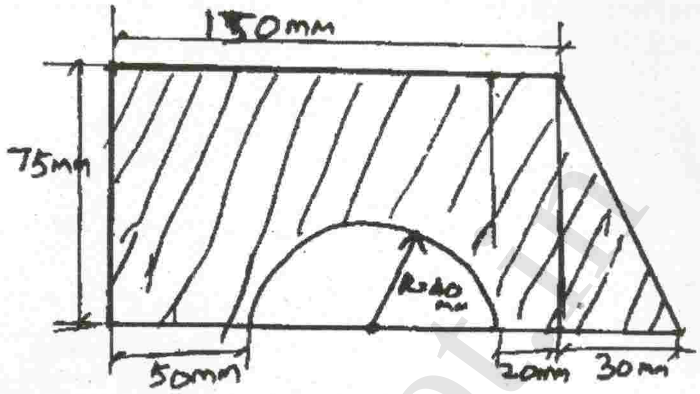


Fig. 4

(i) Determine the coordinates of the centroidal axes. (6)

(ii) Find the Moment of inertia of the area with respect to both the centroidal axes. (10)

Or

(b) Determine the mass moment of inertia of the following :

(i) A solid cylinder of radius 'R' and length 'L'. Let density of the material be ρ. (8)

(ii) A rectangular prism of length 'L'. width 'b', depth 'd' and density ρ. (8)

14. (a) Two blocks A and B each having a weight of 10 N are connected by a slender rod of negligible weight as shown in Figure 5. The coefficient of static friction is 0.3 for all surfaces of contact and the rod forms an angle θ = 30° with the vertical.

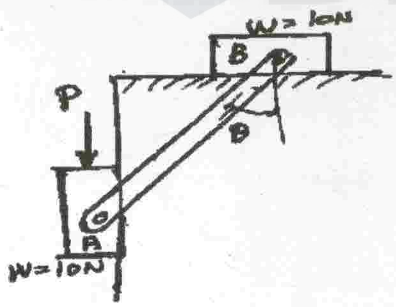


Fig. 5

(i) Show that the system is in equilibrium when P = 0 (6)

(ii) Determine the lowest value of 'P' for which equilibrium is maintained. (10)

Or

(b) The magnitude and direction of the velocities of two identical smooth balls before they strike each other are shown in Figure 6. Assuming the coefficient of restitution, e = 0.6, determine the magnitude and direction of velocities of each ball after impact.

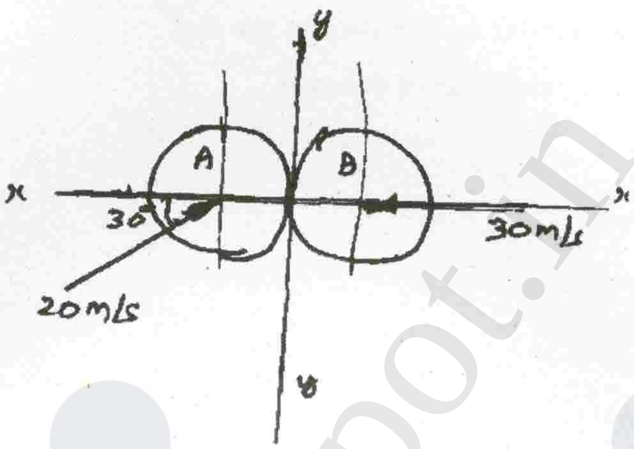


Fig. 6

15. (a) In the engine system shown in Figure 7, the crank AB has a constant angular velocity of 2000 rpm. For the crank position indicated determine,

(i) The angular velocity of the connecting rod AB (8)

(ii) The acceleration of the piston P (8)

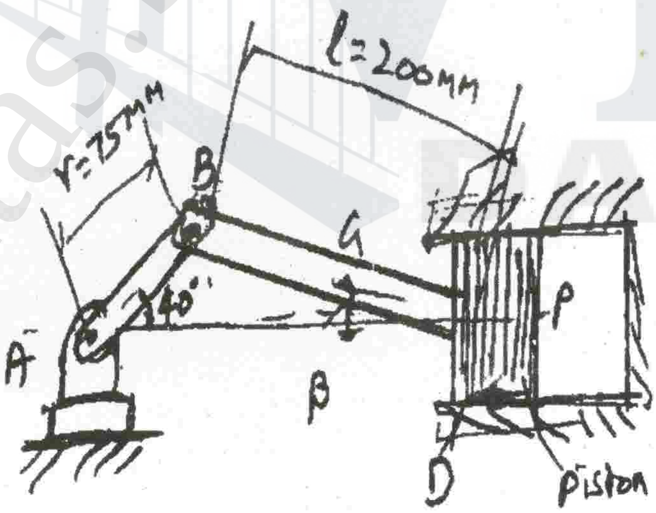


Fig. 7

Or

(b) A cord is wrapped around a homogenous disk of radius r = 0.6 m and mass m = 20 kg. If the cord is pulled upward with a force 'T' of magnitude 200 N, determine,

(i) The acceleration of the center of the disk (5)

(ii) The angular acceleration of the disk (5)

(iii) The acceleration of the cord (6)

Reg. No. : | | | | | | | | | | |

Question Paper Code : C 1595

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2010.

Second Semester

Civil Engineering

GE 1151 — ENGINEERING MECHANICS

(Common to All branches of B.E./B.Tech.)

(Regulation 2004)

(Common to B.E. (Part-Time) First Semester Civil Engineering, Mechanical Engineering — Regulation 2005)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State Parallelogram law of forces.

2. A force vector F is equal to 10 i + 5 j – 8 k. The point of application of this force moves from the point 2 i + k to the point 4 i – j – 4 k. Find the work done by the force.

3. State Varigon's theorem.

4. What is statically determinate beam? Give example.

5. Distinguish between centroid and centre of gravity.

6. What is polar moment of inertia of a circular section?

7. Define Angle of Projection.

8. A body is moving with uniform acceleration and covers 15 m in fifth second and 25 m in 10[th] second. Determine the initial velocity of the body.

9. State Coulomb's laws of dry friction.

10. The weight of a body on earth is 980 N, of the acceleration due to gravity on earth = 9.80 m/s², what will be the weight of the body on the moon, where g = 1.6 m/s²?

PART B — (5 × 16 = 80 marks)

11. (a) Figure 1 shows the coplanar system of forces acting on a flat plate. Determine :

(i) The Resultant and

(ii) X and Y intercepts of the resultant.

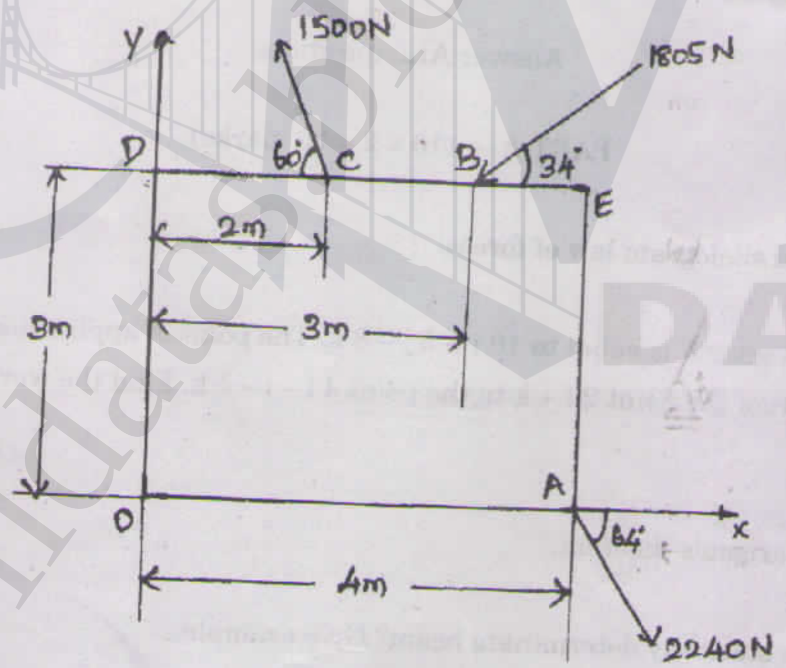


Fig.1

Or

(b) A string ABCD, attached to two fixed points A and D has the weights of 1000 N attached to it at B and C. The weights rest with the portions AB and CD inclined at angles of 30° and 60° respectively, to the vertical as shown in Figure 2. Find the tensions in the portions AB, BC and CD of the string, if the inclinations of the portion BC with the vertical is 120°.

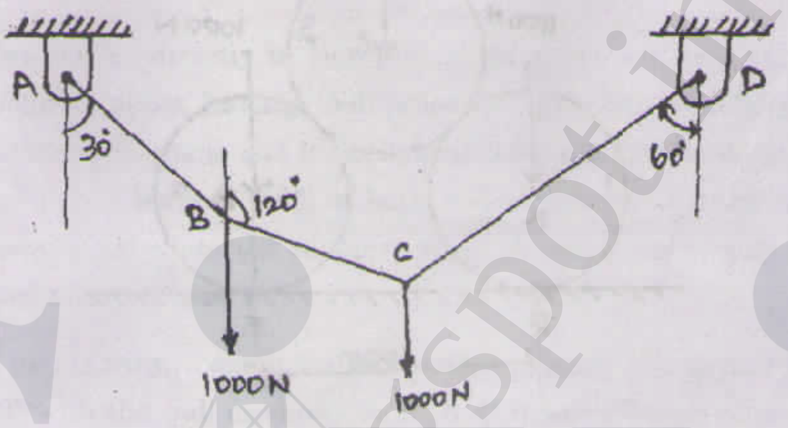


Fig. 2

12. (a) Find the reactions at the support A and B of the beam shown in Figure 3.

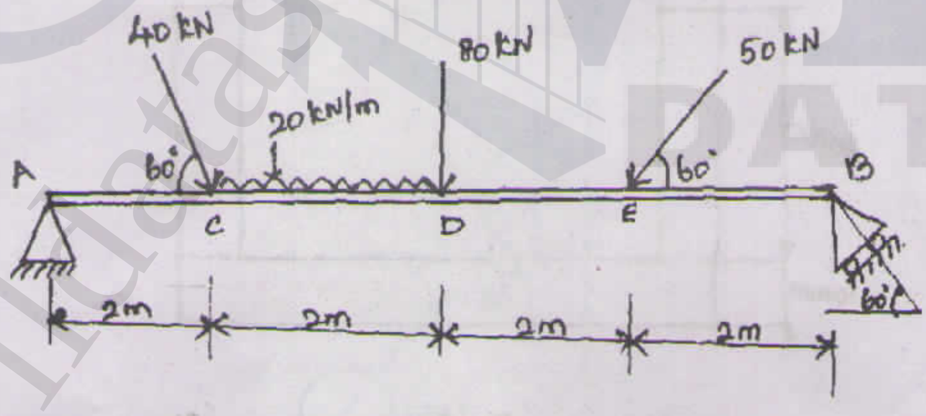


Fig. 3

Or

(b) Two smooth circular cylinders, each of weight W = 1000 N and radius 15 cm, are connected at their centres by a string AB of length = 40 cm and rest upon a horizontal plane, supporting above them a third cylinder of weight = 2000 N and radius 15 cm as shown in Fig. 4. Find the force S in the string AB and the pressure on the floor at the points of contact D and E.

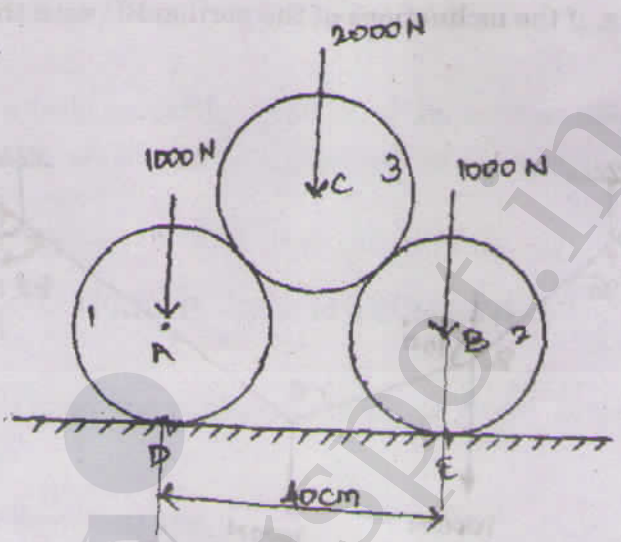


Fig.4.

13. (a) Find the moment of inertia of the section shown below in Fig. 5.

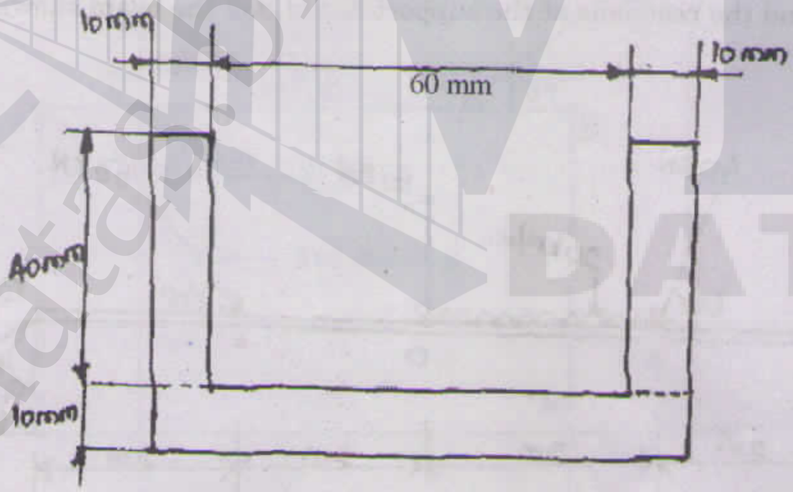


Fig. 5.

Or

(b) Derive the equation for the mass moment of inertia of a right circular cone of base Radius R, Height H and mass M about its axis.

14. (a) An airplane is flying on a straight level course at 200 km/hr at a height of 1000 meter above the ground. An anticraft gun located on the ground fires a shell with an initial velocity of 300 m/s, at the instant when the plane is vertically above it. At what inclination, to the horizontal, should the gun be fired to hit the plane? What time after firing, the gun shell will hit the plane? What will then be the horizontal distance of the plane from the gun?

Or

(b) Two bodies directly in line and 10 m apart are held stationary on an inclined plane having inclination of 20°. The co-efficient of friction between the plane and lower body is 0.08 and that between the plane and the upper body is 0.05, if both bodies are set in motion at the same instant, calculate the distance through which each body travels before they meet together.

15. (a) A ball is thrown against a wall with a velocity 10 m/s making an angle of 30° with the wall as shown in fig.6. If the co-efficient of restitution = 0.5. Find

(i) Direction of the ball after impact, and

(ii) Velocity of the ball after impact.

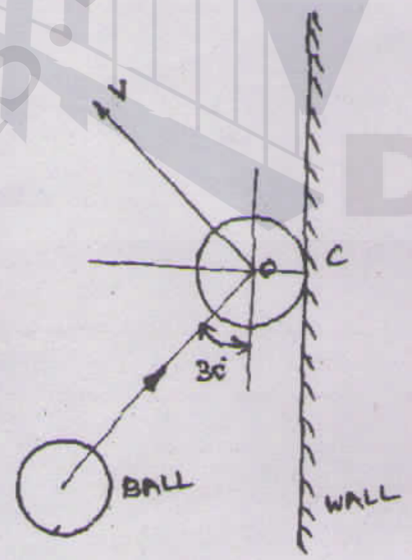


Fig. 6

Or

(b) A bar AB of length 4 m has its ends A and B constrained to move horizontally and vertically as shown in Fig. 7. The end B moves with a velocity of 10 m/s downwards and makes an angle of 50° with vertical. Determine the velocity of point A and mid-point C.

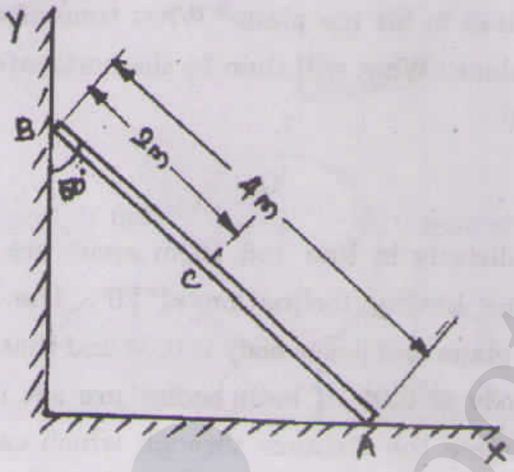


Fig.7.

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Question Paper Code: **E3127**

B.E./B.Tech. DEGREE EXAMINATIONS, MAY/JUNE 2010
Regulations 2008

Second Semester

Common to Civil, Aeronautical, Automobile, Marine, Mechanical, Production, Chemical, Petroleum Engineering and to Biotechnology, Polymer, Textile, Textile(Fashion), Rubber and Plastics Technology

ME2151 Engineering Mechanics

Time: Three Hours Maximum: 100 Marks

Answer ALL Questions

Part A - (10 x 2 = 20 Marks)

1. Define the following terms : (a) Coplanar forces (b) Concurrent forces.

2. State the necessary and sufficient conditions for static equilibrium of a particle in two dimensions.

3. Why the couple moment is said to be a free vector?

4. State the necessary and sufficient conditions for equilibrium of rigid bodies in two dimensions.

5. When will the product of inertia of a lamina become zero?

6. Write the SI units of the mass moment of inertia and of the area moment of inertia of a lamina.

7. A body moves along a straight line so that its displacement from a fixed point on the line is given by $s = 3t^2 + 2t$. Find the velocity and acceleration at the end of 3 seconds.

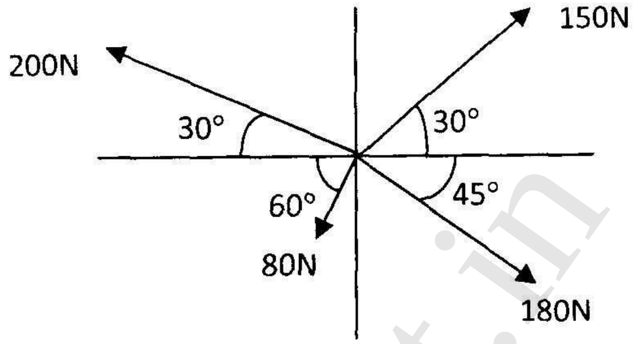
8. A particle of mass 10 kg falls vertically from a height of 100 m from ground. What is the change in potential energy when it has reached a height of 50 m ?

9. State the laws of dry friction.

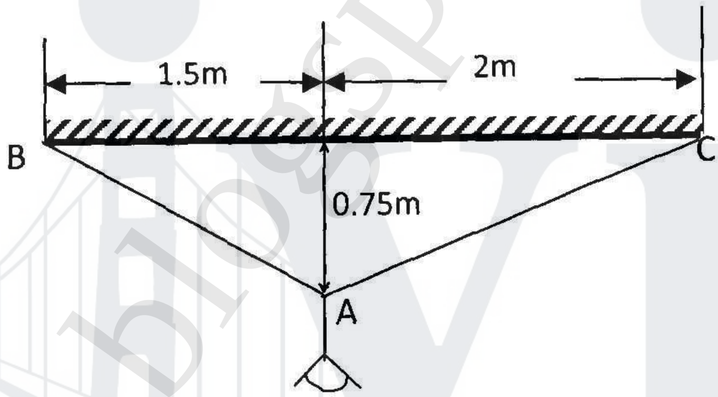
10. What is general plane motion?

