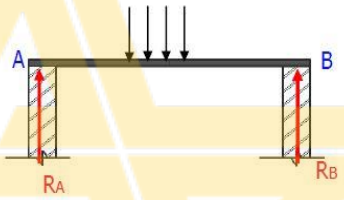
Module-3

1. What are the different types of beams? How do you differentiate them?

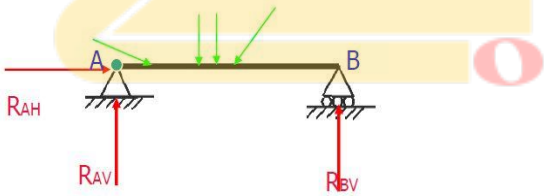
Ans: Beam is horizontal structural element that withstand vertical loads and transfer loads imposed along their length to their end points at walls, columns, foundations, etc. Depending upon the supports over which a beam can rest (at its two ends), beams can be classified as follows

a) Simply supported beam
b) Beam with one end hinged & other on rollers
c) Hinged Beam
d) Over hanging beam
e) Cantilever Beams
f) Propped cantilever
g) Continuous beam

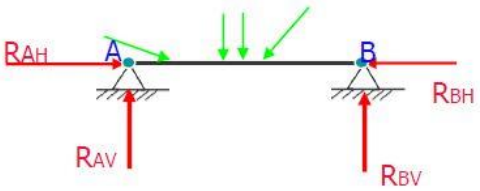
a) Simply supported beam: A beam is said to be simply supported when both ends of the beam rest on simple supports. Such a beam can carry or resist vertical loads only.



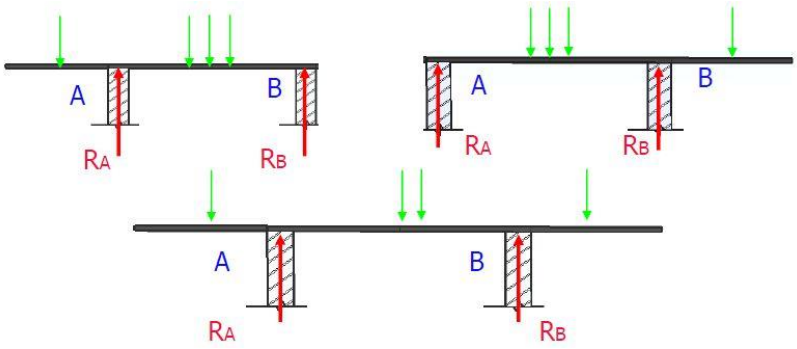
b) Beam with one end hinged & other on rollers: It is a beam where one end of the beam is hinged to a support and the other end rests on a roller support. Such a beam can carry any type of loads.



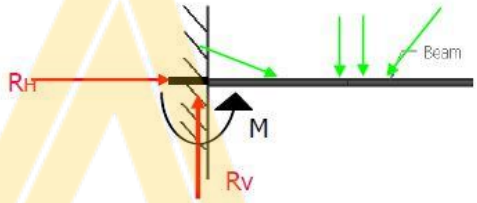
c) Hinged Beam: It is a beam which is hinged to supports at both ends. Such a beam can carry loads is any direction.



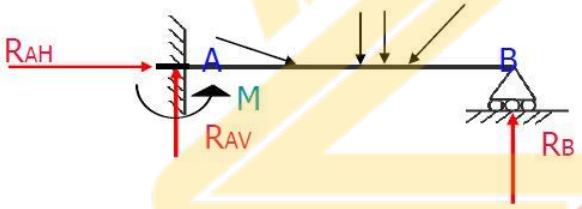
d) **Over hanging beam:** It is a beam which projects beyond the supports. A beam can have over hanging portions on one side or on both sides.



