Engineering Mechanics {17204}

Theory Questions {Question 1}

{This question contains theory questions of 2 marks each from all chapters}

Q.1.Solve any ten   **20 Marks**

a) Simple Machines

b) Simple Machines

c) Simple Machines

d) Force Systems

e) Force Systems

f) Composition of forces

g) Composition of forces

h) Equilibrium

i) Equilibrium

j) Friction

k) Friction

l) Centroid and CG

m) Centroid and CG

Ch.1. Simple Machines { Q1 a),b),c) }

Q.1. Define simple machine and compound machine.

Ans: A simple machine has only one point for the application of effort and one point for load. Its mechanism is simple. Some examples of simple machine are Lever,inclined plane,Screw jack

A compound machine has more than one point for the application of effort and for the load. Its mechanism is compounded and complicated. Some examples of compound machines are planer machine, lathe machine,shaping machine etc.

Q.2.Define Input and Output of Machine.

Input of Machine : The amount of work done by effort on the machine is called input of machine.

$Input = Effort \times Distance\ moved\ by\ effort$
$Input = P \times y$

Output of Machine : the amount of work done by load of the machine is called the output of machine.

$Output = Load \times Distance\ moved\ by\ Load$
$Output = W \times x$

Q.3. Define Mechanical advantage (MA) , velocity ratio (VR) and Efficiency of the machine.

Ans : Mechanical Advantage : It is defined as the ratio of the load lifted by the machine to the effort applied to lift the load..

$$M.A = \frac{Load\ lifted}{Effort\ Applied} = \frac{W}{P}$$

Mechanical advantage is pure number and it has no unit. It is always greater than 1.

Velocity Ratio : It is defined as the ratio of distance moved by the effort to the distance moved by the load.

$$V.R. = \frac{Distance\ moved\ by\ the\ effort}{Distance\ moved\ by\ load} = \frac{y}{x}$$

Efficiency of a machine: Efficiency of a machine is defined as the ratio of output of a machine to the input to the machine.

$$Efficiency = \frac{Output\ of\ a\ machine}{Input\ to\ a\ machine} = \frac{w \times x}{p \times y} = \frac{w/p}{y/x} = \frac{M.A}{V.R}$$

Q.4. What is meant by ideal machine, Ideal effort,Ideal load?

Ans: If the efficiency of a machine is 100%, then the machine is called Ideal Machine. Such machine has **no frictional loss**.

Ideal effort : It is the effort required to lift the load when there is **no friction** in machine.

$$Ideal\ Effort = P_i = \frac{W}{V.R.}$$

Ideal load : It is the load that can be lifted by a given machine when there is **no friction** in the machine.

$$Ideal\ Load = W_i = P \times V.R.$$

Q.5.Define and State formula for effort lost in friction and load lost in friction.

Effort lost in friction : It is the additional effort required to overcome the friction.

$$Effort\ lost\ in\ friction = P_f = p - \frac{W}{VR}$$

Load Lost in friction: It is the additional load that might have been lifted by load for given effort when there would have no friction.

$$Load\ Lost\ in\ friction = W_f = P \times VR - W$$

Q.6.Define Maximum M.A. and state its formula.

Ans: The Mechanical Advantage of the machine when friction is not present in the machine is called maximum MA.

Formula for Max M.A.

$$Maximum\ M.A. = \frac{1}{m}$$

Q.7.What is law of machine and state its importance?.

Ans: "Law of machine is an equation which states the relation between effort & load." Law of machine is important because using it we can find effort required for certain load or load that can be lifted with given effort.

Q.8.What is the significance of law of machine?.

Ans: Law of machine give idea about the load and effort relation of a machine. It also tells us about the friction present in the machine under no load condition.
Law of machine can be use to find the load when effort is known and effort when load is known and also maximum mechanical advantage.

Q.9.What is a reversible machine?.