Part B - (5 x 16 = 80 Marks)

11. (a) (i) Determine the resultant of the concurrent force system shown in figure. (8)

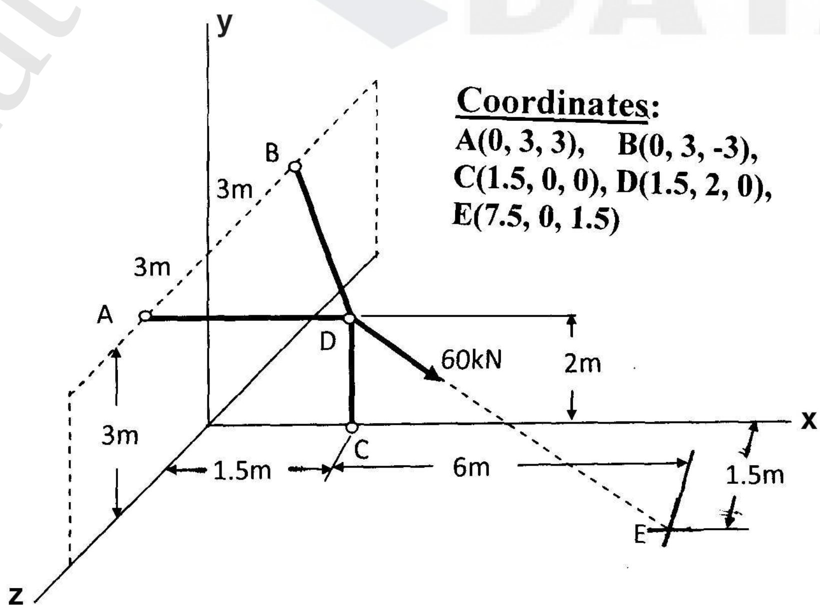


(ii) Figure shows a 10 kg lamp supported by two cables AB and AC. Find the tension in each cable. (8)



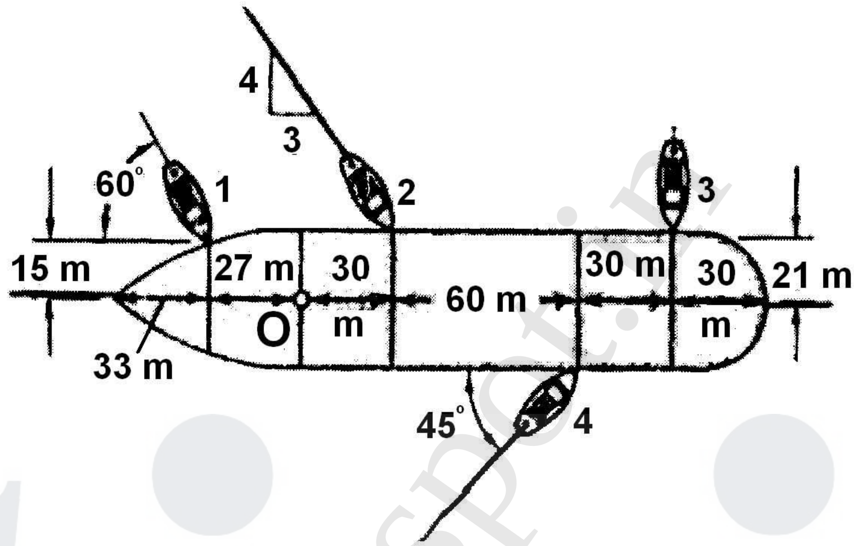
OR

11. (b) In the figure shown, three wires are joined at D.



Two ends A and B are on the wall and the other end C is on the ground. The wire CD is vertical. A force of 60 kN is applied at 'D' and it passes through a point E on the ground as shown in figure. Find the forces in all the three wires. (16)

12. (a) Four tugboats are used to bring an ocean large ship to its pier. Each tugboat exerts a 22.5 kN force in the direction as shown in the figure.

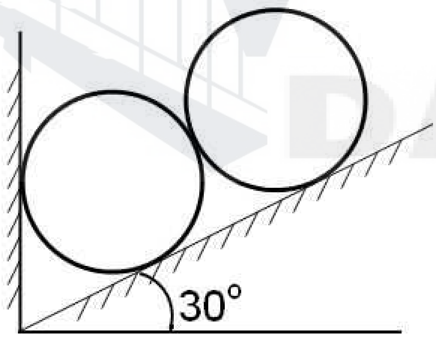


(i) Determine the equivalent force-couple system at O. (12)

(ii) Determine a single equivalent force and its location along the longitudinal axis of the ship. (4)

OR

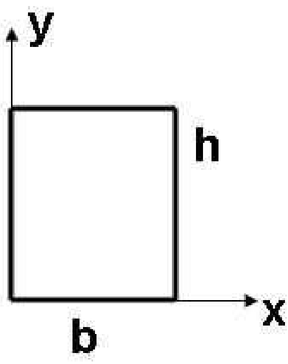
12. (b) Two identical rollers, each of weight 500 N, are supported by an inclined plane making an angle of 30° to the horizontal and a vertical wall as shown in the figure.



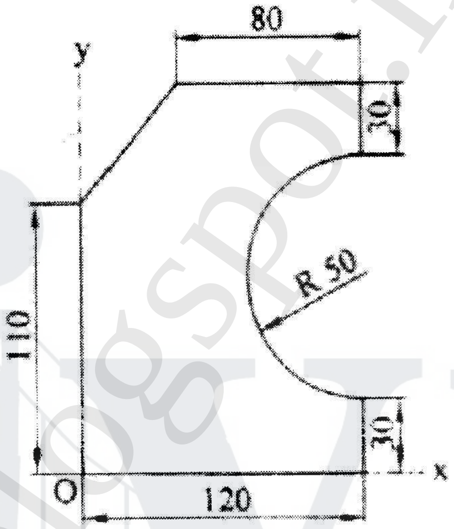
(i) Sketch the free body diagrams of the two rollers. (4)

(ii) Assuming smooth surfaces, find the reactions at the support points. (12)

13. (a) (i) Derive, from first principle, the second moments of area I_{xx} and I_{yy} for the rectangular area when the axes are as shown below: (6)



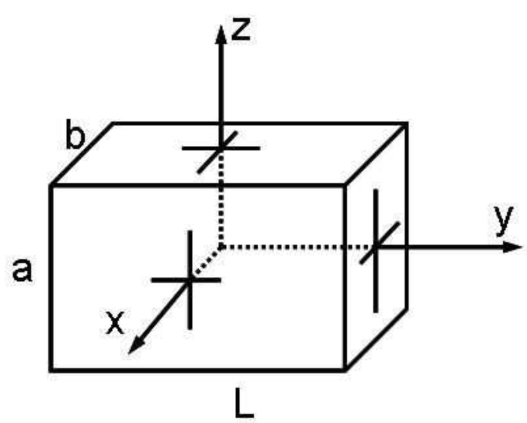
(ii) Locate the centroid of the area shown in figure below. The dimensions are in mm. (10)



OR

13. (b) (i) Explain the steps to be followed to find the principal moments of inertia of a given section. How will you find the inclination of the principal axes? (6)

(ii) A rectangular prism is shown in figure. The origin is at the geometric centre of the prism. The x, y and z-axes pass through the mid points of faces.

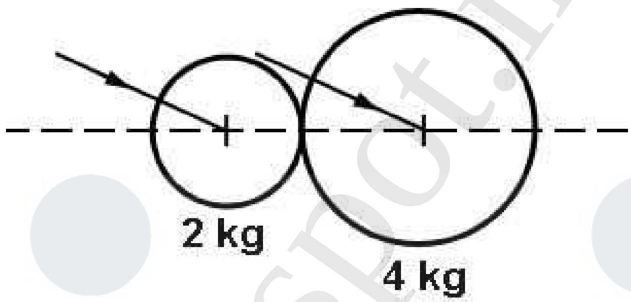


Derive the mass moment of inertia of the prism about the x-axis. (10)

14. (a) Two trains **A** and **B** leave the same station on parallel lines. **A** starts with a uniform acceleration of 0.15 m/s^2 and attains the speed of 24 km/hour, after which, its speed remains constant. **B** leaves 40 seconds later with uniform acceleration of 0.30 m/s^2 to attain a maximum speed of 48 km/hour. Its speed also becomes constant thereafter. When will **B** overtake **A**? (16)

OR

14. (b) A ball of mass 2 kg, moving with a velocity of 3 m/s, impinges on a ball of mass 4 kg moving with a velocity of 1 m/s. The velocities of the two balls are parallel and inclined at 30° to the line of joining their centres at the instant of impact.



If the coefficient of restitution is 0.5, find

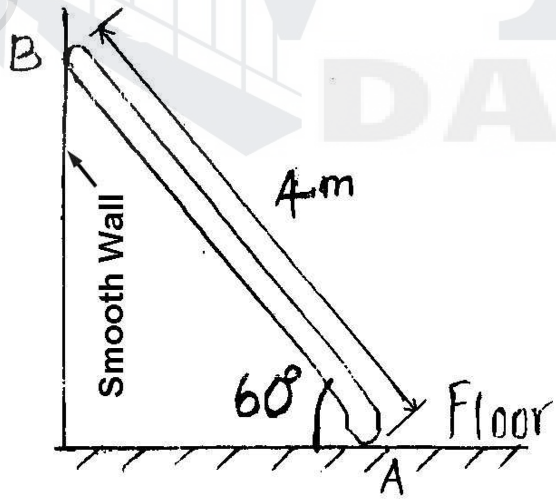
(i) Direction, in which the 4 kg ball will move after impact; (8)

(ii) Velocity of the 4 kg ball after impact; (2)

(iii) Direction, in which the 2 kg ball will move after impact; (4)

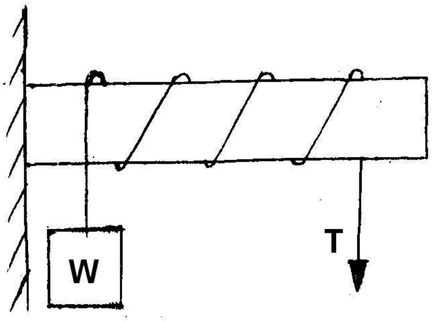
(iv) Velocity of the 2 kg ball after impact. (2)

15. (a) (i) A ladder of weight 1000 N and length 4 m rests as shown in figure.



If a 750 N weight is applied at a distance of 3 m from the top of ladder, it is at the point of sliding. Determine the coefficient of friction between ladder and the floor. (10)

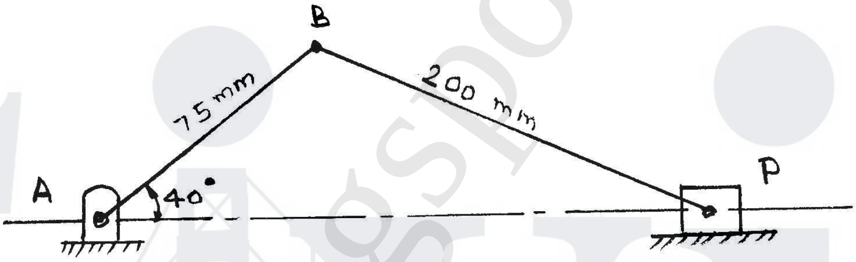
(ii) A rope is wrapped three times around a rod as shown in figure.



Determine the force required on the free end of the rope, to support a load of $W = 20$ kN. Take μ as 0.30. (6)

OR

15. (b) In the engine system shown in figure, the crank AB has a constant clockwise angular speed of 3000 r.p.m.



For the crank position indicated, find

(i) the angular velocity of the connecting rod BP

(ii) velocity of piston P.

(16)

H 1314

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2006.

First Semester

Civil Engineering

GE 131 — ENGINEERING MECHANICS

(Common to All Branches except Marine Engineering)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define equivalent system of forces.

2. A vector A is equal to $2i - 3j + 2k$. Find the projection of this vector on the line joining the point $P(-3, 2, 1)$ and $Q(2, -2, -1)$.

3. The sum of two concurrent forces F_1 and F_2 is 300 N and their resultant is 200 N. The angle between the force F_1 and resultant is 90°. Find the magnitude of each force.

4. What are the necessary and sufficient conditions of equilibrium of rigid bodies in two dimensions and in three dimensions?

5. State and prove perpendicular axis theorem.

6. Explain the theorem of Pappus and Guldinus.

7. Give the equation for belt friction and explain the components.

8. What is instantaneous velocity and instantaneous acceleration?

9. A body is moving with a velocity of 4 m/s. After five seconds the velocity of body becomes 14 m/s, find the acceleration of the body.

10. Explain D'Alembert's principle.

11. (i) Explain dry friction and give the laws of dry friction. (6)

(ii) The forces acting on the block are shown in Figure Q. 11 (ii). Determine whether the block is in equilibrium and find the magnitude and direction of the friction force. Take $\mu_s = 0.35$ and $\mu_k = 0.25$. (10)

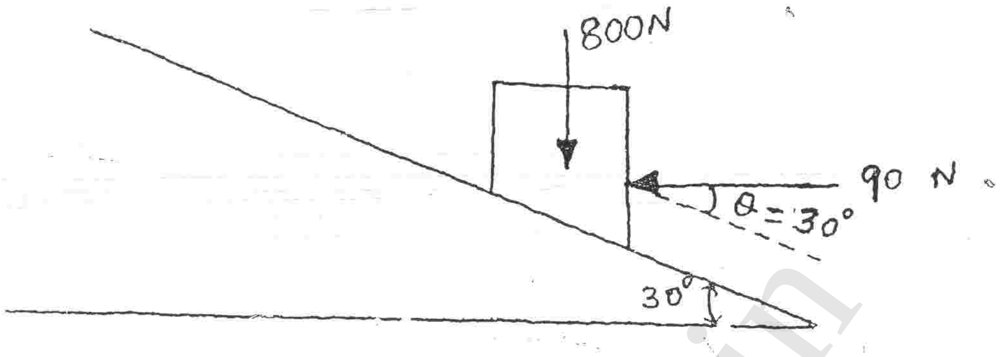


Fig. Q. 11 (ii)

12. (a) Two spheres each of weight 500 N and of radius 100 mm rest in a horizontal channel of width of 360 mm as shown in Figure Q. 12 (a). Find the reactions on the points of contact A, B and C. Assume all the surfaces of contact are smooth. (16)

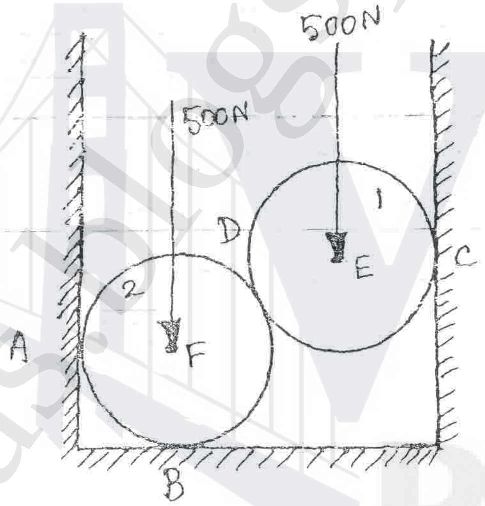


Fig. Q. 12 (a)

Or

41

(b) Determine the magnitude and direction of force F shown in Fig. Q. 12 (b) so that the particle A is in equilibrium. (16)

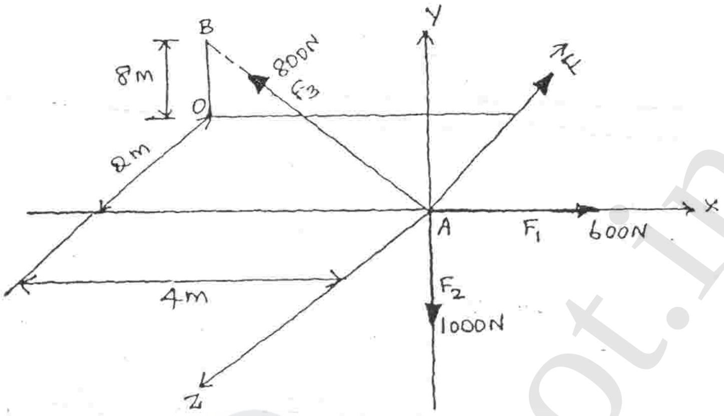


Fig. Q. 12 (b)

13. (a) Locate the centroid for the area shown in Fig. Q. 13 (a). (16)

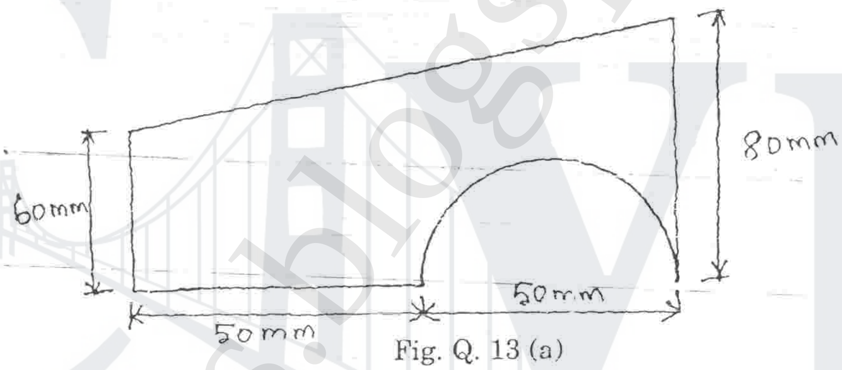


Fig. Q. 13 (a)

Or

(b) Find moment of inertia about 1–1 and 2–2 axes for the area shown in Fig. Q. 13 (b). (16)

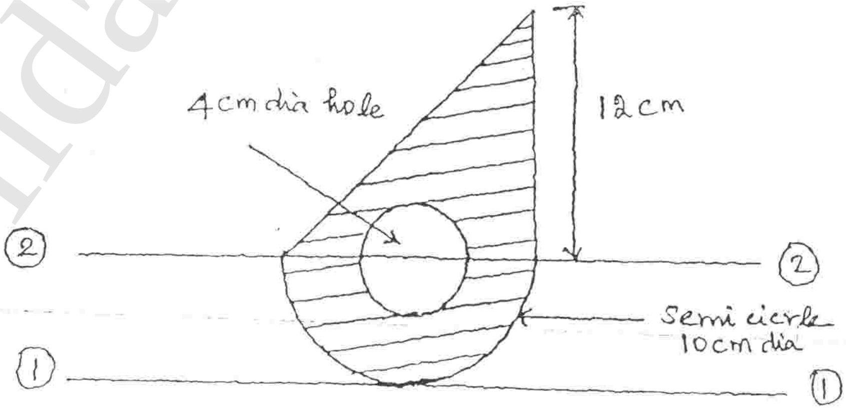


Fig. Q. 13 (b)

14. (a) Two electric trains A and B leave the same station on parallel lines. The train A starts with a uniform acceleration of 0.15 m/s^2 and attains a speed of 40 km/hr when the steam is reduced to keep the speed constant. The train B leaves 1 minute after, with a uniform acceleration of 0.3 m/s^2 to attain a maximum speed of 70 km/hr. When the train B will overtake the train A? (16)

Or

(b) A particle is projected in air with a uniform velocity 70 m/s at an angle of 40° with the horizontal. Determine

(i) horizontal range

(ii) the maximum height attained by the particle, and

(iii) the time of flight. (16)

15. (a) A fly wheel weighing 60 kN having radius of gyration 1 m loses its speed from 400 r.p.m. to 280 r.p.m. in 2 minutes. Determine

(i) the retarding torque acting on it

(ii) change in kinetic energy during the above period and

(iii) change in its angular momentum during the same period. (16)

Or

(b) A 120 kg pulley having a radius of gyration of 0.4 m is connected to two cylinders as shown in Fig. Q. 15 (b). Assume no axle friction and determine the angular acceleration of the pulley and the acceleration of each cylinder. (16)

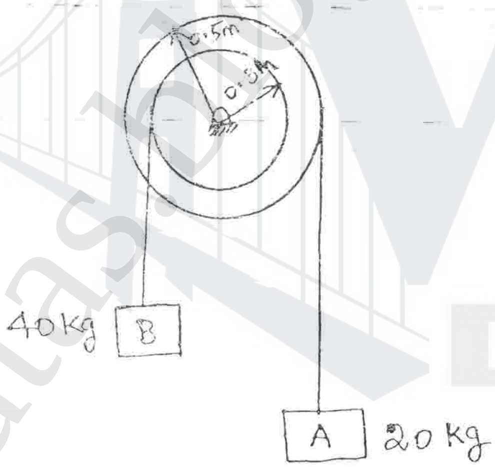


Fig. Q. 15 (b)

L 1108

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2006.

Second Semester

Aeronautical Engineering

GE 1151 — ENGINEERING MECHANICS

(Common to all branches and BE (PT) I Sem. R-2005 Civil and Mechanical)

Time : Three hours   Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. State the equations of equilibrium of a coplanar system of forces.

2. A force of magnitude 700 N is directed along PQ where P is (0.8, 0, 1.2) m and Q is (1.4, 1.2, 0) m. Write the vector form of the force.

3. State Varignon's theorem.

4. Three couples + 12 Nm, – 35 Nm and + 100 Nm are acting in the xy, yz and xz. Write the vector form.

5. A semi-circular lamina having radius 100 mm is located in the xy plane such that its diametral edge coincides with y-axis. Determine the x co-ordinate of its centroid.

6. Define principal axes and principal moment of Inertia.

7. A particle starting from rest, moves in a straight line and its acceleration is given by $a = 40 - 46t^2$ m/sec^2 where t is in sec. Determine the velocity of the particle when it has travelled 52 m.

8. A steel ball is thrown vertically upwards from the top of a building 25 m above the ground with an initial velocity of 18 m/sec. Find the maximum height reached by the ball from the ground.

9. State the laws of dry friction.

10. What is general plane motion?

PART B — (5 × 16 = 80 marks)

11. Determine the tension in the cables AB, AC and AD if the crate shown in Fig. Q. 11. is weighing 9.07 kg.

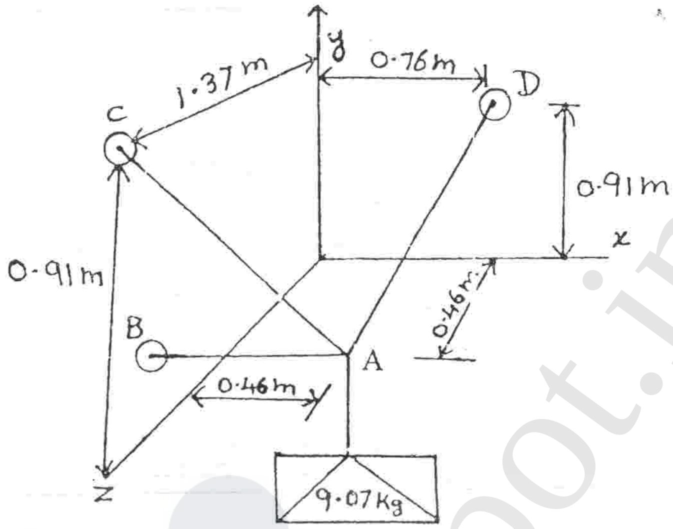


Fig. Q. 11

12. (a) Determine the reactions at supports A, B, C and D, for the beam shown in Fig. Q. 12 (a).