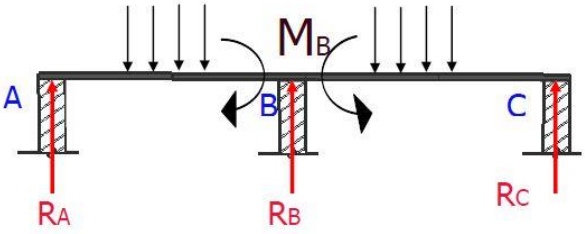
e) **Cantilever Beams:** It is a beam, with one end fixed and other and free. Such a beam can carry loads in any directions.



f) **Propped cantilever:** It is a beam which has a fixed support at one end and a simple support at the other end.



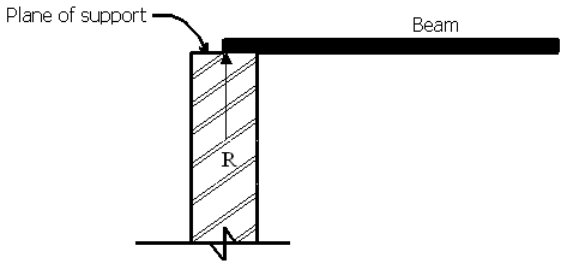
g) Continuous beam: It is a beam which rests over a series of supports at more than two points.



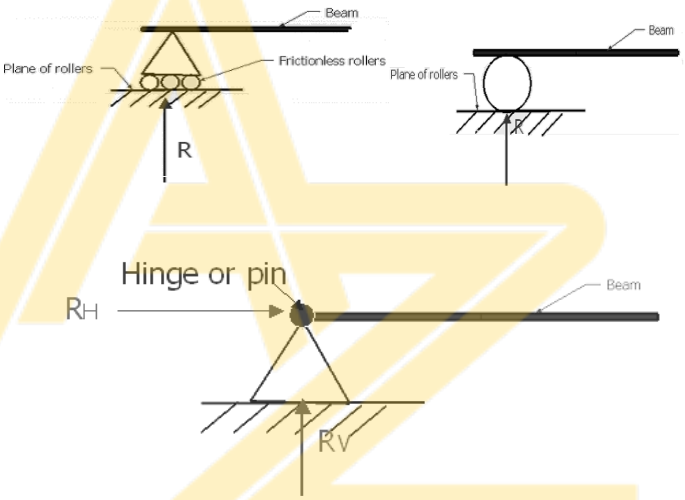
2) Explain the different types of supports with sketches.

Supports are structures which prevent the beam or the body from moving and help to maintain equilibrium. A beam can have different types of supports as follows. The support reactions developed at each support are represented as follows.

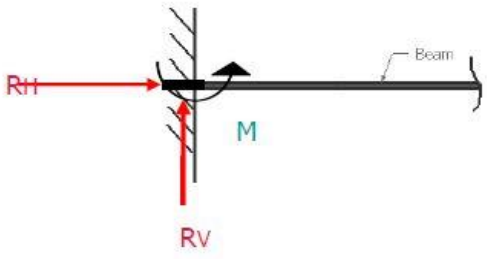
a) Simple support: This is a support where a beam rests freely on a support. The beam is free to move only horizontally and also can rotate about the support. In such a support one reaction, which is perpendicular to the plane of support, is developed.



b) Roller support: This is a support in which a beam rests on rollers, which are frictionless. At such a support, the beam is free to move horizontally and as well rotate about the support. Here one reaction which is perpendicular to the plane of rollers is developed.



c) Fixed support: This is a support which prevents the beam from moving in any direction and also prevents rotation of the beam. In such a support a horizontal reaction, vertical reaction and a Fixed End Moment are developed to keep the beam in equilibrium.



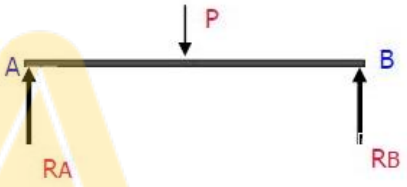
3) Explain the different types of loads acting on the beams with sketches.