Ans: A lifting machine in which the load starts moving back to its original position when the effort is removed is called reversible machine.
Such machine has efficiency more than 50%.

Q.10.What is a Self-locking machine?.

Ans: A lifting machine in which the load remains at its position even when the effort is removed is called self locking machine machine. Example is screw jack
Such machine has efficiency less than 50%.

Q.11.State the condition for reversibility of machine.

Ans: For a lifting machine,

If $\eta > 50\%$ .....$Machine\ is\ reversible$

If $\eta < 50\%$ .....$Machine\ is\ irreversible$ (or self locking)

If $\eta = 50\%$ .....$Machine\ is\ on\ the\ point\ of\ reversing.$

Q. 12. Define effort , State SI Unit

Ans : The force applied to lift the load is called effort SI unit is Newton

Ch.2. Force systems { Q1 d),e),f) }

Q.12. Define applied mechanics, Statics, Dynamics, Kinetics and Kinematics.

Applied Mechanics(Engg.Mechanics) :It is the branch of science which deals with study of the forces and it effects on bodies at rest or in motion.
Statics :- It is the branch of applied mechanics which deals with study of forces and its effect on bodies at rest.
Dynamics :- It is the branch of applied mechanics which deals with the study of forces and its effect on bodies in motion.
Kinetics :- It is the branch of dynamics which deals with study of forces and their effect on bodies in motion considering mass of the body.
Kinematics :- It is the branch of dynamics which deals with the study of forces and their effect on bodies in motion without considering mass.

Q.13.Define Rigid Body.

" Rigid Body is defined as the body whose particles do not change their relative position on application of forces."
There is no perfect rigid body in the universe, everybody tends to slightly deform on application of force.

Q.14.Classify force systems.
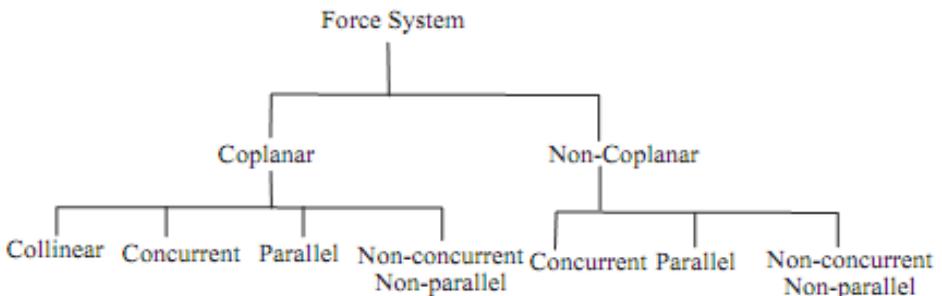
Parallel forces can be further classified as like parallel(in same direction) and unlike parallel forces.

Q.15.Define force and state its SI unit.

Force is defined as," An external agency either push or pull which changes the state of body (from rest to motion or motion to rest)."
Numerically force is equal to product of mass and acceleration.
F= mass x acceleration
S.I.unit of force is Newton.

Q.16.Define one Newton force.

Ans. It is the force which acts on a body of mass 1 kg and produces an acceleration of $1\,m/s^2$ in it.
$$Force = Mass \times Acceleration$$
$$1\,Newton = 1\,kg \times m/s^2$$

Q.17.State the characteristics of force.

Ans. There are four characteristic of force
1] Magnitude : like 10N, 20N, 30N.
2] Direction : Angle with axis.
3] Point of application : Point
4] Sense : Pull or push

Q.18.State the effect of a force

Ans :A force can produce the following effects:
1. It can impart motion to any object in rest condition.
2. It can make a moving object to come to rest.
3. It can deform the object and change its shape.
4. It can break an object into pieces.

Q.19.What is Bow's Notation ? Where is used ?

Ans. Bow's notation is method of representing force graphically. In Bow's Notation a force is represented in magnitude by suitable scale and in direction by given angle.