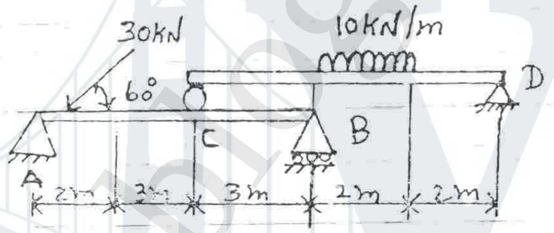


Fig. Q. 12 (a)

Or

(b) Determine the resultant of the coplanar non-concurrent force system shown in Fig. Q. 12 (b). Calculate its magnitude and direction and locate its position with respect to the sides AB and AD.

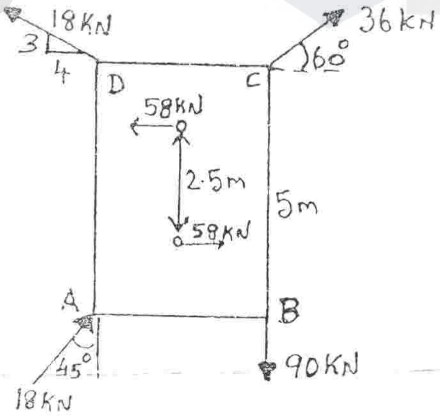


Fig. Q. 12 (b)

99

13. (a) Find I_{xx}, I_{yy} through centroid of the Fig. Q. 13 (a) with uniform thickness of 3 cm throughout.

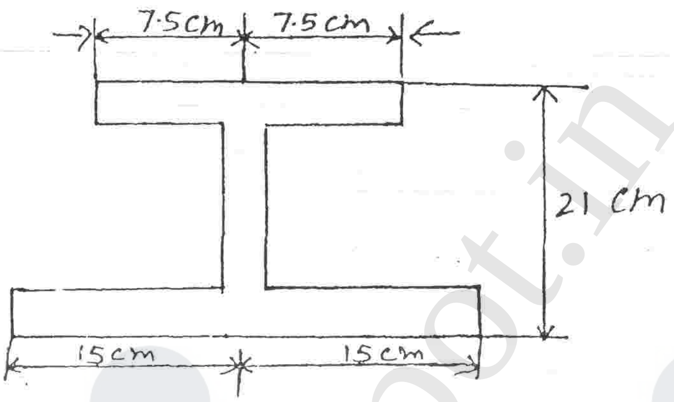


Fig. Q. 13 (a)

Or

(b) Derive an equation for the mass moment of Inertia of cone.

14. (a) A stone is projected with a speed of 30 m/s at an angle of elevation of 50°. Find its velocity

(i) After two seconds

(ii) At the highest point of its path

(iii) at a height of 6 m.

Find also the time interval between the two points at which the stone attains a speed of 23 m/s.

Or

(b) In the oblique central impact shown in Fig. Q. 14 (b), the co-efficient of restitution is 0.8. The flat disks shown, slide on a smooth horizontal surface. Determine the final velocity of each disk directly after impact.

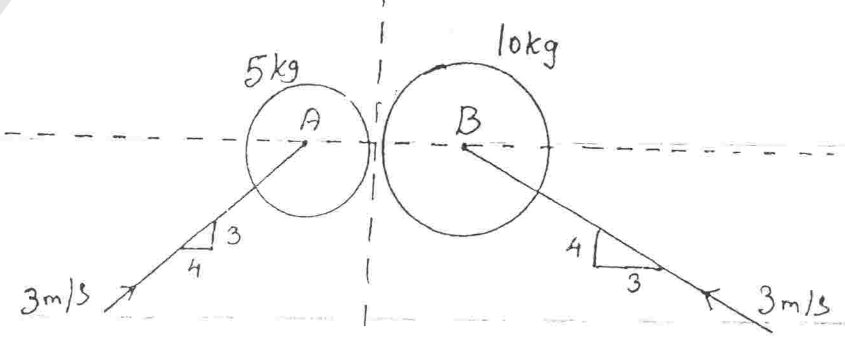


Fig. Q. 14 (b)

100

15. (a) Determine whether the block shown in Fig. Q 15 (a) having a mass of 40 kg is in equilibrium and find the magnitude and direction of the friction force.

Take $\mu_s = 0.40$ and $\mu_k = 0.30$.

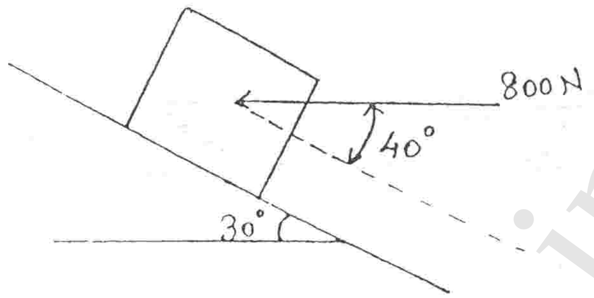


Fig. Q. 15 (a)

Or

(b) Determine the least value of 'P' required to cause the motion impend the system shown in Fig. Q. 15 (b) assume coefficient of friction on all contact surface as 0.2.

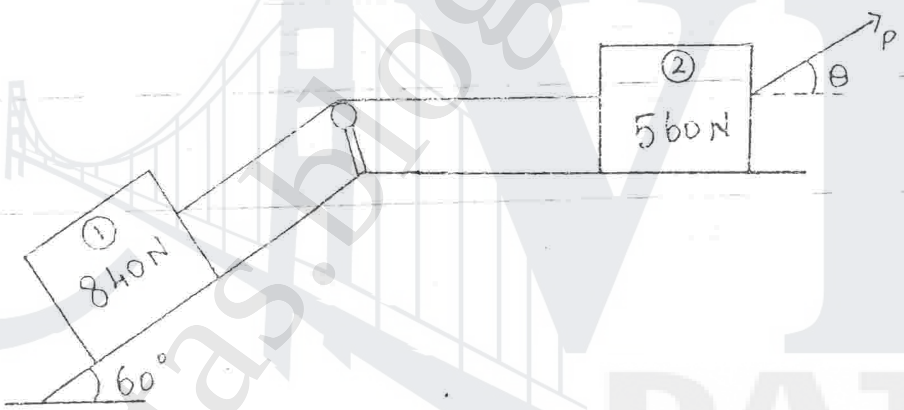


Fig. Q. 15 (b)

Reg. No. :

Question Paper Code : 10405

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2012.

Second Semester

Common to Civil, Aeronautical, Automobile, Marine, Mechanical, Production, Chemical, Petroleum Engineering, Biotechnology, Polymer, Textile, Textile (Fashion), Rubber and Plastics Technology, Materials Science and Engineering, Manufacturing Engineering, Mechatronics Engineering, Industrial Engineering, Industrial and Management Engineering, Environmental Engineering, Geoinformatics, Mechanical and Automation Engineering, Petrochemical Engineering, Chemical and Electrochemical Engineering, Petrochemical Technology, Pharmaceutical Technology and Textile Chemistry

ME 2151 / 113201 / ME 25 / 10122 ME 205 / 080120002 / CE 1151 — ENGINEERING MECHANICS

(Regulation 2008)

Time : Three hours | Maximum : 100 marks

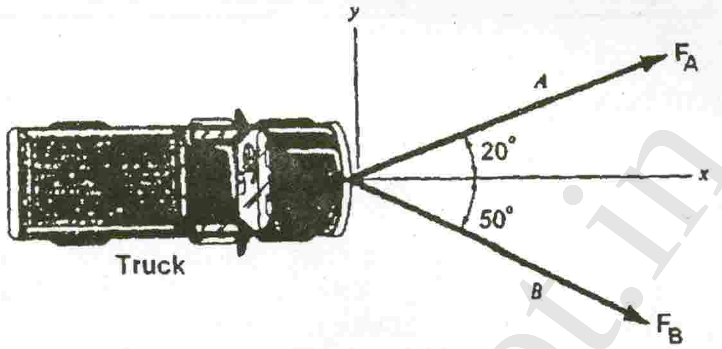
Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

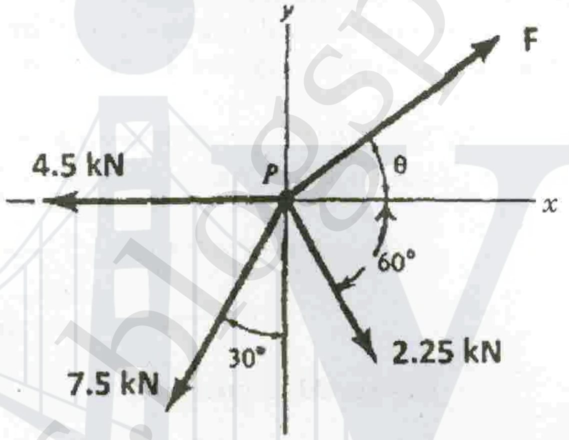
1. State Lame's Theorem.
2. What is the difference between a resultant force and equilibrant force?
3. What is meant by free body diagram of a rigid body?
4. Write the conditions of equilibrium of a system of parallel forces acting in a plane.
5. Define radius of gyration with respect to x-axis of an area.
6. State parallel axis theorem with simple sketch.
7. A body moves along a straight line so that its displacement from a fixed point on the line is given by $s = 3t^2 + 2t$. Find the velocity and acceleration at the end of 3 seconds.
8. A particle of mass 10 kg falls vertically from a height of 100 m from ground. What is the change in potential energy when it has reached a height of 50 m?
9. When do we say that the motion of a body is impending?
10. How do, at any given instant, the velocity and acceleration of different points of a rigid body vary when it is undergoing translation?

PART B — (5 × 16 = 80 marks)

11. (a) (i) The truck shown is to be towed using two ropes. Determine the magnitudes of forces F_A and F_B acting on each rope in order to develop a resultant force of 950 N directed along the positive X-axis. (8)

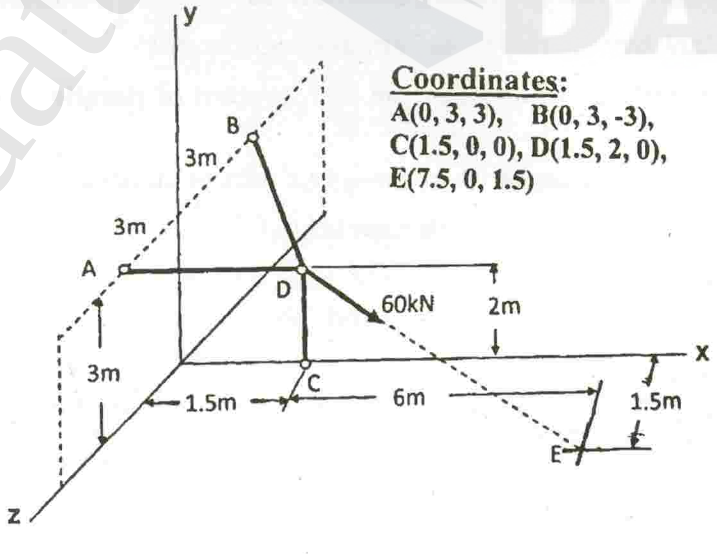


(ii) Determine the magnitude and angle θ of F so that particle P, shown in figure, is in equilibrium. (8)



Or

(b) In the figure shown, three wires are joined at D.

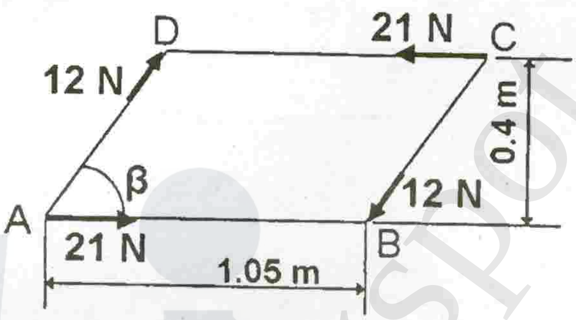


 10405

Two ends A and B are on the wall and the other end C is on the ground. The wire CD is vertical. A force of 60 kN is applied at 'D' and it passes through a point E on the ground as shown in figure. Find the forces in all the three wires. (16)

12. (a) (i) A force $(10i+20j-5k)N$ acts at a point $P(4,3,2)$ m. Determine the moment of this force about the point $Q(2,3,4)$ m in vector form. Also find the magnitude of the moment and its angles with respect to x, y, z axes. (8)

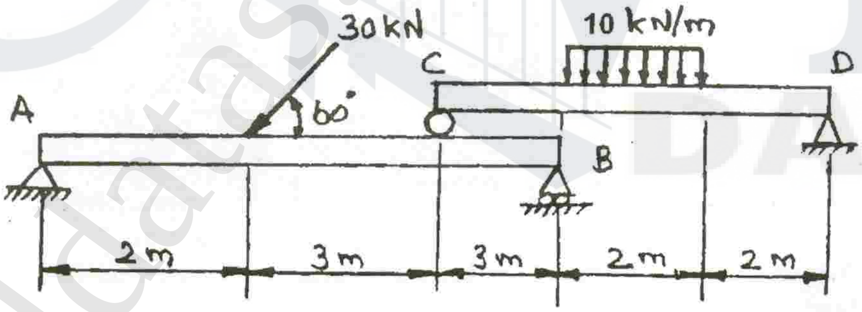
(ii) A plate $ABCD$ in the shape of a parallelogram is acted upon by two couples, as shown in the figure.



Determine the angle β if the resultant couple is 1.8 N.m clockwise. (8)

Or

(b) Two beams AB and CD are shown in figure. A and D are hinged supports. B and C are roller supports.

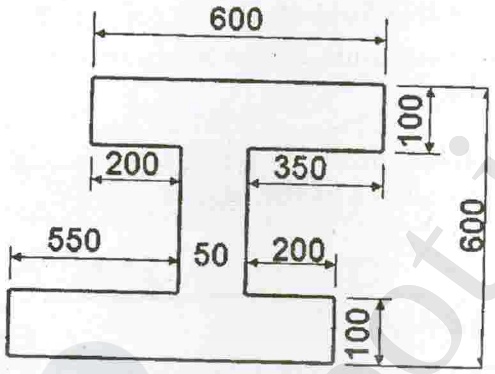


(i) Sketch the free body diagram of the beam AB and determine the reactions at the supports A and B. (9)

(ii) Sketch the free body diagram of the beam CD and determine the reactions at the supports C and D. (7)

13. (a) (i) Derive, from first principles, the second moment of area of a circle about its diametral axis. (6)

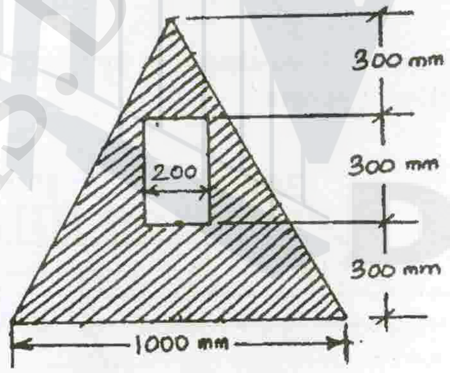
(ii) For the section shown in figure below, locate the horizontal and vertical centroidal axes. (10)



Or

(b) (i) Calculate the centroidal polar moment of inertia of a rectangular section with breadth of 100 mm and height of 200 mm. (4)

(ii) Find the moment of inertia of the shaded area shown in figure about the vertical and horizontal centroidal axes. The width of the hole is 200 mm. (12)



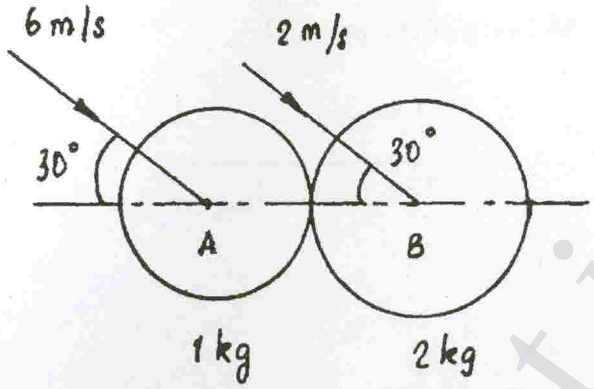
14. (a) A ball is projected with an initial velocity of u at an angle of α with the horizontal.

(i) Derive the expressions for x and y positions of the ball in terms of time t. Also derive the expressions for the time of flight, maximum height attained and horizontal range. (10)

(ii) If the initial velocity is 10 m/s and $\alpha = 45°$, find the time of flight, maximum height attained and horizontal range. (6)

Or

(b) A ball of mass 1 kg moving with a velocity of 6 m/s strikes another ball of mass 2 kg moving with a velocity of 2 m/s at the instant of impact the velocities of the two balls are parallel and inclined at 30° to the line joining their centers as shown in the figure.



If the coefficient of restitution is 0.5, find the velocity and the direction of the two balls after impact. Also calculate the loss in kinetic energy due to impact and the percentage of loss. (16)

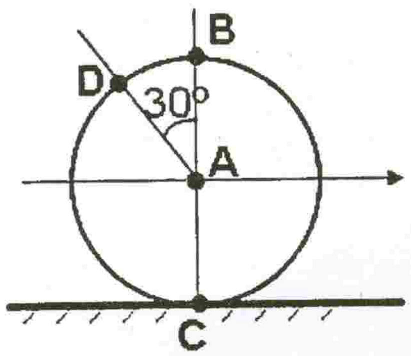
15. (a) (i) A block weighing 36 N is resting on a rough inclined plane having an inclination of 30°. A force of 12 N is applied at an angle of 10° up the plane and the block is just on the point of moving down the plane. Determine the coefficient of friction. (8)

(ii) A flat belt develops a tight side tension of 2000 N during power transmission; the coefficient of friction between pulley and belt is 0.3; the angle of lap on smaller pulley is 165° and the belt speed is 18 m/s. Determine the power that can be transmitted, if the belt is assumed to be perfectly elastic and without mass. (8)

Or

(b) (i) A rigid body is undergoing general plane motion. Write down the relationship of the velocities of two points A and B on it and explain. (6)

(ii) An automobile travels to the right at a constant speed of 72 km/h. The diameter of the wheel is 560 mm.



Determine the magnitude and direction of the following :

(1) Angular velocity of the wheel. (2)

(2) Velocity of the point B. (2)

(3) Velocity of the point C. (2)

(4) Velocity of the point D. (4)

Question Paper Code : 21556

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2013.

Second Semester

Civil Engineering

ME 2151/ ME 25/ 10122 ME 205/ 080120002/ CE 1151 – ENGINEERING MECHANICS

(Common to Aeronautical, Automobile, Marine, Mechanical, Production, Chemical, Petroleum Engineering, Biotechnology, Polymer, Textile, Textile (Fashion), Plastic Technology, Materials Science and Engineering, Manufacturing Engineering Mechatronics Engineering, Industrial Engineering, Industrial Engineering and Management, Environmental Engineering Geoinformatics, Mechanical and Automation Engineering, Petrochemical Engineering, Chemical and Electrochemical Engineering, Petrochemical Technology, Pharmaceutical Technology, Textile Chemistry, Mechanical Engineering (sand wich) and Robotics and Automation)

(Regulation 2008/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What is meant by force-couple system?

2. Find the unit vector of a force $\vec{F} = 4\vec{i} - 5\vec{j} + 8\vec{k}$.

3. State Varignon's theorem.

4. Write the equations of equilibrium of a rigid body in two dimensions.

5. When will the centroid and centre of mass coincides?

6. Find the radius of gyration of a rectangular area of MI about its base $9 \times 10^4\ cm^4$ and cross-sectional area $300\ cm^2$.

7. A car runs with an initial velocity of 30 m/s and uniform acceleration of $3 m/s^2$. Find its velocity after 5 seconds.

8. State D'Alembert's principle.

9. What is meant by general plane motion?

10. A flywheel has a mass moment of inertia of 11 $kg.m^2$ about the axis of rotation. It runs at a constant angular velocity of 94.25 rad/s. find the kinetic energy of the flywheel.

PART B — (5 × 16 = 80 marks)

11. (a) A system of four forces P,Q, R and S of magnitude 5 kN, 8 kN, 6 kN and 4 kN respectively acting on a body are shown in rectangular coordinates as shown in Fig. 11 (a). Find the moments of the forces about the origin O. Also, find the resultant moment of the forces about O. The distances are in metres.

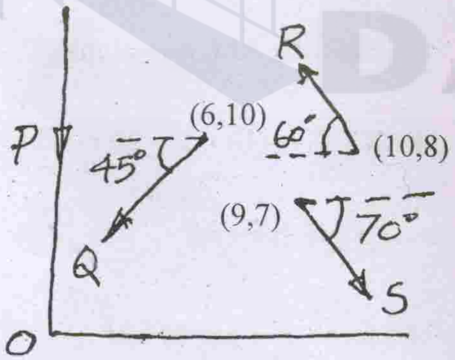


Figure 11 (a)

Or

(b) A body is acted upon by a system of forces and a couple as shown in Fig 11 (b). Determine the resultant of the system of forces. Also locate the points of intersection of the system of forces. Also locate the points of intersection of the resultant with the arm PQ, QR and RS.