Bow's Notation is used in graphical solution of force system.

actual diagram   Bow's notation
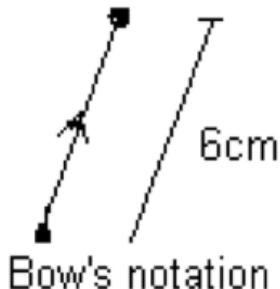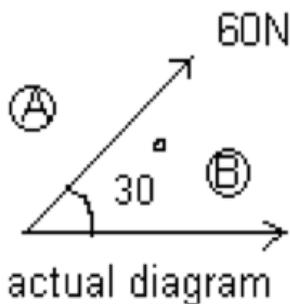
Q.20.State the principle transmissibility of force.

Ans. It state that :*"If a force acts at a point on a body,it can be assumed to act at any other point on the line of action of force within the same body"*
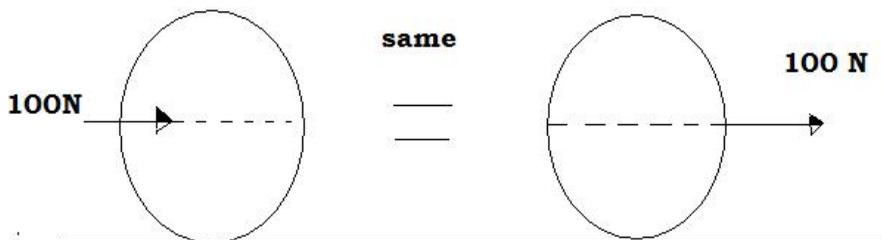

Figure shows the force of 100N is transferred on the line of action.

Q.21.Define Resolution of force.

Ans. The method of representing a single force into number of forces without changing its effects it is called Resolution of force.

Q.22.Define Moment of a force and state its SI unit.

Ans. *"The moment of a force about a point is the product of the force and the perpendicular distance of its line of action from the point."*
Moment= Force×Perpendicular distance
SI unit of moment is N-m.(Newton-Meter).
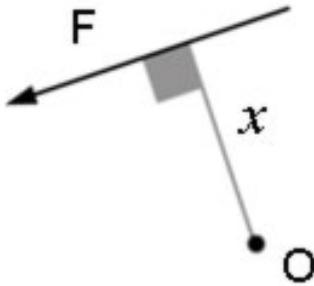
Moments are of two types: Clockwise moments and anticlockwise moments
Sign convention : Clockwise moments are taken as positive and anti clockwise moments are taken as negative for calculation purpose.

$$M = F\,x$$

Q.23. State Varignon's Theorem of moments .

It states that, **" Sum of moments of all forces acting on a body about a point is same as the moment of its resultant about the same point."**
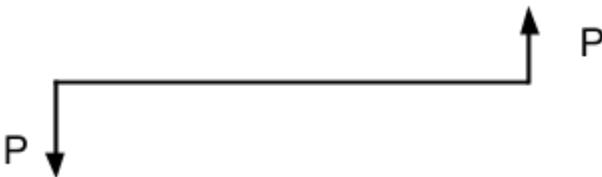
$$\Sigma M = R \times x$$

Where $\Sigma M = sum\ of\ moments\ of\ all\ forces\ about\ a\ point$

$R \times x = Moment\ of\ resultant\ about\ same\ point$

Q.24.Define couple? State its properties.

Ans. ***"Two equal unlike parallel, non – collinear forces form a couple."***

Properties of couple :-
i] Resultant force of couple is Zero .
ii]The moment of couple about any point is constant.
iii] The couple can be balanced only by other opposite couple.

iv] The moment of couple is equal to the product of one of the force and arm of couple.

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Ch.3. Composition of Forces { Q1 f) , g) }

Q.25. Define Resultant force.

 " Resultant is a single force which when acts on a body produces same effect as produced by several forces acting on the body."

Q.26.State Parallelogram law of forces

Ans. *"If two forces acting at and away from the point are represented by two adjacent side of parallelogram. Then the diagonal (Passing through point of intersection) represent resultant in magnitude and direction."*
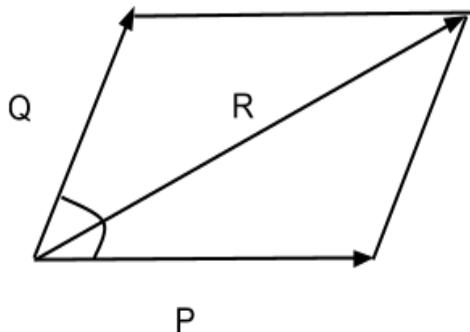
P= First force
Q=Second force
$\theta = Angle\ between\ forces,$
Resultant by parallelogram law
$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\theta}$$

Q.27. What is Space diagram and vector diagram?

Ans : Space diagram :*"The diagram which shows the exact location and direction of forces acting on a body is called the space diagram."*
Vector diagram:*"The diagram which is drawn to the scale of forces, each line representing the force in its magnitude and direction is called vector diagram."*

Q.28.What is polar diagram and Funicular polygon?

Polar diagram:*" The diagram constructed from vector diagram, by selecting a suitable point as pole to which each point of vector diagram is connected, is called polar diagram."*

Funicular Polygon:*"The diagram which is drawn to find the exact position of resultant in the space diagram is called the Funicular polygon. It is obtained from the rays of polar diagram."*

Use of Funicular polygon : It is used to find the location of the resultant.

Ch.4. Equilibrium { Q1 h) , i) }

Q.25. Define equilibrium and state analytical and graphical conditions of equilibrium.

Ans: "A body is said to be in equilibrium when the resultant of several forces acting on it is zero."

Analytical conditions:

1. Sum of components in x direction must be zero (Efx=0)

2. Sum of components in Y direction must be zero (Efy=0)

3.Sum of all moments about any point must be zero(Em=0)

Graphical conditions:

1.The force polygon must close by itself

2. The funicular polygon must close by itself.

Q.26.Differentiate between Resultant and equilibrant.

Resultant	Equilibrant
1) It is defined as a single force which produces the same effect on the body as produced by several forces.	1) It is defined as a single force which keeps the body in equilibrium.
2) Resultant causes the displacement of the body	2)Equilibrant cause the body to remain at rest

Q.28. What is the relation between resultant and equilibrant?

Ans ; Resultant and equilibrant are e*qual in magnitude but opposite in direction*. Resultant causes the displacement of the body whereas the equilibrant cause the body to remain in equilibrium.

Q.27. What is free body diagram?

Ans : A diagram showing only active and reactive forces acting on the body without surrounding is called free body diagram .
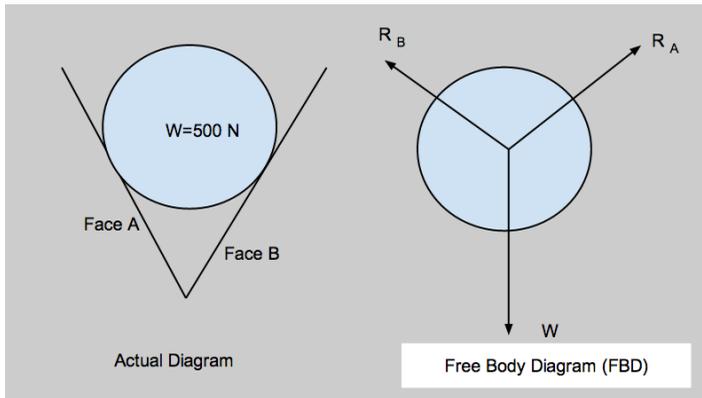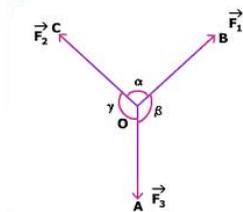

Actual Diagram

Free Body Diagram (FBD)

Diagram shows actual forces and second diagram is FBD.