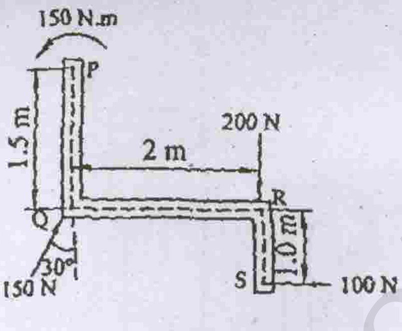


Figure 11 (b)

12. (a) 4000 N load acts on the beam held by a cable PQ as shown in Fig. 12 (a). The weight of the beam can be neglected. Draw the free-body diagram of the beam and find the tension in the cable PQ. Also find the reaction force at R.

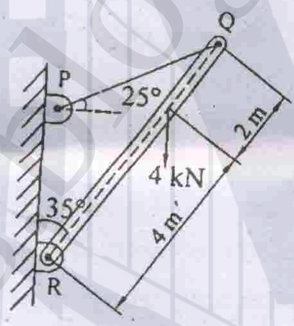


Figure 12 (a)

Or

(b) A beam is acted upon by a system of forces as shown in Figure 12 (b). Find the support reactions.

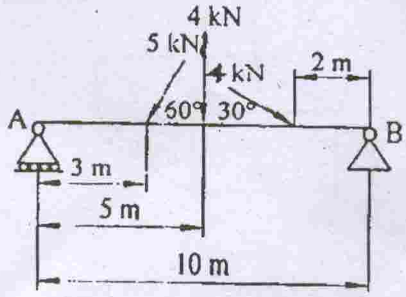


Figure 12 (b)

13. (a) Find the position of the centroid of the solid combination shown in Fig. 13 (a) consisting of a solid cone of height 50 mm and base diameter 80 mm and a cylinder of height 100 mm and diameter 80 mm with a semicircular cut as shown.

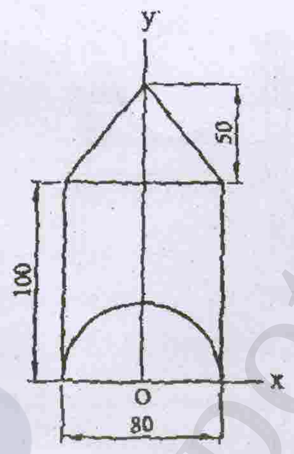


Figure 13 (a)

Or

(b) A rectangular R.C.C. column is centrally cast over a concrete bed. R.C.C. in Figure 13 (b) column is of section 30 × 45 cm and height 4 m. The concrete bed is of size 3 × 4.5 m and thickness 30 cm. find the mass moment of inertia of the column and bed combination about its vertical centroidal axis. Mass density of concrete = 2500 kg/m^3.

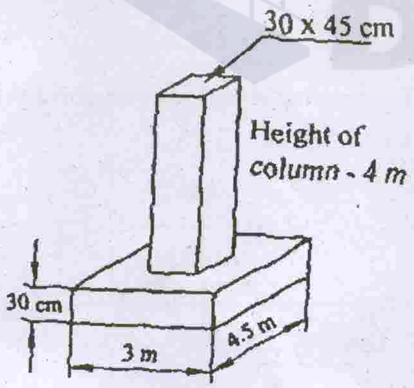


Figure 13 (b)

14. (a) Water drips from a tap fitted to a barrel at the rate of four drops per second as shown in Figure 14 (a). Find the vertical separation between two consecutive drops after the lower drops has attained a velocity of 3 m/s.

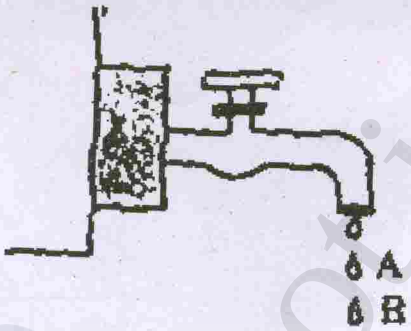


Figure 14 (a)

Or

(b) Block P of weight 100 N and block Q of weight 50 N are connected by a cord that passes over a smooth pulley as shown in Figure 14 (b). Find the acceleration of the blocks and the tension in the cord when the system is released from rest. Neglect the mass of the pulley. Use the principle of work and energy.

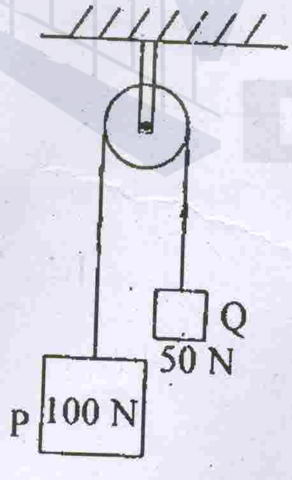


Figure 14 (b)

15. (a) A force of 300 N is required just to move a block up a plane inclined at 20° to the horizontal, the force being applied parallel to the plane Figure 15(a). If the inclination of the plane is increased to 25°, the force required just to move the block up is 340 N, (the force is acting parallel to the plane). Determine the weight of the block and the coefficient of friction.

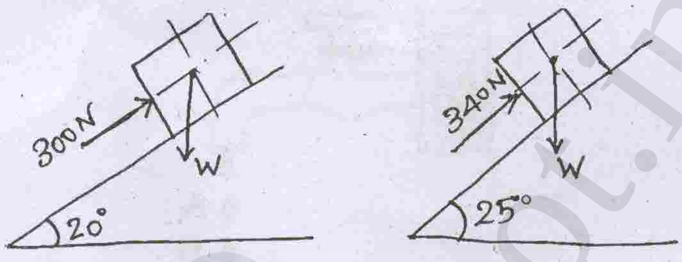


Figure. 15 (a)

Or

(b) A cast iron hoop of radius 200 mm is released from rest on a 25° incline as shown in Fig 15 (b). Find the angular acceleration of the hoop and the time taken by it to move a distance of 4 m down the slope. $\mu_s = 0.25$.

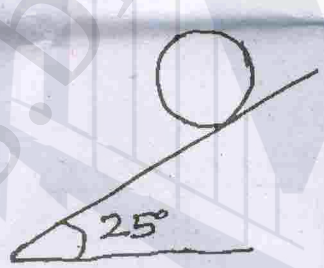


Figure 15 (b)

Reg. No. :

Question Paper Code : 51616

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014.

Second Semester

Civil Engineering

ME 2151/ME 25/080120002/CE 1151/10122 ME 205 — ENGINEERING MECHANICS

(Common to Aeronautical, Automobile, Marine, Mechanical, Production, Chemical, Petroleum Engineering, Biotechnology, Polymer, Textile, Textile (Fashion), Plastic Technology, Materials Science and Engineering, Manufacturing Engineering, Mechatronics Engineering, Industrial Engineering, Industrial Engineering and Management, Environmental Engineering, Geoinformatics, Mechanical and Automation Engineering, Petrochemical Engineering, Chemical and Electrochemical Engineering, Petrochemical Technology, Pharmaceutical Technology, Textile Chemistry and Mechanical Engineering (Sandwich))

(Regulation 2008/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Find the length of the line joining the origin with a point $(2,1,-2)$.

2. Find the magnitude and location of the single equivalent force of the system shown in Fig.2.

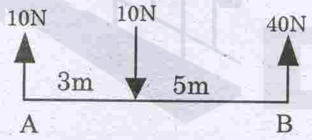


Fig.2.

3. State polygon law of equilibrium

4. State the different types of supports.

5. Define first moment of an area about an axis.

6. What is the radius of gyration of a circle of diameter d about its diameter?

7. A stone is dropped from the top of a tower. It strikes the ground after four seconds. Find the height of the tower.

8. State the principle of work and energy.

9. Define coefficient of static friction.

10. A body is rotating with an initial angular velocity of 3 rad/s. Its angular velocity increases to 10 rad/s in 5 seconds. Find the angular acceleration of the body.

PART B — (5 × 16 = 80 marks)

11. (a) A beam is loaded as shown in Fig .11 (a). Find the magnitude, direction and the location of the resultant of the system of forces.

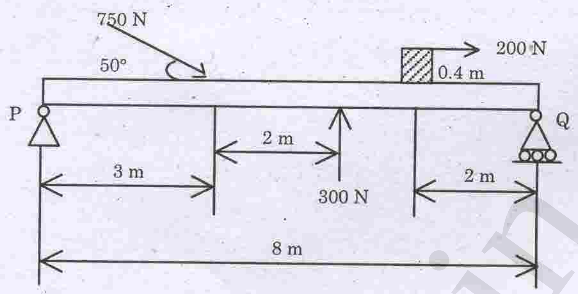


Fig. 11(a)

Or

(b) A system of forces acts as shown in Fig.11(b). Find the magnitude of A and B so that the resultant of the force system passes through P and Q.

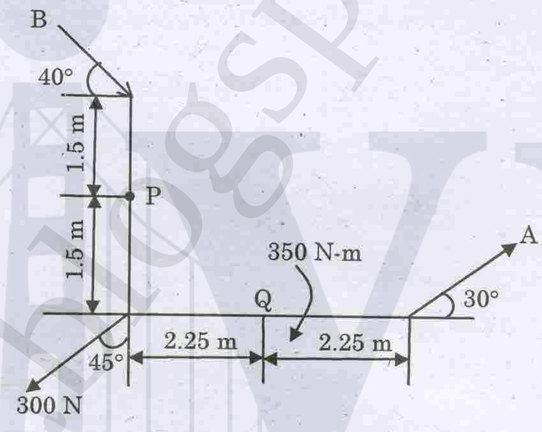


Fig. 11(b)

12. (a) Two identical rollers each of weight 2.5 kN rest in between an inclined wall and a vertical wall as shown in Fig.12(a). Determine the reactions at the points of contact P, Q and R. Assume the wall surfaces to be smooth.

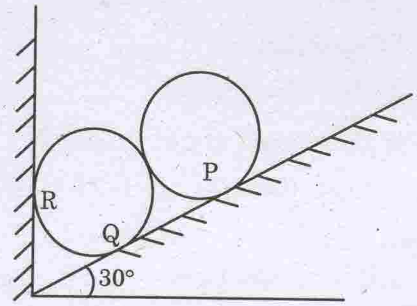


Fig. 12(a)

Or

(b) Determine the support reactions of the simply supported beam shown in Fig. 12 (b).

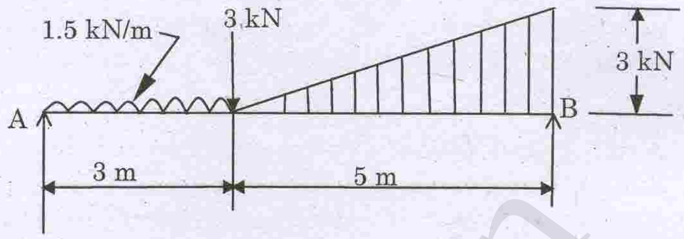


Fig.12(b)

13. (a) Locate the centroid of the area shown in Fig. 13(a). The dimensions are in mm.

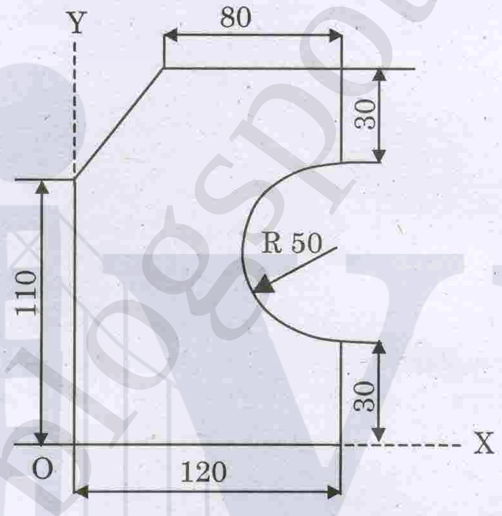


Fig. 13(a)

Or

(b) Find the moment of inertia of the built up section shown in Fig.13(b) about the axis passing through the centre of gravity parallel to the top flange plate.

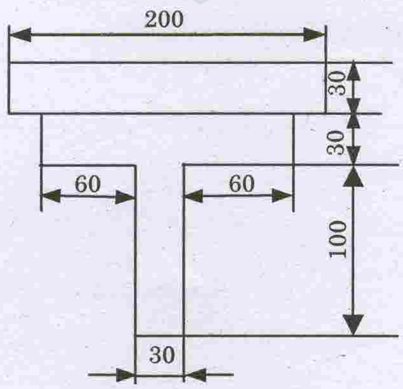


Fig. 13(b)

14. (a) The motion of a particle moving along a straight line is expressed as $s = t^3 - 8t^2 - 3t + 15$. Find (i) the time at which the velocity of the particle will be zero. (ii) the distance travelled by the particle at that time (iii) The acceleration of the particle at that time (iv) the net displacement of the particle from $t = 2$ seconds to $t = 4$ seconds.

Or

(b) A block and pulley system is shown in Fig. 14(b). The coefficient of kinetic friction between the block and the plane is 0.25. The pulley is frictionless. Find the acceleration of the blocks and the tension in the string when the system is just released. Also find the time required for 100 kg block to come down by 2 m.

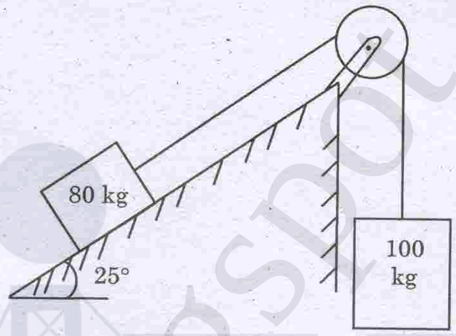


Fig. 14(b)

15. (a) A pull of 250N inclined at 25° to the horizontal plane is required just to move a body kept on a rough horizontal plane. But the push required just to move the body is 300 N. If the push is inclined at 25° to the horizontal, find the weight of the body and the coefficient of friction between the body and the plane.

Or

(b) Two wheel rims P and Q weighing 90N and 150 N respectively are released from rest to roll down an inclined plane simultaneously. The plane is inclined at 30° to the horizontal. The external radii of the rims P and Q and 80 mm and 120 mm respectively. Their radii of gyration are 100 mm and 120 mm respectively. Assuming rolling with slipping, find the relative acceleration of P with respect to Q parallel to the plane. Also find the velocity of P after 4 seconds.

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B 710

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2005.

First Semester

(Common to All Branches except Marine Engineering)

GE 131 — ENGINEERING MECHANICS

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the different laws of mechanics?

2. Explain coplanar concurrent forces.

3. Two forces $\vec{F}_1 = 5\vec{i}$ and $\vec{F}_2 = 8.66\,\vec{j}$ pass through a point whose co-ordinates are (2, 1). Calculate the moment of the force about the origin.

4. Explain perpendicular axis theorem.

5. Give the centroid of the semicircle shown in Fig. Q. 5.

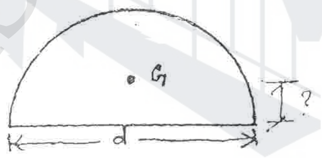

Fig. Q. 5

6. What is angle of friction?

7. What is uniformly accelerated rectilinear motion?

8. A car accelerates uniformly from a speed of 30 km/h to a speed of 75 km/h in 5 s. Determine the acceleration of the car and also the distance travelled during 5 s.

9. What is meant by time of restitution?

10. Define angular acceleration.

11. (i) A flywheel starts rotating from rest and is given an acceleration of 1 rad/s^2. Find the angular velocity and speed in rpm, after 1.5 minutes. If the flywheel is brought to rest with a uniform angular retardation of 0.5 rad/s^2, determine the time taken by the flywheel in seconds to come to rest. (8)

(ii) What is angular acceleration of the pulley shown in Fig. Q 11 (ii) turning under the action of two masses? (8)

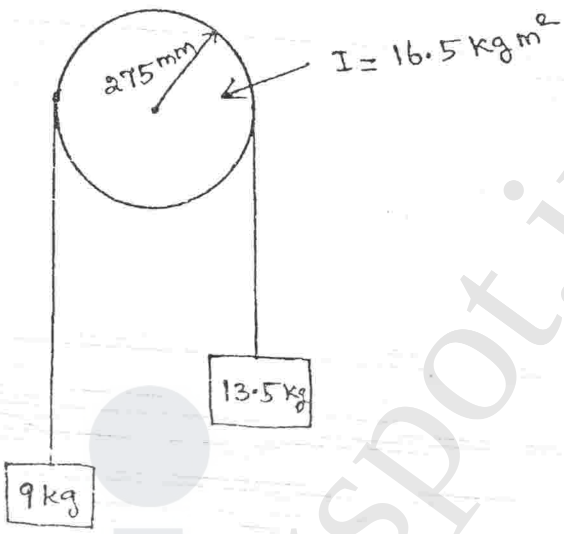

Fig. Q. 11 (ii)

12. (a) (i) Find the magnitude and direction of the resultant force for the system of forces acting on a particle A as shown in Fig. Q. 12 (a) (i). (8)

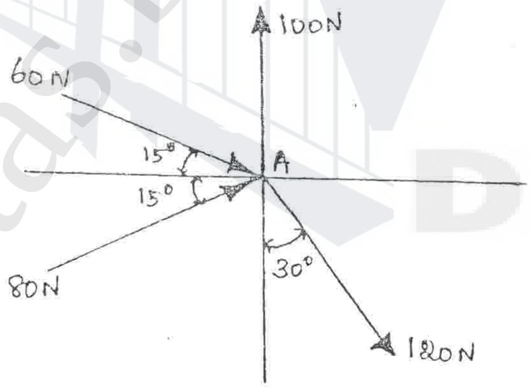

Fig. Q. 12 (a) (i)

(ii) A ball of weight 120 N rests in a right–angled groove as shown in Fig. Q. 12 (a) (ii). The sides of the groove are inclined to an angle of 30° and 60° to the horizontal. If all the surfaces are smooth, then, determine the reactions R_A and R_C at the points of contact. (8)

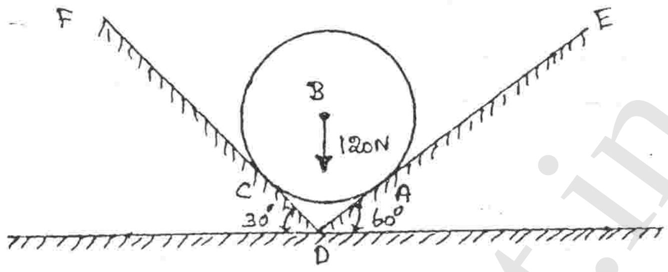

Fig. Q. 12 (a) (ii)

Or

(b) Forces 32 kN, 24 kN, 24 kN and 120 kN are concurrent at origin and are respectively directed through the points whose co–ordinates are A (2, 1, 6), B (4, –2, 5), C (–3, –2, 1) and D (5, 1, –2). Determine the resultant of the system. (16)

13. (a) Find the reactions at A and B for the beam shown in Fig. Q. 13 (a). (16)

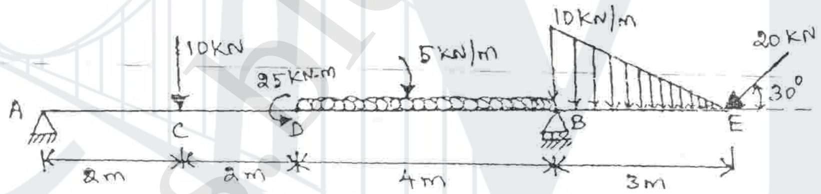

Fig. Q. 13 (a)

Or

(b) Refering to the Fig. Q. 13 (b) shown below, determine the least value of the force P to cause motion to impend rightwards. Assume the coefficient of friction under the blocks to be 0.2 and pulley to be frictionless. (16)

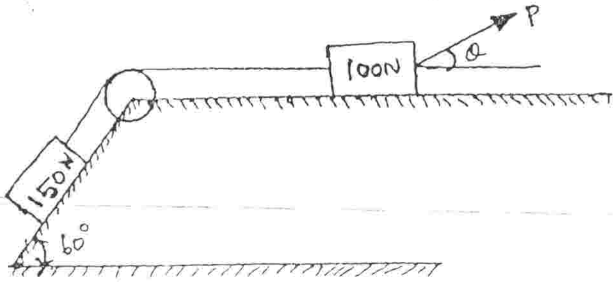

Fig. Q. 13 (b)

14. (a) Determine the position of the centre of gravity of the plane figure shown in Fig. Q. 14 (a). (16)

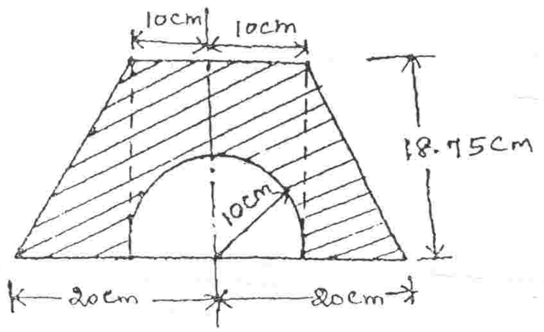

Fig. Q. 14 (a)

Or

(b) Determine the moment of inertia of the section shown in Fig. Q. 14 (b) about XX axis passing through its centre of gravity and the base BC. (16)

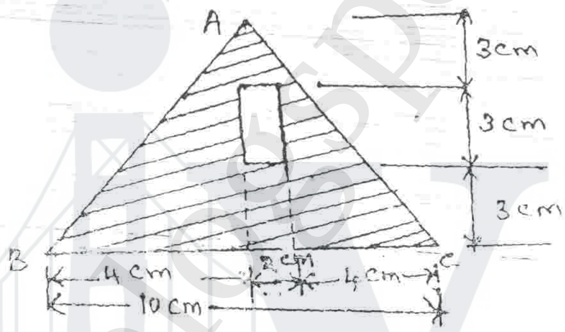

Fig. Q. 14 (b)

15. (a) Two vehicles travel between two stations 50 km apart. Both vehicles start at the same time from the same station. The first vehicle travels at 50 km/h while the second vehicle travels at 30 km/h. If the first vehicle halts in the second station for 5 minutes and then returns with the same speed, determine where the two vehicles will meet. (16)

Or

(b) A projectile is fired with an initial velocity of 250 m/s at a target located at a horizontal distance of 4 km and vertical distance of 700 m above the gun. Determine the value of firing angle to hit the target. Neglect air resistance. (16)

Reg. No. :

S 4043

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2007.