Q.28. State and explain Lami's Theorem.

Ans.It states that," If three forces acting at a point keep the body in equilibrium then each force is proportional to sine of angle between other two forces."

$$\frac{F1}{Sin\gamma} = \frac{F2}{sin\beta} = \frac{F3}{Sin\alpha}$$

Q.29. State the limitations of the Lami's theorem.

Ans: Following are the limitations of Lami's theorem
1) It is applicable to three forces only.
2) It is applicable to concurrent forces only.
3) It is applicable only when body is in equilibrium

Q.30. What is a beam? What are its different types.

Ans: A beam is defined as a structural member which transfers the load on supports safely.

In engineering, beams are of six types:

1.   Simply supported - a beam supported on the ends which are free to rotate and have no moment resistance.
2.   Fixed - a beam supported on both ends and restrained from rotation.
3.   Overhanging - a simple beam extending beyond its support on one end.
4.   Double overhanging - a simple beam with both ends extending beyond its supports on both ends.
5.   Continuous - a beam extending over more than two supports.
6.   Cantilever - a projecting beam fixed only at one end.

Q.31. What are different types of end supports of beams?
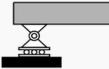
Following are the types of supports
1) Movable (roller) support
2) Hinged support
3) Fixed support

Q.32.What are the different types of loads a beam is subjected to?

Following are the loads
1.Point load
2.Uniformly distributed load
3.Uniformly varying load.

Ch.5. Friction { Q1 j) , k) }

Q.33. Define friction. What are types of friction.

Ans: It is defined as a resistance offered by one surface to another surface when they are in contact with each other.
There are two types of friction
1.Static friction
2.Dynamic friction.

Q.34. What is dynamic friction?.

Ans: Dynamic or kinetic friction is experienced by the body in motion.
Dynamic friction is of two types
1) Rolling friction
2) Sliding friction

Q.35. Define limiting friction.

Ans. The maximum value frictional force which acts on a body is called as limiting friction.
$F = \mu . R$
Where,
 F= Limiting force of friction
$\mu =$Coefficient of friction
R= Normal reaction

Q.36. Define coefficient of friction.

Ans. Coefficient of friction is the ratio of limiting friction to normal reaction.
$\mu = \dfrac{F}{R}$

Q.37. Define angle of friction.

Ans. It is the angle made by resultant reaction with the normal reaction when the body is in limiting equilibrium.

Q.38. Define angle of repose.

ANGLE OF REPOSE

–Raise the inclined plane until the block begins to slide.
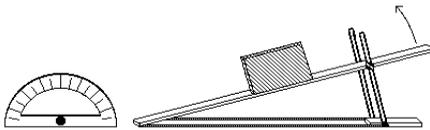
Ans. When a body is kept on an inclined plane and is just at the point of moving down the plane without applying any external force on it, the inclination of plane at that time is called the angle of repose..

Q.39.State law of static friction.

1] The frictional force always tangential to surface of contact.
2] The frictional force always acts in opposite reaction of motion.
3] When the body is in limiting equilibrium the ratio of limiting friction to the normal reaction is called coefficient of friction.
4] Static friction is always more than dynamic friction.

## Q.40.Stage advantages and disadvantages of friction .

Ans. Advantages of friction :-
1]We can walk on road due to friction.
2] A vehicle moving on road can be stopped by applying break this is due to friction.
3] The vehicle can be controlled with clutch the clutch work of friction.
4] Tyres can hold grip on road due to friction.
Disadvantages :-
1] Energy is lost due to friction.

2] Due to friction there is wear and tear of machine.
3] More effort required to lift a load due to friction.
4] Due to friction there is more consumption of fuel.