Second Semester

(Regulation 2004)

Civil Engineering

GE 1151 — ENGINEERING MECHANICS

(Common to All branches)

(Common to B.E. (Part–Time) First Semester – Reg. 2005)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Using Lame's theorem calculate the forces in the member CA and CB for the system shown in Fig. Q. 1.

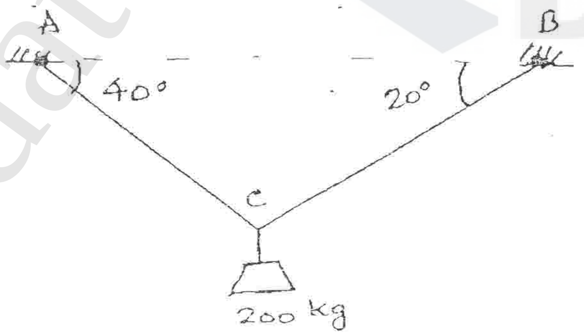

Fig. Q. 1

2. A force F has the components $F_x = 20$ N, $F_y = -30$ N, $F_z = 60$ N. Find the angle 'θ_y' it forms with the coordinates axes y.

3. Explain with the help of sketches the Wrench resultant.

4. State Varignon's theorem, using this calculate the moment about 'O' for the system shown in Fig. Q. 4.

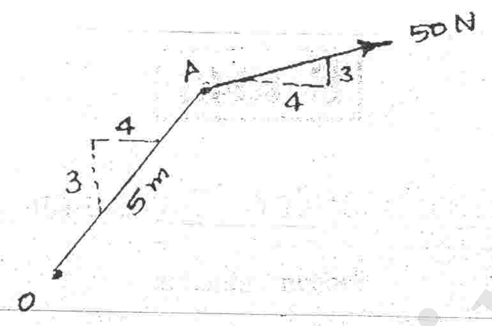

Fig. Q. 4

5. Calculate $\bar{y}$ for the shaded area shown in Fig. Q. 5

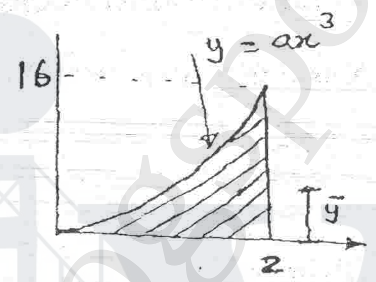

Fig. Q. 5

6. Calculate moment of inertia I_{XX} for plane area shown in Fig. Q. 6. All dimensions are in mm.

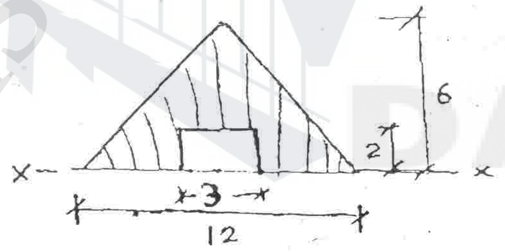

Fig. Q. 6

7. A golf ball is dropped from a height of 10 m on to a fixed steel plate. The coefficient of restitution is 0.85. Find the height to which the ball rebounds at the first bounce.

8. State principle of conservation of energy.

9. Define rolling resistance with a sketch.

10. Define instantaneous centre of rotation. Locate the instantaneous centre of rotation of the system shown in Fig. Q. 10.

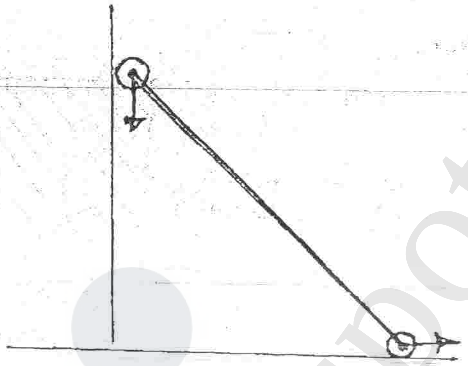

Fig. Q. 10

PART B — (5 × 16 = 80 marks)

11. (a) Calculate the moment of inertia about XX axis. (XX axis is the centroidal axis) for the plane figure shown in Fig. Q. 11 (a). Assume AB as the reference axis to locate XX. (16)

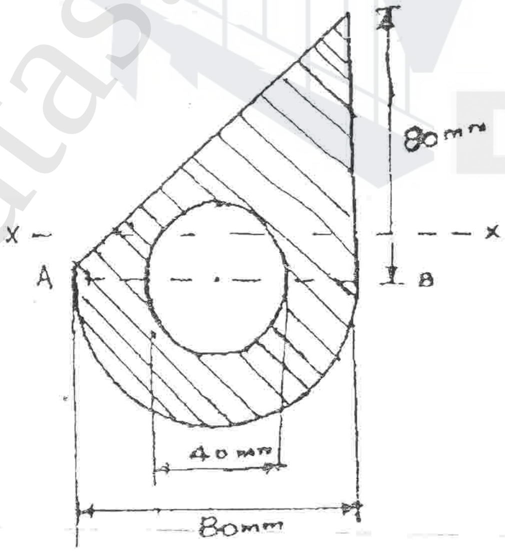

Fig. Q. 11 (a)

Or

(b) Locate the centroid for the following sections as shown in Fig. Q. 11 (b) (i) and (ii). $(2 \times 8 = 16)$

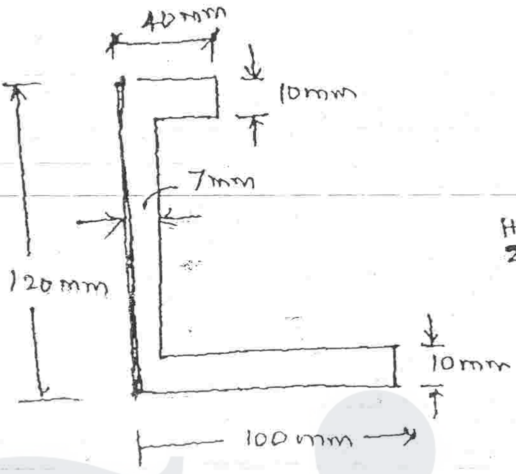

Fig. Q. 11 (b) (i)

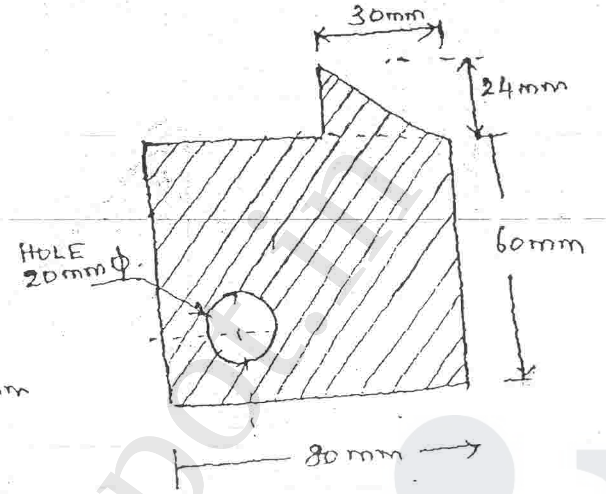

Fig. Q. 11 (b) (ii)

12. (a) Determine the resultant of the force system acting in plane shown in Fig. Q. 12 (a). Locate the distance from A where the resultant cuts the x axis.

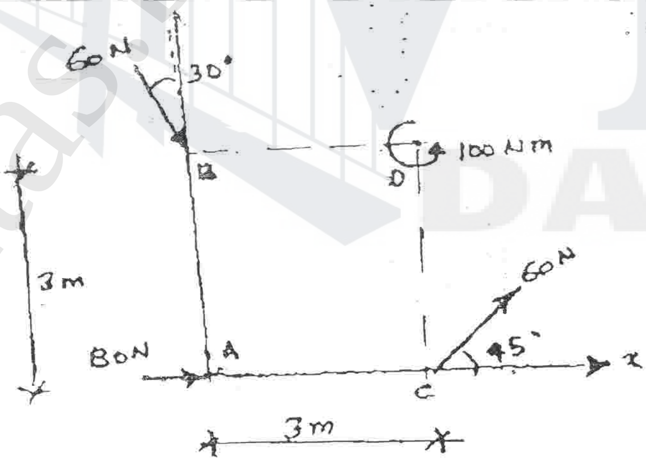

Fig. Q. 12 (a)

Or

(b) A container weighing 450 kN is suspended at P by using two cables PB and PA anchored as shown in Fig. Q. 12 (b). A horizontal force F keeps the Q. 12 (b) container in the current position. Find the magnitude of Force F and forces in cable PA and PB.

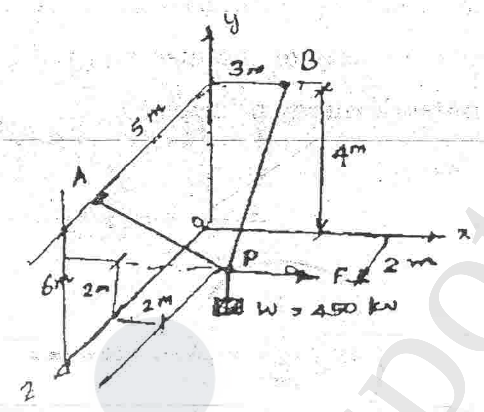

Fig. Q. 12 (b)

13. (a) Two identical rollers each of weight 5 kN rest in between an inclined wall and a vertical wall as shown in Fig. Q. 13 (a). Determine the reactions at the points of contact P, Q and R. Assume the wall surfaces to be smooth.

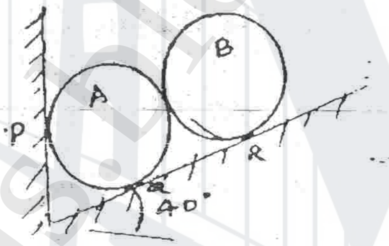

Fig. Q. 13 (a)

Or

(b) A shaft is subjected to forces in x, y and z direction as shown in Fig. Q. 13 (b). Replace these forces by a resultant R at origin O and a couple.

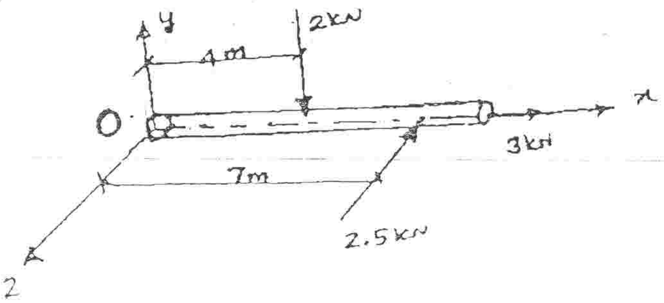

Fig. Q. 13 (b)

14. (a) A rod CD of 8 kg, length 0.8 m is welded to a uniform disc of mass 5 kg and radius 0.16 m. A spring of constant $k =$ 100 N/mm is attached to a disc as shown in Fig. Q. 14 (a). When the rod CD is horizontal, the spring is unstretched. Assembly is released from rest from the position shown. What is angular velocity of the disc and rod if it has rotated through $\pi/2$ angle (use work energy principle).

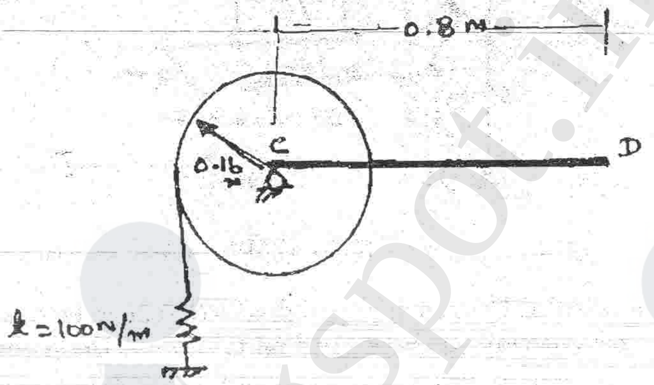

Fig. Q. 14 (a)

Or

(b) Two bodies of weights w_1 and w_2 respectively are connected by an inextensible string passing over a frictionless pulley. The coefficient of friction between w_1 and plane is 0.2. What is the velocity of the weights before w_1 reaches the top edge of plane. Calculate the velocity of weights after 2 secs if $w_1 = 100\,\text{N}$; $w_2 = 80\,\text{N}$; $\alpha = 30°$. Refer Fig. Q. 14 (b). (Use impulse momentum principle)

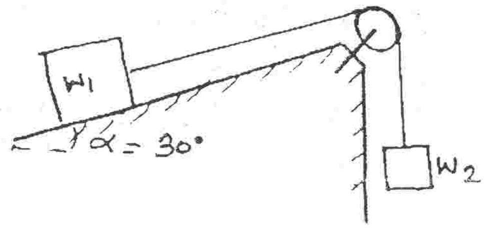

Fig. Q. 14 (b)

15. (a) A pulley assembly shown in Fig. Q. 15 (a) weighs 50 kg, with a radius of gyration of 0.35 m. The blocks A and B are connected through strings wrapped around the pulleys. Determine the acceleration of each block and tension in each string.

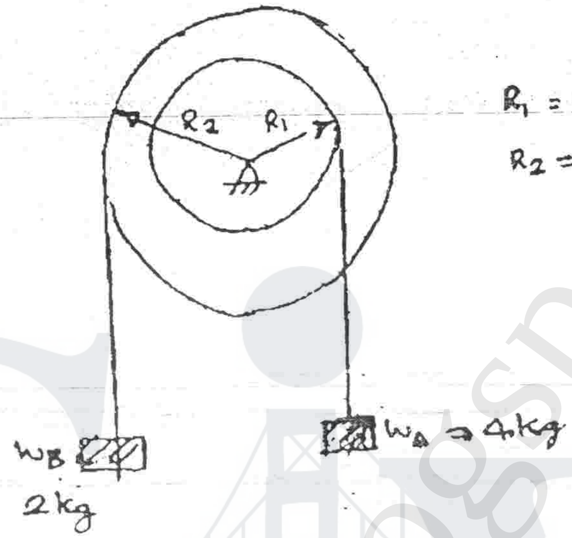

Fig. Q. 15 (a)

Or

(b) Blocks A and B connected through a cord rest on inclined planes as shown in Fig. Q. 15 (b). What is the tension in the cord is the friction at block A reaches the maximum value? State whether the system is at rest or motion. (16)

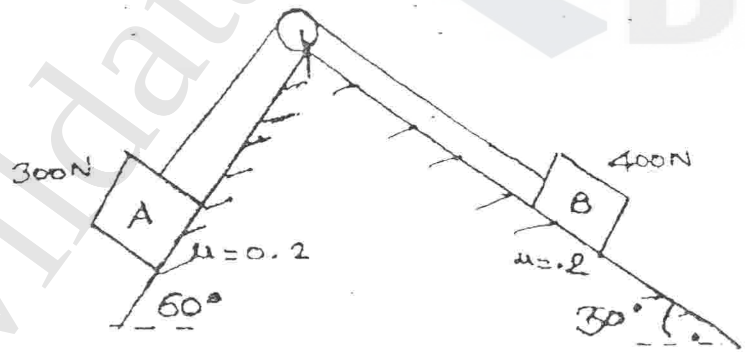

Fig. Q. 15 (b)

D 134

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2005.

Second Semester

Civil Engineering

(Common to all branches)

GE 1151 — ENGINEERING MECHANICS

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. State the principle of Transmissibility.

2. Three coplanar forces of magnitude P Newtons each are acting on a particle. If their lines of action make equal angles with each other, show that the forces are in equilibrium.

3. State the Varignon's theorem.

4. Find the moment of the force of 15 N acting along the positive direction of X–axis about the point $A\,(2, 3)$.

5. Distinguish between centroid and centre of gravity.

6. Define product of inertia.

7. Explain briefly the two types of collision.

8. If the distance x cm travelled by a particle in t–seconds is given by $x = 20t^2 + 50t + 19$, find the velocity and acceleration after 3 seconds.

9. State the laws of friction.

10. Briefly explain "step of the belt" in belt drives.

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PART B — (5 × 16 = 80 marks)

11. For a section given in fig. 1;

(i) Locate the horizontal centroidal axis–X. (8)

(ii) Locate the vertical centroidal axis–Y. (8)

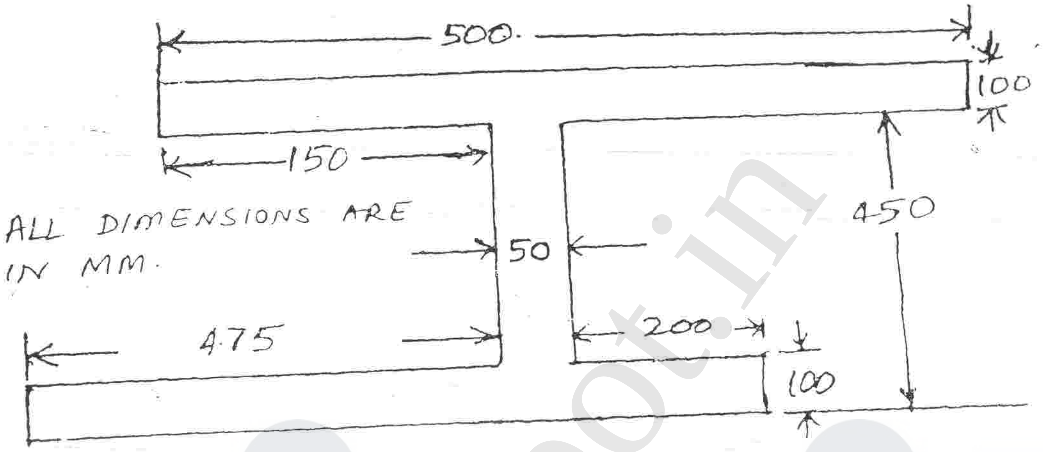

fig. 1

12. (a) A pole AB, 6 m long is held by three guy wires as shown in fig. 2. Determine the moment about each of the coordinate axes of the force exerted by wire BE on point B. The tension 'T' in wire BE is known to be 840 N. (16)

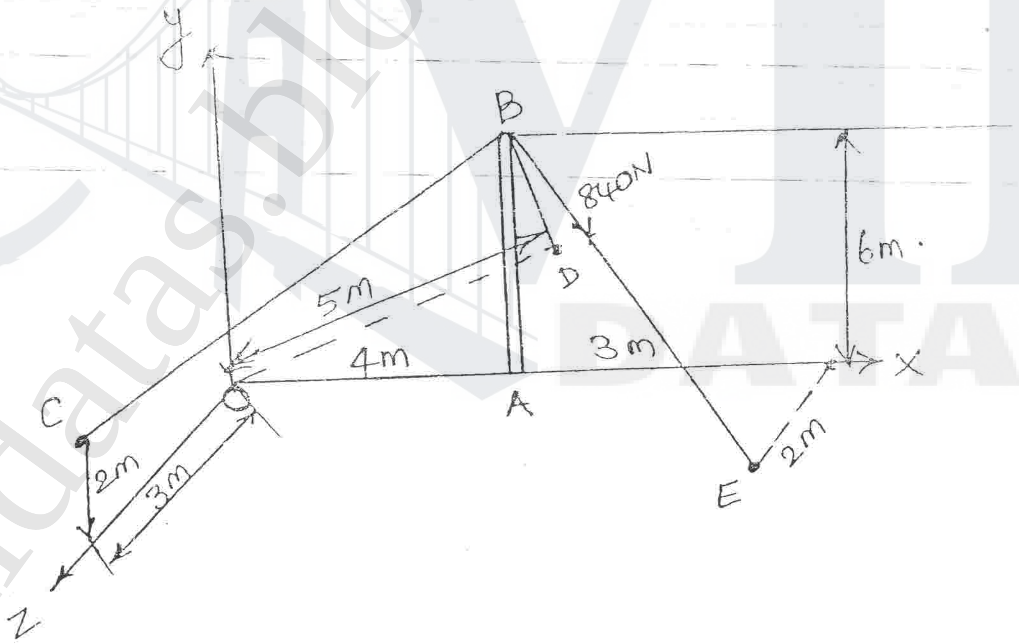

fig. 2

Or

(b) Determine the magnitude and direction of a single force P which keeps in equilibrium. The system of forces acting is shown in fig. 3. (16)

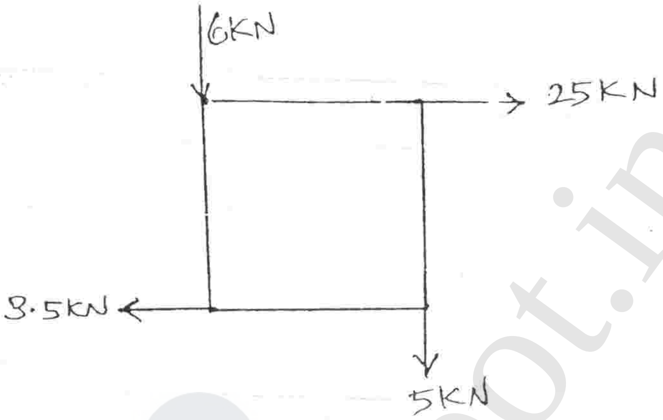

fig. 3

13. (a) Find the reactions at supports A and B of the beam as shown in fig. 4. (16)

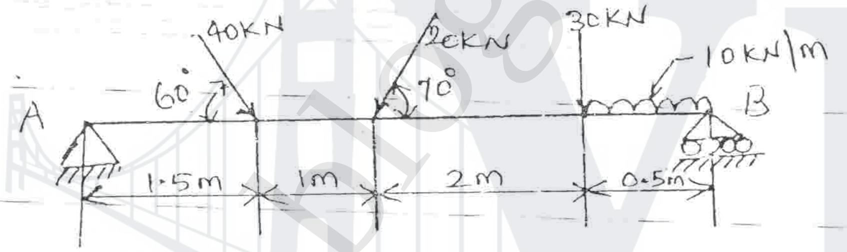

fig. 4

Or

(b) Forces of magnitudes 1, 2, 3, 4 and $2\sqrt{2}$ Newtons act respectively along the sides AB, BC, CD, DA and the diagonal AC of the square ABCD whose side is 3 m. Show that their resultant is couple and find its moment. (16)

14. (a) A force F = 30 N acts parallel to the inclined plane as it accelerates a block of mass m = 2 kg upto the 30° incline with a coefficient of kinetic friction $\mu_K = 0.3$ as shown in fig. 5. A spring whose force constant 'K' is 40 Nm^{-1} is attached to the block which starts from rest at a position $x = 0$, where the spring is unstressed. Find the speed of the block after travelling 0.2 m up the incline? Use work energy method. (16)

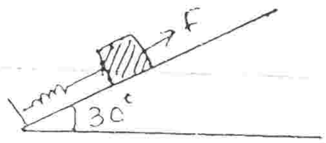

fig. 5

Or

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(b) (i) A stone is thrown upwards from the top of a tower 70 m high with a velocity of 19.2 m/S. Determine its position and velocity when $t = 6$ sec. (8)

(ii) An elevator is required to lift a body of mass 65 kg. Find the acceleration of the elevator, which could cause a pressure of 800 Newtons on the floor. (8)

15. (a) Block A weighing 1500 N is to be raised by means of 15° wedge as shown in fig. 6. Assume the coefficient of friction between all contact surfaces be 0.2. Weight of the block B is 500 N. Determine the minimum force required to move the block A upwards. (16)

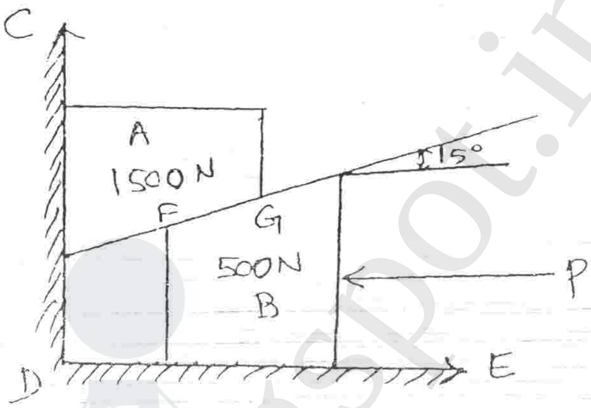

fig. 6

Or

(b) A reciprocating engine mechanism is shown in fig. 7. The crank OA is of length 150 mm and rotating at 600 rpm. The connecting rod AB is 700 mm long. Find

(i) The angular velocity of the connecting rod. (5)

(ii) The velocity of piston B. (5)

(iii) The velocity of point C on the connecting rod at a distance of 200 mm from A when $\theta = 45°$ (6)

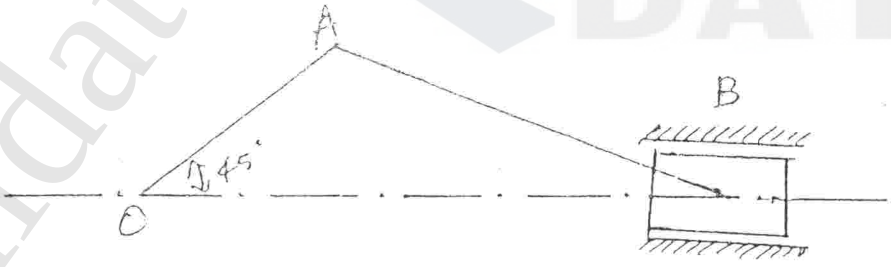

fig. 7

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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2006.

First Semester

GE 131 — ENGINEERING MECHANICS

(Common to all branches except Marine Engineering)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Distinguish between units and dimensions. Give an example.

2. A force of magnitude 50 kN is acting along the line joining $A(2, 0, 6)$m and $B(3, -2, 0)$m. Write the vector form of the force.

3. Two forces of magnitude 50 kN and 80 kN are acting on a particle, such that the angle between the two is 135°. If both the forces are acting away from the particle, calculate the resultant and find its direction.

4. Draw neat sketches and mark reaction at supports :

   (a) Simply supported beam AB of span L.

   (b) Cantilever beam of length L.

5. Locate the centroid and calculate moment of inertia about centroidal axes of a semicircular lamina of radius 2 m.

6. Define coefficient of friction and express its relationship with angle of friction.

7. If $x = 3.5t^3 - 7t^2$, determine acceleration, velocity and position of the particle, when $t = 5$ sec.

8. A stone is projected at such an angle that the horizontal range is $4\sqrt{3}$ times the maximum height. Find the angle of projection.

9. Consider a wheel rolling on a straight track. Illustrate the characteristics of general plane motion.

10. Write work energy equation of rigid body. Mention the meaning for all parameters used in the equation.

PART B — (5 × 16 = 80 marks)

11. (a) Four forces of magnitude 10 kN, 20 kN, 30 kN and 50 kN are acting on a particle O. The angles made by the forces with X-axis are 45°, 90°, 150° and 240° respectively. All the angles are measured in anticlockwise direction. Find the magnitude and direction of equilibrant.

Or

(b) (i) A system of parallel forces acting on a rigidbar ABCD is shown in Fig. Q 11 (b) (i). Reduce this system to a single force and couple at A. (4)

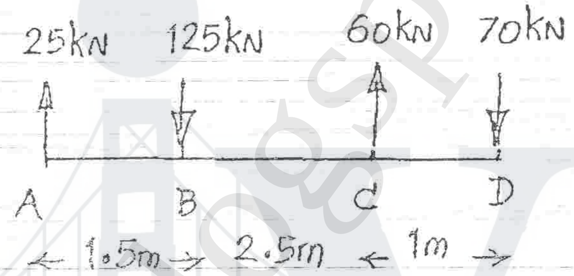

Fig. Q. 11 (b) (i)

(ii) Determine the magnitude, direction and position of resultant force for the system of forces shown in Fig. Q 11 (b) (ii). (12)

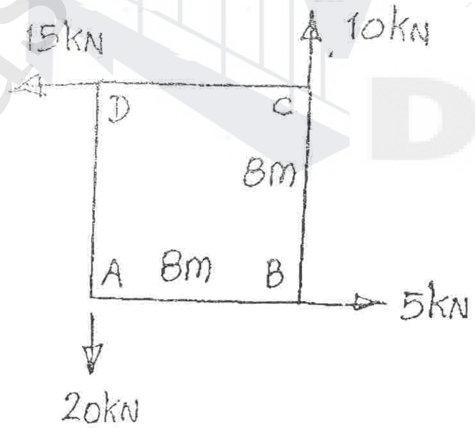

Fig. Q. 11 (b) (ii)

12. (a) (i) A 60 kN force passes from point $A(0, 0.9, 1.2)$ to point $B(3.6, 0, 2.4)$. Find the moment of this force about point $C(3.6, 1.8, 1.2)$. (7)

(ii) The X, Y, Z components of a force are 54 kN, – 36 kN and 36 kN respectively. Find the magnitude of the force and angle it makes with X, Y and Z axes. Also find the component of the force along the line joining $A(1, 2, -3)$ and $B(-1, -2, 2)$. (9)

Or

(b) (i) Determine the reactions at supports A and B of the over hanging beam shown in Fig. Q. 12 (b) (i). (10)

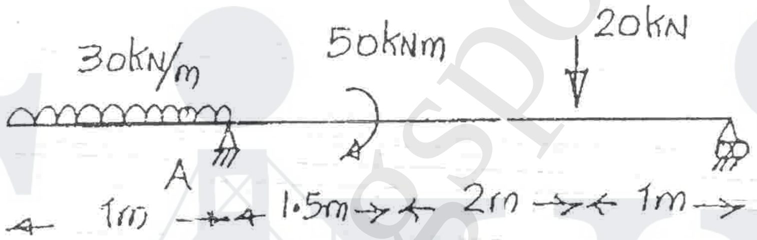

Fig. Q. 12 (b) (i)

(ii) State laws of Coloumb friction. (4)

(iii) Define rolling resistance. (2)

13. (a) (i) An inverted T section is shown in Fig. Q. 13 (a) (i). Calculate the moment of inertia of the section about XX axis parallel to the base and passing through the centroid. Also calculate radius of gyration. (12)

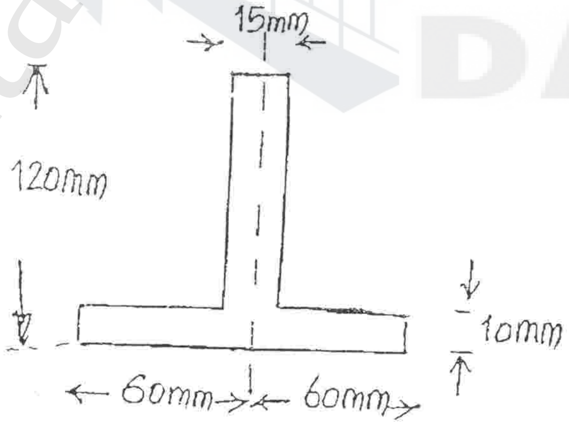

Fig. Q. 13 (a) (i)

(ii) Derive the expression for mass moment of inertia about the vertical centroidal axis of a thin rectangular plate of width 'b', depth 'd' and thickness 't'. (4)

Or

(b) Locate the centroid and find I_{xx}, I_{yy} about the axes passing through the centroid of lamina shown in Fig. Q. 13 (b).

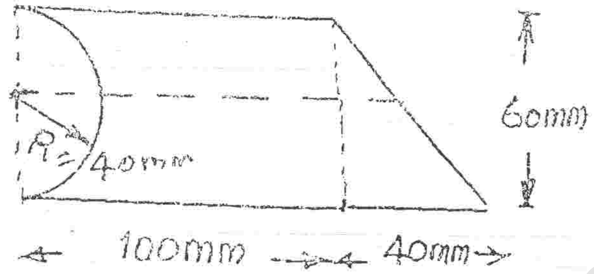

Fig. Q. 13 (b)

14. (a) A shot is fired with a bullet with an initial velocity of 40 m/s from a point 20 m in front of a vertical wall 10 m high. Find the angle of projection with horizontal to enable the shot to just clear the wall.

Or

(b) (i) Distinguish between direct central impact and oblique central impact. (4)

(ii) A ball of mass 90 kg moving with a velocity of 5 m/s strikes directly another ball of mass 50 kg moving in opposite direction with a velocity of 10 m/s. If the coefficient of restitution is 0.6, calculate the velocity of each ball after impact. (12)

15. (a) (i) The angle of rotation of a rigid body is expressed as $\theta = 3t^3 - 5t^2 + 7t + 9$ where θ is expressed in radians and t in seconds. Calculate angular velocity and angular acceleration when $t = 3$ sec. (8)

(ii) A stone is allowed to fall from the edge of a tower 100 m high. What will be its velocity after 2 seconds? Also determine the time taken to reach the ground. (8)

Or

(b) Two bodies weighing 1000 N and 250 N are connected by thread and move along a rough horizontal plane under the action of a force 500 N applied to the first body of weight 1000 N. The coefficient of friction between the sliding surfaces of the bodies and the plane is 0.2. Determine the acceleration of the two bodies and the tension in the thread.

12. (a) (i) A 60 kN force passes from point $A(0, 0.9, 1.2)$ to point $B(3.6, 0, 2.4)$. Find the moment of this force about point $C(3.6, 1.8, 1.2)$. (7)

(ii) The X, Y, Z components of a force are 54 kN, – 36 kN and 36 kN respectively. Find the magnitude of the force and angle it makes with X, Y and Z axes. Also find the component of the force along the line joining $A(1, 2, -3)$ and $B(-1, -2, 2)$. (9)

Or

(b) (i) Determine the reactions at supports A and B of the over hanging beam shown in Fig. Q. 12 (b) (i). (10)

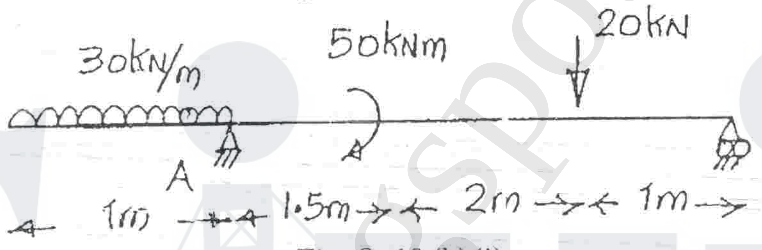

Fig. Q. 12 (b) (i)

(ii) State laws of Coloumb friction. (4)

(iii) Define rolling resistance. (2)

13. (a) (i) An inverted T section is shown in Fig. Q. 13 (a) (i). Calculate the moment of inertia of the section about XX axis parallel to the base and passing through the centroid. Also calculate radius of gyration. (12)

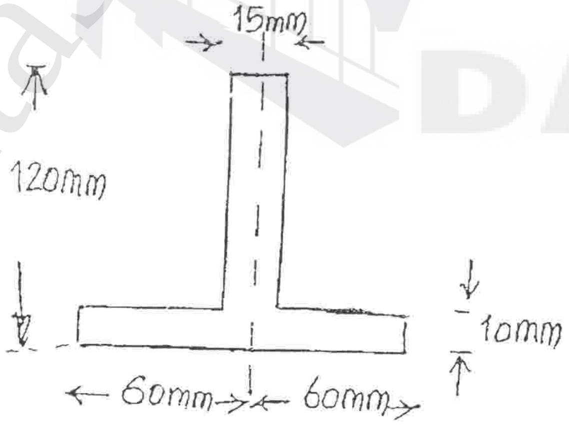

Fig. Q. 13 (a) (i)

(ii) Derive the expression for mass moment of inertia about the vertical centroidal axis of a thin rectangular plate of width 'b', depth 'd' and thickness 't'. (4)

Or

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B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2006.

Second Semester

Civil Engineering

GE 1151 — ENGINEERING MECHANICS

(Common to all Branches and B.E (Part - Time) First Semester R 2005)

(Regulation – 2004)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. A 100 N force acts at the origin in a direction defined by the angles $\theta_x = 75°$ and $\theta_y = 45°$. Determine θ_z and the component of the force in the z direction.

2. State the principle of Transmissibility.

3. What is a couple? What is the moment of couple?

4. State Varignon's theorem.

5. What are principal axes?

6. State the perpendicular axis theorem.

7. State the Newton's Second law of motion.

8. Define the term 'Coefficient of restitution'.

9. Define the term 'angle of repose'.

10. What is meant by Centrode?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Check whether the particle 'O' shown in figure Q. 11 (a) is in equilibrium under the given system of forces. If not determine the magnitude and direction of the force necessary to keep the particle in equilibrium. (8)

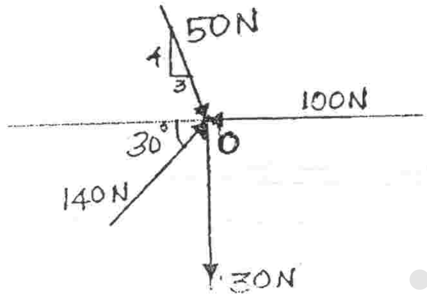

Figure Q. 11 (a)

(ii) A force is represented in a vector form P = 20i–8j–14k, N. Determine the projection of this force on a line which originate from (2,–4,5) and passes through the point (5,2,–4). Also find the angle between the force and the line. (8)

Or

(b) A rigid bar ABCD, is subjected to a system of forces as shown in figure Q. 11(b). Determine the resultant of the force system and also deduce the system to a single force and couple at A.

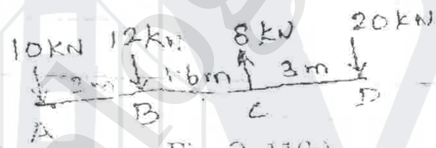

Fig. Q. 11(b)

12. (a) (i) A force of magnitude 200 N is acting along the line joining P(2, 4, 8) m and Q(4, 7, 10) m. find the moment of the force about the point R(7, 10, 15) m. (6)

(ii) A beam AB, 1.7 m long is loaded as shown in figure Q. 12 (a) (ii). Determine the reactions at supports A and B. (10)

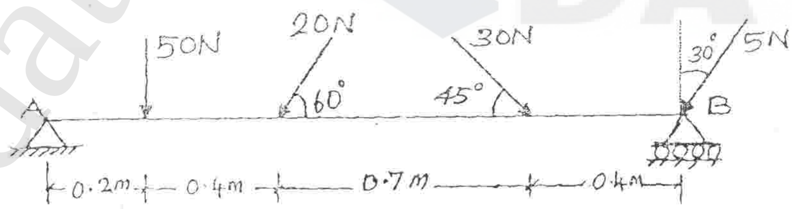

Figure Q. 12 (a) (ii)

Or

(b) (i) What is meant by equilibrium of a rigid body? What are the conditions of equilibrium for a rigid body in three dimension? (4)

(ii) A vertical pole of 9 m high is held in position by three guy wires as shown in figure Q. 12 (b). The bottom of the pole is supported at the ground using a ball and socket arrangement. If the force in the cable BE is 1260 N, determine the forces in other cables and also the reaction at the bottom of the pole. (12)

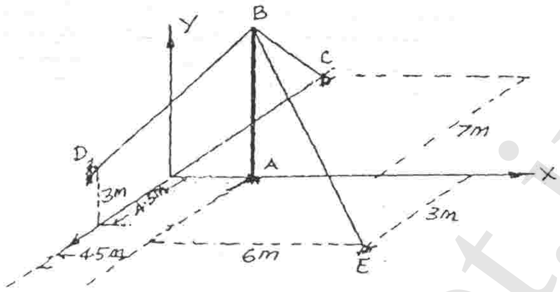

Figure Q. 12 (b)

13. (a) (i) What is meant by polar moment of inertia? (3)

(ii) The cross-section of a hollow circular lamina is as shown in figure. Q 13 (a) (ii). Locate the position of the centroid of the net area and then work out the moments of inertia about both the horizontal and vertical centroidal axes. (13)

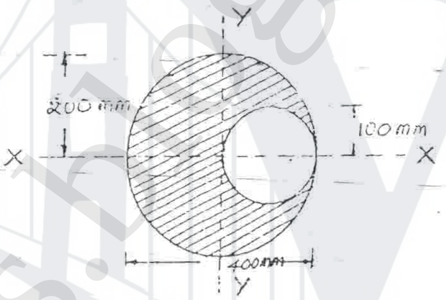

Fig. Q. 13(a)(ii)

Or

(b) (i) Find the second moment of area of the plane lamina shown in figure Q. 13 (b) (i) with respect to the given XX-axis. (8)

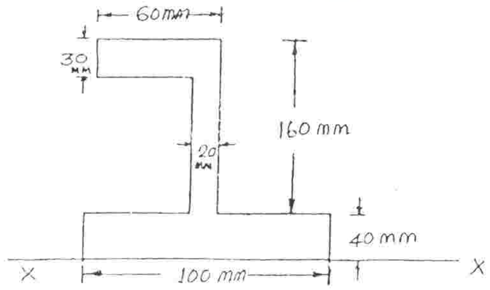

Figure Q. 13 (b) (i)

(ii) Derive the relation for mass moment of inertia of a solid sphere of radius 'r' about its diameter. (8)

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14. (a) (i) The angle of rotation of a body is given as the function of time by the equation, $\theta = \theta_0 + at^2 + bt^3$ where θ_0 is the initial angular displacement, a and b are constants. Obtain the general expression for

(1) The angular velocity and

(2) The angular acceleration of the body.