Q.41.Draw free body diagram of Ladder friction.

u.Rw

Rw

Wall

Rf

W

Floor

u.Rf
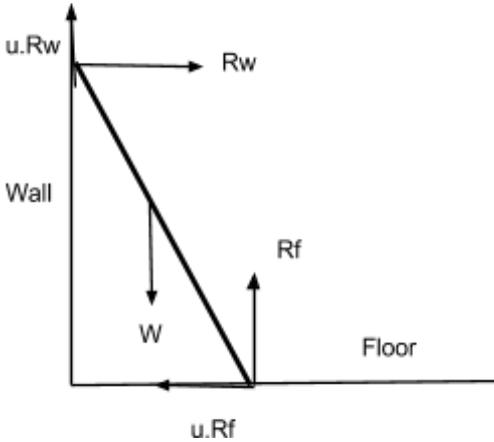
Ch.6. Centroid and center of gravity { Q1 j) , k) }

Q.42. Define Centroid and Centre of Gravity.

Ans: Centroid : The point at which **the area of a lamina** is supposed to be concentrated is known as centroid.

Centre of Gravity : The point at which the **whole weight of the body** is supposed to be concentrated is known as centre of gravity.

Q.43. Differentiate between Centroid and centre of gravity.

Centroid	Centre of Gravity
The point at which **the area of a lamina** is supposed to be concentrated is known as centroid	Centre of Gravity : The point at which the **whole weight of the body** is supposed to be concentrated is known as centre of gravity.
It is used in case of plane figures like square,rectangle,circle and triangle.	It is used in case of solid bodies like cube, cylinder, sphere and cone.

Q.44. Show the position of centroid for the following figures
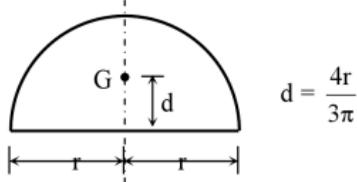## 1) Rectangle 2) triangle 3) Semicircle.4) Quarter Circle
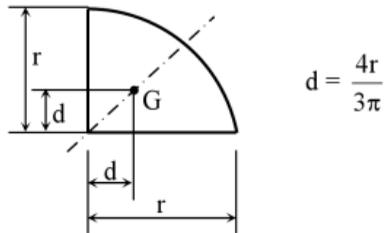
1. Rectangle

   Area = bh
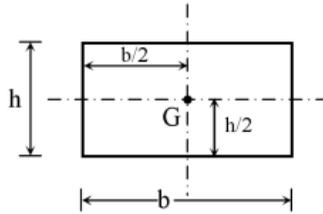
2. Any general triangle
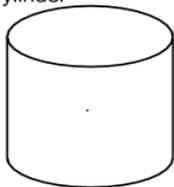
   Area = 1/2 bh
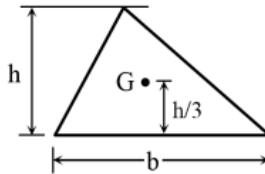
3. Semicircle

   Area = $\pi r^2/2$

$$d = \frac{4r}{3\pi}$$

4. Quarter circle

   Area = $\pi r^2/4$

$$d = \frac{4r}{3\pi}$$

Q.44. Show the position of center of gravity for the following figures
1) Cylinder 2) Cone 3) Sphere 4) Hemisphere

Cylinder

$X=r$ $Y=h/2$
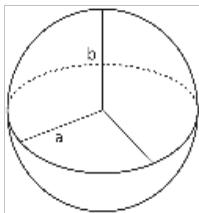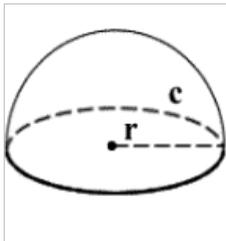
Cone
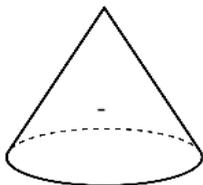
$X=r$ $Y=h/4$

Sphere

$X=r$ $Y=r$

Hemisphere

$X=r$ $Y=3r/8$