If the initial angular velocity be (3π) radians per second and after two seconds the angular velocity is (8π) radians per second, find the constants a and b. (10)

(ii) A body of mass 50 kg moving with a velocity of 6 m/sec, collides directly with a stationary body of mass 30 kg. If the two bodies become coupled so that they move on together after the impact in the same direction. What is their common velocity? (6)

Or

(b) A bullet is fired from the top of a mountain of height 300 metre with a velocity of 200 m/s at an angle of elevation of 40° Determine the

(i) Maximum elevation reached by the bullet above the ground.

(ii) Horizontal distance between the point of firing and the point where the bullet will strike the ground and

(iii) Magnitude and direction of velocity with which the bullet will strike the ground. (16)

15. (a) A block weighing 1350 N is placed on an inclined plane whose inclination to the horizontal is 37°. A force of 450 N acts on the body in the upward direction parallel to the plane. Determine whether the block is in equilibrium or not, and also find the frictional force between the body and the plane. The coefficient of static and kinetic frictions are 0.25 and 0.20 respectively. (16)

Or

(b) (i) Find the ratio of tension in tight and in slack sides of a belt with contact angle of 160° with pulley. Assume the coefficient of friction $\mu = 0.22$. If the slack tension is 100 N, what is the value of tension on tight side? (6)

(ii) Two bodies of weight 40 N and 20 N are connected to the two ends of a light inextensible string, passing over a smooth pulley. The weight of 40 N is placed on a smooth horizontal surface while the weight of 20 N is hanging free in air. Find

(1) The acceleration of the system and

(2) The tension in the string.

Take $g = 9.81\ m/sec^2$. (10)

Reg. No. :

Question Paper Code : 11516

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2012.

Second Semester

ME 2151/113201/ME 25/10122 ME 205/080120002/CE 1151 — ENGINEERING MECHANICS

(Common to Civil, Aeronautical, Automobile, Marine, Mechanical, Production, Chemical, Petroleum Engineering, Biotechnology, Polymer, Textile, Textile (Fashion), Rubber and Plastics Technology, Materials Science and Engineering, Manufacturing Engineering, Mechatronics Engineering, Industrial Engineering, Industrial Engineering and Management, Environmental Engineering, Geoinformatics, Mechanical and Automation Engineering, Petrochemical Engineering, Chemical and Electrochemical Engineering, Petrochemical Technology, Pharmaceutical Technology and Textile Chemistry)

(Regulation 2008)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Find the angle between the forces A and B given as

   $\vec{A} = 3i - 2j + 4k$

   $\vec{B} = 5i + 3j - 4k$

2. How will you find the direction cosine in the Z-direction of the resultant force of a concurrent spatial force system?

3. Distinguish between a couple and a moment.

4. State Varignon's theorem.

5. Distinguish between centroid and centre of gravity.

6. Define principal axes and principal moment of inertia.

7. A car moves on a circular path of radius 25 m, with a uniform speed of 9 m/s. Determine the total acceleration on the car.

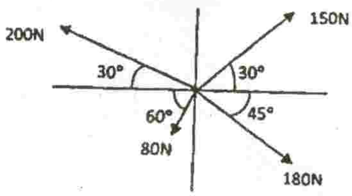
8. What is D' Alembert's principle?

9. When do we say that the motion of a body is impending?

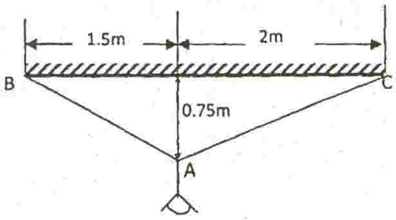
10. A wheel of radius 50 cm is moving on rails, with a speed of 12 m/s. Find the angular speed of the wheel.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Determine the resultant of the concurrent force system shown in figure. (8)



(ii) Figure shows a 10 kg lamp supported by two cables AB and AC. Find the tension in each cable. (8)

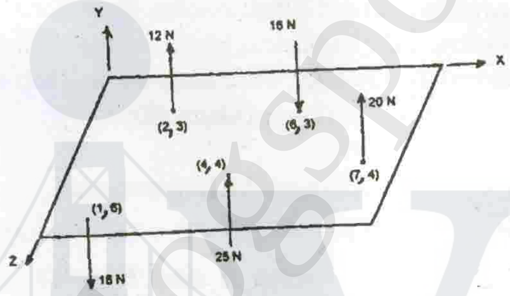


Or

(b) Forces 32 kN, 24 kN, 24 kN and 120 kN are concurrent at origin and are respectively directed through the points whose coordinates are A (2, 1, 6), B (4, -2, 5), C (-3, -2, 1) and D (5, 1, -2). Determine the magnitude of the resultant and the angles it makes with coordinate axes. (16)

12. (a) (i) Distinguish between '**Moment of a force about a point**' and '**Moment of a force about an axis**'. (4)

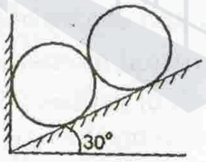
(ii)



Find the resultant force and its location of the force system shown in figure. The (x, z) coordinates of the points of application of the forces are given in metres. (12)

Or

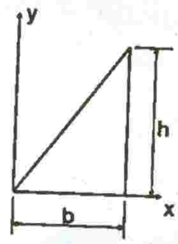
(b) Two identical rollers, each of weight 500 N, are supported by an inclined plane making an angle of 30° to the horizontal and a vertical wall as shown in the figure.



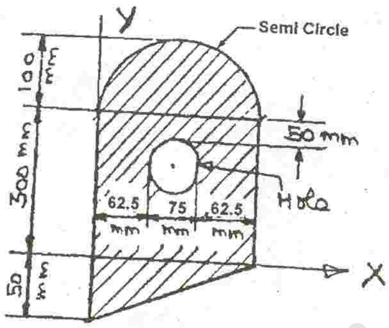
(i) Sketch the free body diagrams of the two rollers. (4)

(ii) Assuming smooth surfaces, find the reactions at the support points. (12)

13. (a) (i) Derive the expressions for the location of the centroid of a triangular area shown in figure, by direct integration. (6)

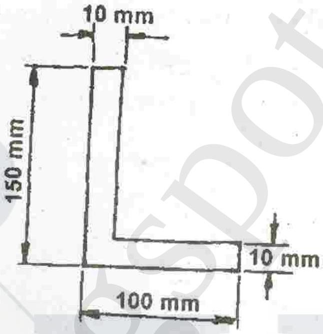


(ii) Locate the centroid of the plane area shown in figure below. (10)



Or

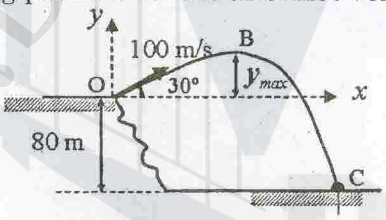
(b) (i) An area in the form of L section is shown in figure.



Find the moments of inertia I_{xx}, I_{yy} and I_{xy} about its centroidal axes. (11)

(ii) Also determine the principal moments of inertia. (5)

14. (a) A Bullet is fired making an angle 30° to the horizontal from a hill which strikes the target which is 80 m lower than the horizontal passing through the firing point. The initial bullet velocity is 100 m/s.



Find the following :

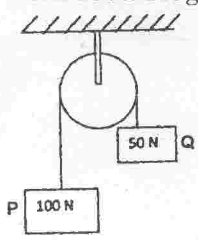
(i) The maximum height above horizontal to which the bullet will rise. (4)

(ii) The velocity of bullet when it strikes the target. (6)

(iii) The total time required for the bullet when it strikes the target. (6)

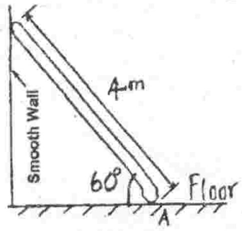
Or

(b) (i) Block P of weight 100 N and block Q of weight 50 N are connected by a rope that passes over a smooth pulley as shown in figure. Find the acceleration of the blocks and the tension in the rope, when the system is released from rest. Neglect the mass of the pulley. (8)



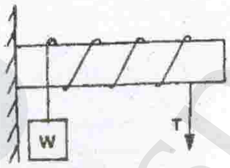
(ii) A 2000 kg automobile is driven down a 5° inclined plane at a speed of 100 km/h when the brakes are applied causing a constant total breaking force (applied by the road on the tires) of 7 kN. Determine the distance traveled by the automobile as it comes to a stop. (8)

15. (a) (i) A ladder of weight 1000 N and length 4 m rests as shown in figure.



If a 750 N weight is applied at a distance of 3 m from the top of ladder, it is at the point of sliding. Determine the coefficient of friction between ladder and the floor. (10)

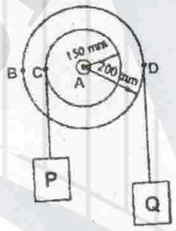
(ii) A rope is wrapped three times around a rod as shown in figure.



Determine the force T required on the free end of the rope, to support a load of W = 20 kN. Take μ as 0.30. (6)

Or

(b) Figure shows a stepped pulley. The smaller radius is 150 mm and the bigger radius is 200 mm. Two loads P and Q are connected by inextensible taut cords.



Load P moves with an initial velocity of 0.2 m/s and has a constant acceleration of 0.25 m/s^2 both downwards. Determine

(i) The number of revolutions turned by the pulley in 4 seconds. (6)

(ii) Velocity and the distance traveled by load Q after 4 seconds. (5)

(iii) Acceleration of point B located on the rim of the pulley at $t = 0$. Give both magnitude and direction. (5)

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Reg. No. :

Question Paper Code : Q 2720

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

Annual Pattern — First Year

Civil Engineering

GEIX 04 — ENGINEERING MECHANICS

(Common to Bio-Technology/Chemical Engineering/
Petroleum Engineering/Polymer Technology/Textile Technology/
Textile Technology (Textile Chemistry))

(Regulation 2004)

Time : Three hours — Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the necessary and sufficient conditions for equilibrium of a particle in space.

2. Explain briefly the principle of transmissibility.

3. Represent the rectangular components of moment of a force in determinant form.

4. What is the significance of a free body diagram?

5. Define the terms : (a) lead angle and (b) pitch of a screw.

6. Give the cause of rolling resistance.

7. Express the integrals for finding moment of inertia of an area.

8. Find the moment of inertia of a right triangle of width 60 mm and height 90 mm about its base.

9. State the principle of work and energy.

10. Define the terms position vector and velocity as applied to curvilinear motion of particles.

PART B — (5 × 16 = 80 marks)

11. (a) Determine the tension in the cables AB, AC and AD if the crate shown in Fig. 1 is weighing 10 kg.

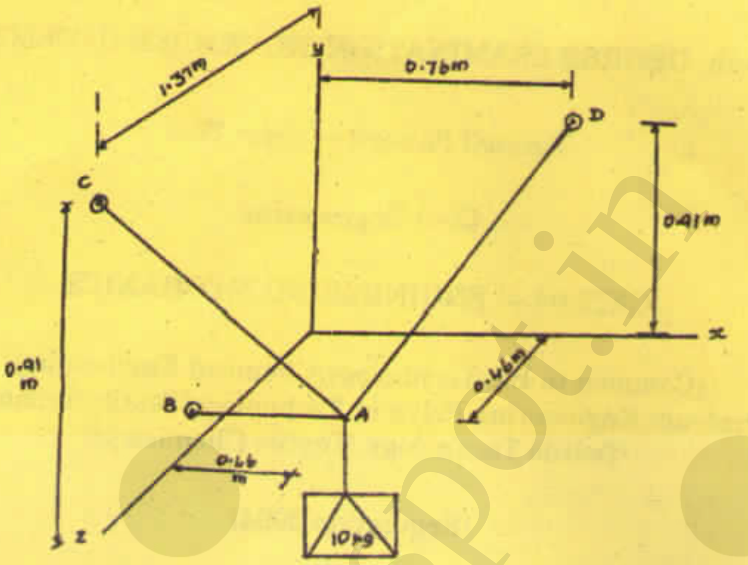

Fig. 1

Or

(b) A 100 kg crate is hung by means of two cables AB and AC, which are attached to the top of a vertical wall. A horizontal force of magnitude 185 N perpendicular to the wall holds the cylinder in the position as shown in Fig. 2. Determine the tension in each cable.

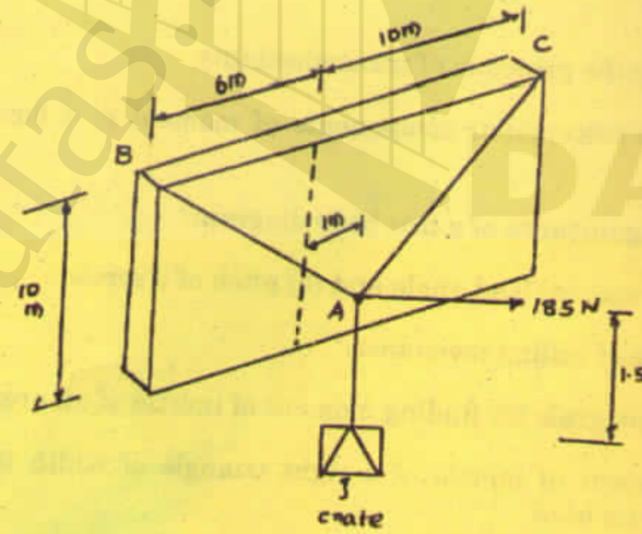

Fig. 2

12. (a) Determine the moment created by the force acting at point B of the rod shown in Fig. 3. about point A.

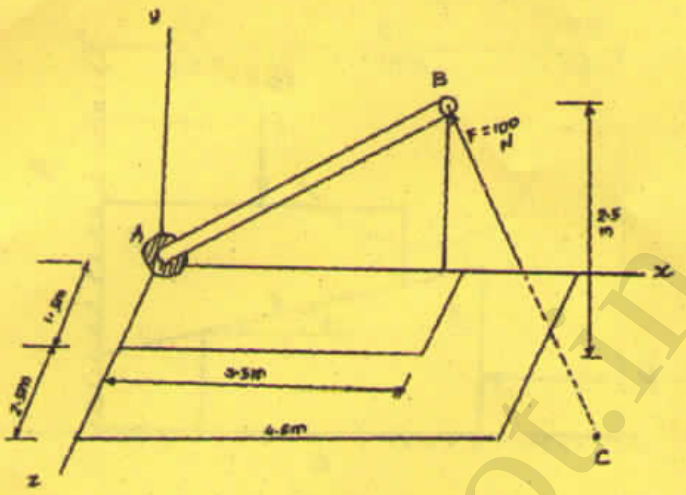

Fig. 3

Or

(b) The 8 m pipe AB shown in Fig. 4 has a fixed end at A. A steel cable is stretched from B to a point C on the vertical wall. If the tension in the cable is 1200 N, determine the moment about A of the force exerted by the cable at B.

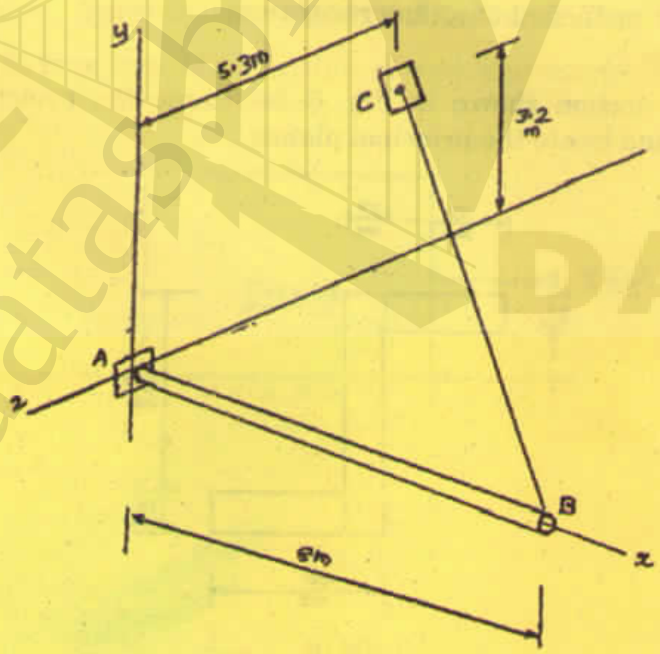

Fig. 4

13. (a) Determine the smallest force P required to lift the 15 kN load shown in Fig. 5. The coefficient of static friction between A and C and between B and D is 0.3 and that between A and B is 0.4.

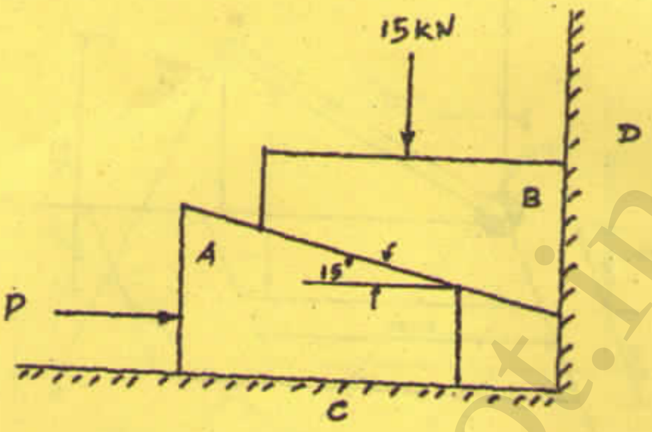

Fig. 5

Or

(b) (i) Assuming the coefficient of rolling resistance to be 3.0 mm, determine the horizontal force required to move a 2700 kg automobile along a horizontal road at a constant speed. The diameter of each tyre is 1150 mm. Neglect all forms of friction except rolling resistance. (10)

(ii) A wheel 250 mm in diameter carries a load of 10 kN. If a horizontal force of 100 N is necessary to move it over a level surface, determine the coefficient of rolling resistance. (6)

14. (a) For the section shown in Fig. 6 determine the principal moments of inertia and locate the principal planes.

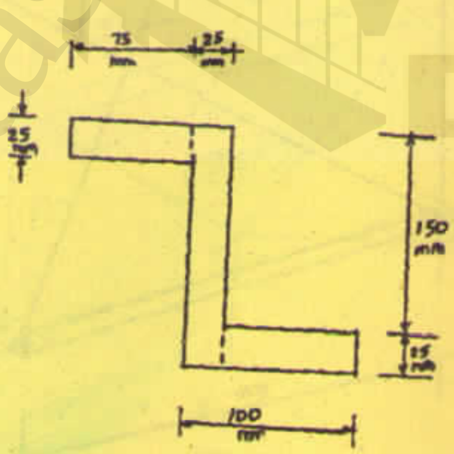

Fig. 6

Or

(b) Find the moments of inertia about the centroidal axes for the section shown in Fig. 7.

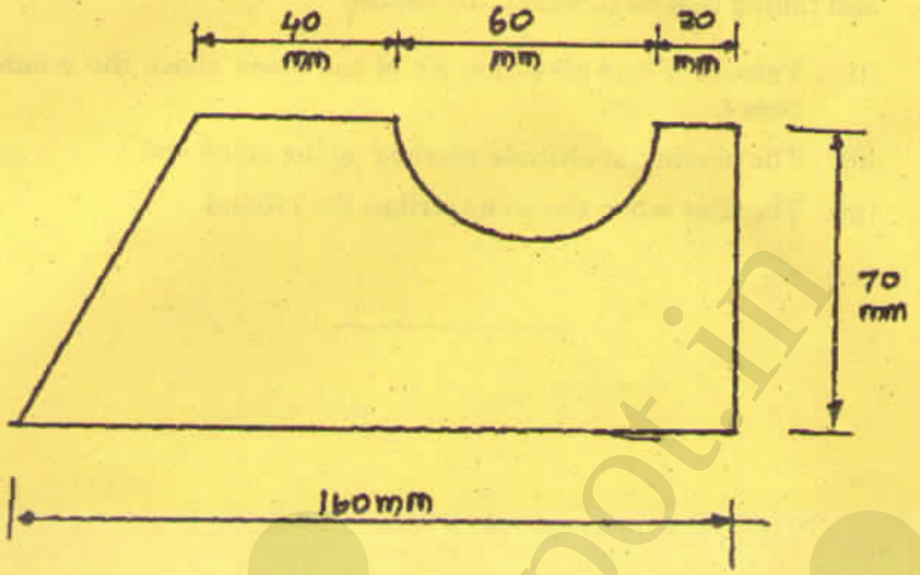

Fig. 7

15. (a) The 50 kg block shown in Fig. 8 rests on a horizontal plane for which the coefficient of kinetic friction is 0.3. If the block is pulled by a 350 N force as shown, determine the velocity of the block after it has moved 65 m starting from rest. Use principle of work and energy.

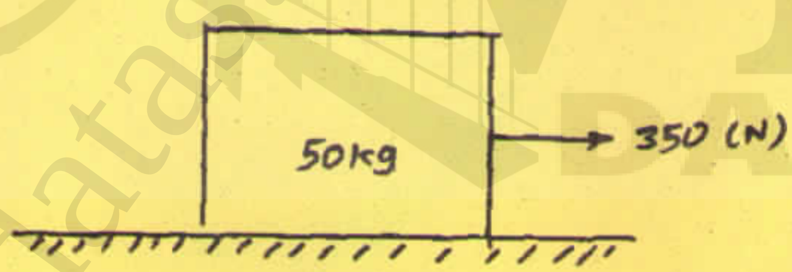

Fig. 8

Or

(b) A stone is thrown vertically upward from the top of a 30 m high building with a velocity of 15m/s. Taking the acceleration of stone as 9.81 m/s^2, and taking that as constant, determine

(i) Velocity V and elevation SY of the stone above the ground at any time *t*,

(ii) The maximum altitude reached by the stone and

(iii) The time when the stone strikes the ground.

Reg. No. :

Question Paper Code : R 3822

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009.

First Semester

Civil Engineering

GE 131 — ENGINEERING MECHANICS

(Regulation 2001)

(Common to all branches of B.E/B.Tech. except Marine Engineering)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Two forces $P = 100$ kN and $Q = 200$ kN act at the origin. P is directed towards a point $(-2, 3, -5)$ metres and Q towards $(6, -8, -4)$ metres. What is the result and corresponding unit vector?

2. Define principle of transmissibility of forces.

3. Two forces $\vec{F}_1 = 5\vec{i}$ and $\vec{F}_2 = 8.66\,\vec{j}$ pass through a point whose co-ordinates are $(2, 1)$. Calculate the moment of the force about the origin.

4. Explain perpendicular axis theorem.

5. Define product of inertia.

6. Give the centroid of quarter circular arc.

7. Give the equation for belt friction and explain the components.

8. What is instantaneous velocity and instantaneous acceleration?

9. State the principle of work and energy.

10. What do you mean by general plane motion?

PART B — (5 × 16 = 80 marks)

11. (a) If five forces act on a particle as shown in Fig. Q 11 (a) determine the magnitude and direction of resultant force.

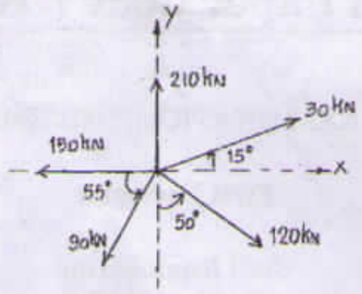

Fig. Q 11 (a)

Or

(b) A tripod is acted upon by forces at 'p' as follows: 20 kN along positive x direction, 40 kN along the negative y direction. Three legs rest on ground at points $A(-4,0,0)$, $B(5,0,2)$ and $C(-2,0,-3)$. Height of 'p' above origin is 10 m. Coordinate of $P(0,10,0)$. Find the forces in legs of tripod.

12. (a) A force acts at the origin of a co-ordinate system in a direction defined by the angls $\theta_x = 69.3°$ and $\theta_z = 57.9°$. Knowing that the y component of the force is –174 N, determine

(i) the angle θ_y

(ii) the other components and the magnitude of the force

(iii) projection of this force on xz plan and its magnitude and

(iv) moment of this force about a point of co-ordinate $(2, 3, 4)$ and its magnitude. (16)

Or

(b) Four forces and a couple are applied to a rectangular plate as shown in Fig Q. 12 (b). Determine the magnitude and direction of the resultant force-couple system. Also determine the distance x from o along x-axis where the resultant intersects. (16)

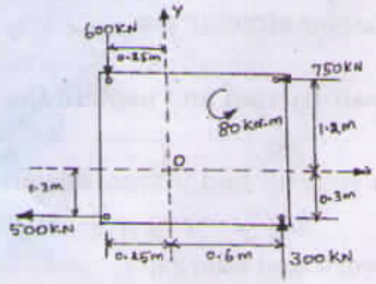

Fig Q. 12 (b)

13. (a) (i) An inverted T section is shown in Fig Q. 13 (a) (i). Calculate the moment of inertia of the section about XX axis parallel to the base and passing through the centroid. Also calculate radius of gyration. (12)

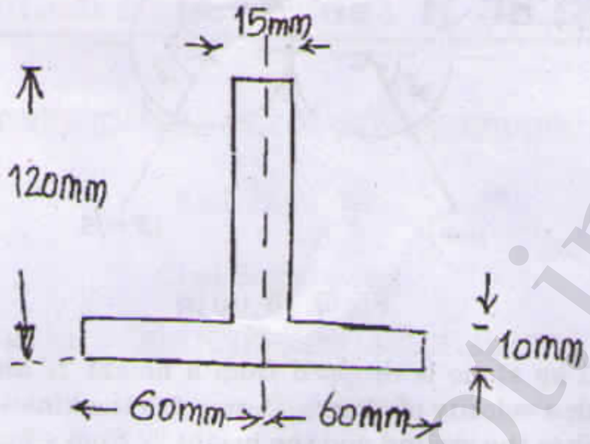

Fig Q 13 (a) (i)

(ii) Derive the expression for mass moment of inertia about the vertical centroidal axis of a thin rectangular place of width '*b*', depth '*d*' and thickness '*t*'. (4)

Or

(b) Locate the centroid and find I_{xx}, I_{yy} about the axes passing through the centroid of lamina shown in Fig Q 13 (b)

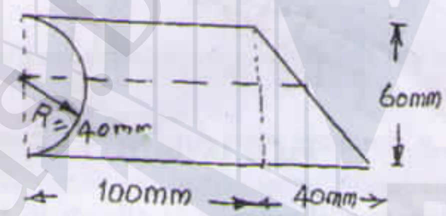

Fig Q. 13 (b)

14. (a) A ladder of weight 400 N and 6 m long is placed against a vertical wall. The angle of ladder makes 30° with respect to the wall. The coefficient of friction between the wall and the ladder is 0.25 and that between ladder and floor is 0.3 . How high a man of weight 1200 N can climb, before the ladder begins to slip.

Or

(b) A belt is running over a pulley of diameter 1.2 m at 300 rpm. The angle of contract is 150° and coefficient of friction is 0.35. If the maximum tension in the belt is 500 N, determine the power transmitted by it.

15. (a) (i) Two identical spheres A and B strike each other as shown in figure 15 (a) (i). If $e= 0.9$, find the velocity and the direction of each ball after impact. (10)

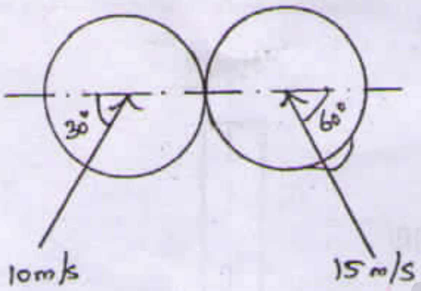

Fig Q. 15 (a) (i)

(ii) A 3 kg stone is dropped from a height 'h' and strikes the ground with a velocity of 30 m/s. Determine the kinetic energy of stone as it strikes the ground and the height 'h' from which it was dropped. (6)

Or

(b) (i) The system shown in figure 15 (b) (i) is released from rest. Block A and B weight 500 N and. 800 N respectively. The coefficient of friction between block A and plane is 0.2. Find the acceleration of each block, the distance moved and the velocity of each block after 5 seconds . Also find the tension in the cable. (8)

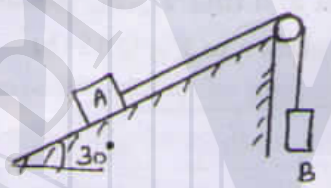

Fig Q.15 (b) (i)

(ii) Each of the two slender rods shown in figure 15 (b) (ii) is 0.75 m long has mass of 6 kg. The system is released from rest when $\beta = 60°$. Determine the angular velocity of the rod when $\beta = 20°$ and velocity at D at the same instant. (8)

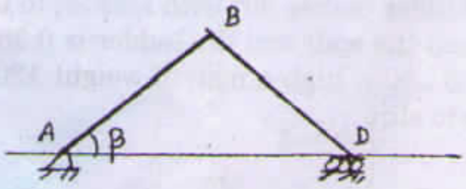

Figure Q. 15 (b) (ii)

Reg. No. :

Question Paper Code : U4013

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2009

Second Semester

Civil Engineering

ME 2151 — ENGINEERING MECHANICS

(Common to Chemical Engineering, Plastics Technology, Petroleum Engineering, Polymer Technology, Mechanical Engineering, Automobile Engineering, Aeronautical Engineering, Textile Technology (Fashion Technology), Biotechnology, Marine Engineering, Production Engineering, Textile Technology)

(Regulation 2008)

Time : Three hours | Maximum : 100 Marks

Answer ALL Questions

PART A — (10 × 2 = 20 Marks)

1. A force $\vec{F} = 9\hat{i} + 6\hat{j} - 15\hat{k}$ acts through the origin. What is the magnitude of the force and the angle it makes with X, Y and Z axis?

2. State the principal of transmissibility of forces with simple sketch.

3. Explain free body diagram with one example.

4. State Varignon's theorem.

5. State parallel axis theorem with simple sketch.

6. Distinguish between centroid and center of gravity.

7. Explain the difference between kinematics and kinetics.

8. A train running at 80 km/h is brought to a standing halt after 50 seconds. Find the retardation and the distance traveled by the train before it comes to a halt.

9. List out the different types of friction. What is coefficient of static friction?

10. A rigid body is acted upon by a force of 100 N, the velocity of body changes from 15 m/s to 25 m/s during a period of 50 s. Find the mass of body and the distance moved by the body during the time of interval.

PART B — (5 × 16 = 80 Marks)

11. (a) Two cylinder P and Q rest in channel as shown in the Figure 1. The cylinder P has diameter of 100 mm and weighs 200 N where as the cylinder Q has diameter of 180 mm and weighs 500 N. If the bottom

width of the box is 180 mm, with one side vertical and other inclined at 60°, determine the reactions at all the four points of contact.

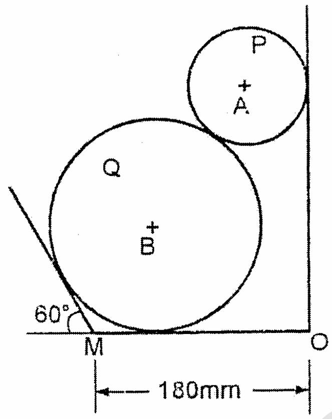

Figure 1

Or

(b) A horizontal force P normal to the wall holds the cylinder in the position shown in Figure 2. Determine the magnitude of P and the tension in each cable.

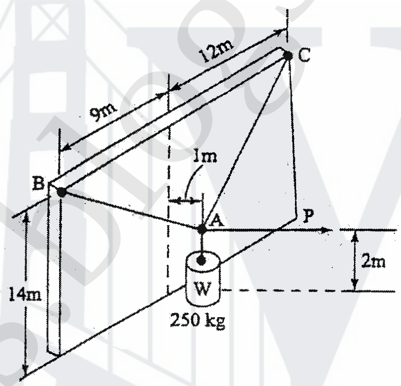

Figure 2

12. (a) The slab in Figure 3 is subjected to parallel forces. Determine the magnitude and direction of resultant force equivalent to the given force system and locate its point of application on the slab.

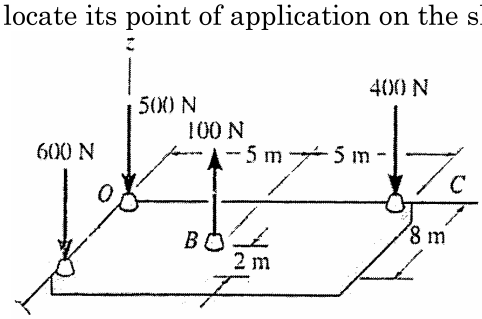

Figure 3

Or

(b) The lever ABC of a component of a machine is hinged at B, and is subjected to a system of coplanar forces as shown in Figure 4. Neglecting friction, find the magnitude of the force (P) to keep the lever in equilibrium. Also determine the magnitude and direction of the reaction at B.

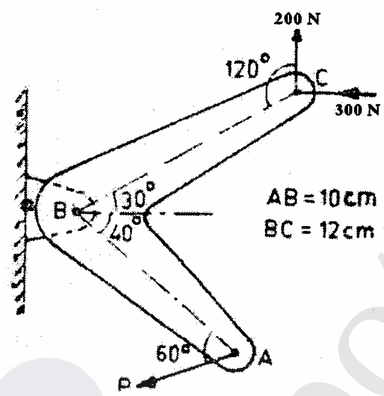

Figure 4

13. (a) Calculate the centroidal moment of inertia of the shaded area shown in Figure 5.

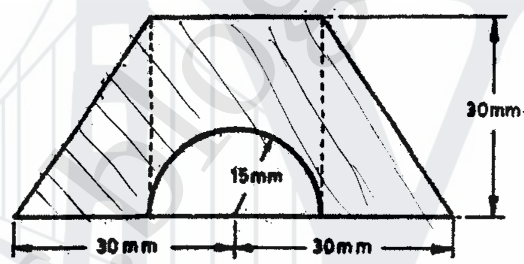

Figure 5

Or

(b) A steel forging consists of a 60 × 20 × 20 mm rectangular prism and two cylinders of diameter 20 mm and length 30 mm as shown in Figure 6. Determine the moments of inertia of the forging with respect to the coordinate axes, knowing that the density of steel is 7850 kg/m^3.

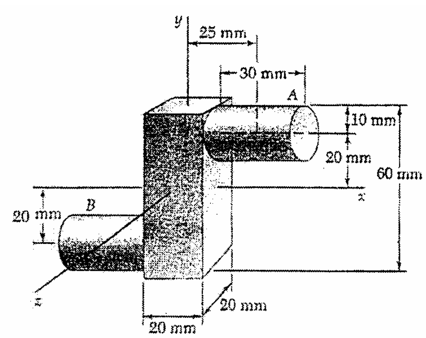

Figure 6

14. (a) Two trains A and B leave the same station on parallel lines. A starts with a uniform acceleration of 0.15 m/s^2 and attains the speed of 24 km/hour when the steam is reduced to keep speed constant. B leaves 40 seconds after with uniform acceleration of 0.30 m/s^2 to attain a maximum speed of 48 km/hour. When will B overtake A?

Or

(b) A ball of mass 2 kg, moving with a velocity of 3 m/sec, impinges on a ball of mass 4 kg moving with a velocity of 1 m/sec. The velocities of the two balls are parallel and inclined at 30° to the line of joining their centres at the instant of impact. If the coefficient of restitution be 0.5, find

(i) Direction, in which the 4 kg ball will move after impact;

(ii) Velocity of the 4kg ball after impact;

(iii) Direction, in which the 2 kg ball will move after impact; and

(iv) Velocity of the 4 kg ball after impact.

15. (a) Two pulleys, one 450 mm diameter and the other 200 mm diameter are on parallel shaft 1.95 m apart and are connected by a open belt. Find the length of the belt required and the angle of contact between the belt and each pulley. What power can be transmitted by the belt when the larger pulley rotates at 200 rpm, if the maximum permissible tension in the belt is 1000 N, and the coefficient of friction between the belt and pulley is 0.25?

Or

(b) Two masses of 30 kg and 10 kg are tied to the two ends of a light string passing over a composite pulley of radius of gyration as 70 mm and mass 4 kg as shown in Figure 7. Find the pulls in the two parts of the string and the angular acceleration of the pulley.

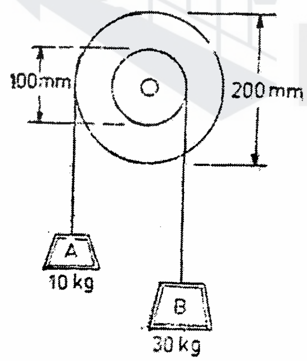

Figure 7

B.E./B.Tech.Degree Examinations, November/December 2010
Regulations 2008
Second Semester

Common to Civil, Aeronautical, Automobile, Marine, Mechanical,
Production, Chemical , Petroleum Engineering and to Biotechnology,
Polymer, Textile, Textile(Fashion), Rubber and Plastics Technology

ME2151 Engineering Mechanics

Time: Three Hours Maximum: 100 Marks
Answer ALL Questions
Part A - (10 x 2 = 20 Marks)

1. Define the following terms : (a) Coplanar forces (b) Concurrent forces.
2. What i s the difference between a resultant force and equilibration force?
3. What is meant by free body diagram of a rigid body?
4. Write the conditions of equilibrium of a system of parallel forces acting in a plane.
5. De¯ne radius of gyration with respect to x-axis of an area.
6. State parallel axis theorem with simple sketch.
7. The angular rotation of an accelerated disc is given by µ = (9=32)t3 + (3=4)t2 + 6t radians. Find its angular acceleration when t = 2 sec.
8. What i s linear momentum?
9. Define : Coefficient of static friction.
10. A body is rotating with an angular velocity of 5 radians/sec. After 4 seconds, the angular velocity of the body becomes 13 radians/sec. Determine the angular acceleration of the body.

Part B - (5 x 16 = 80 Marks)

11. (a) (i) Determine the resultant of the concurrent force system shown in the following (Marks 8)
(ii) The following figure shows a 10 kg lamp supported by two cables AB and AC. Find the tension in each cable. (Marks 8)

OR

11. (b) Forces 32 kN, 24 kN, 24 kN and 120 kN are concurrent at origin and are respectively directed through the points whose coordinates are A(2, 1, 6), B (4, -2, 5), C (-3, -2, 1) and D (5, 1, -2). Determine the magnitude of the resultant and the angles it makes with coordinate axes. (16)

12. (a) (i) A force (10i + 20j ¡ 5k)N acts at a point P (4, 3, 2) m. Determine the moment of this force about the point Q(2, 3, 4) m in vector form. Also find the magnitude of the moment and its angles with respect to x; y; z axes. (Marks 8)
(ii) A plate ABCD in the shape of a parallelogram is acted upon by two couples, as shown in the figure.
Determine the angle ¯ if the resultant couple is 1.8 N.m clockwise. (Marks 8)

OR

12. (b) Two beams AB and CD are shown in figure. A and D are hinged supports. B and C are roller supports.
(i) Sketch the free body diagram of the beam AB and determine the reactions at the supports A and B. (Marks 9)
(ii) Sketch the free body diagram of the beam CD and determine the reactions

at the supports C and D. (Marks 7)
13. (a) (i) Derive, from first principle, the second moments of area
Ixx and Iyy for the rectangular area when the axes are as shown below:
(Marks 6)
(ii) Derive, by direct integration, an expression for the second moment of area
of a triangle, shown in figure, about x-axis. (Marks 10)

13. (b) (i) Calculate the centroid polar moment of inertia of a rectangular section
with breadth of 100 mm and height of 200 mm. (Marks 4)
(ii) Find the moment of inertia of the shaded area shown in figure about the
vertical and horizontal centroid axes. The width of the hole i s 200 mm.
(Marks 12)
14. (a) (i) A stone i s thrown vertically upwards from a point on a bridge located 40
m above the water. If it strikes the water 4 s after release, determine the
speed at which the stone was thrown and the speed at which the stone
strikes the water. (Marks 8)
(ii) A bomb is dropped from an aerospace flying at a speed of 800 km/h at
a height of 1500 m above the level ground. Find the horizontal distance
covered by the bomb after its release. Also and the time required for the
bomb to hit the target and the velocity with which the bomb hits the
target. (Marks 8)
OR
14. (b) A ball of mass 1 kg moving with a velocity of 6 m/s strikes another ball of
mass
2 kg moving with a velocity of 2 m/s at the instant of impact the velocities of
the two balls are parallel and inclined at 30± to the line joining their centers
as shown in the figure.
If the coefficient of restitution i s 0.5, find the velocity and the direction of the
two balls after impact. Also calculate the loss in kinetic energy due to impact
and the percentage of loss. (Marks 16)

15. (a) (i) Two blocks A and B of mass 50 kg and 100 kg respectively are connected
by a string C which passes through a frictionless pulley connected with the
fixed wall by another string D as shown in figure.
Find the force P required to pull the block B. Also find the tension in the
string D. Take coefficient of friction at all contact surfaces as 0.3. (8)
(ii) In a belt drive, the smaller pulley is subjected to a tension T1 on the tight
side and a tension T2 on the slack side. Derive a relation between these
tensions in terms of the coefficient of friction and the angle of wrap. (Marks 8)
OR
15. (b) The figure given below shows a stepped pulley. The smaller radius is 150mm
and the bigger radius i s 200 mm. Two loads P and Q are connected by
inextensible taut cords.
Load P moves with an initial velocity of 0.2 m/s and has a constant acceleration
of 0.25 m/s2 both downwards. Determine
(i) The number of revolutions turned by the pulley in 4 seconds
(Marks 6)
(ii) Velocity and the distance traveled by load Q after 4 seconds.
(Marks 5)
(iii) Acceleration of point B located on the rim of the pulley at t = 0. Give
both magnitude and direction. (Marks 5)