Types of loads:

a) Point load or Concentrated load
b) Uniformly distributed load (UDL)
c) Uniformly varying load (UVL)

The various types of loads that can act over a beam can be listed as follows.

a) Point load or concentrated load: If a load acts over a very small length of the beam, it is assumed to act at the midpoint of the loaded length and such a loading is termed as Point load or Concentrated load.

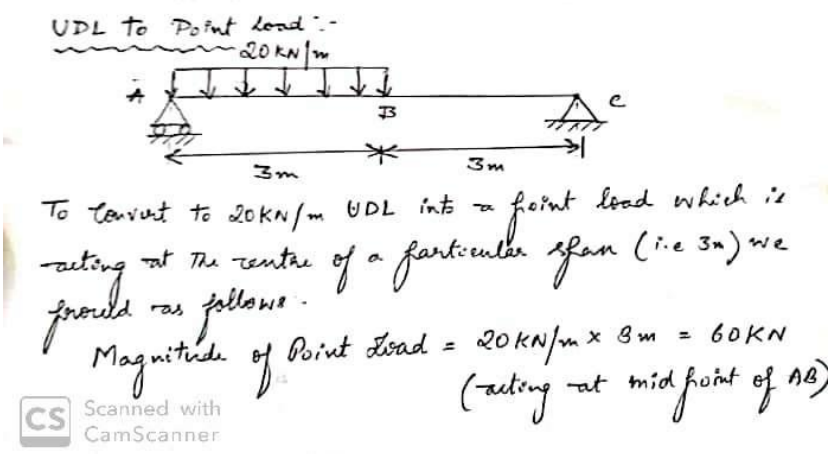


b) Uniformly distributed load (UDL): If a beam is loaded in such a manner that each unit length of the beam carries the same intensity of loading, then such a loading is called UDL.

A UDL cannot be considered in the same manner for applying conditions of equilibrium on the beam. The UDL should be replaced by an equivalent point load or total load acting through the midpoint of the loaded length.

The magnitude of the point load or total load is equal to the product of the intensity of loading and the loaded length (distance).

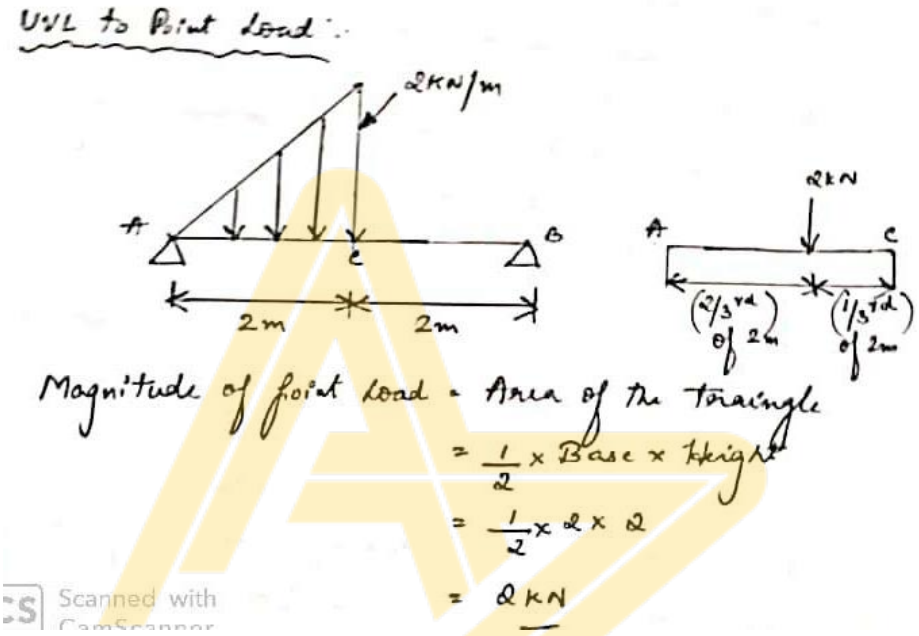
Conversion from UDL to Point Load



c) Uniformly varying load (UVL): If a beam is loaded in such a manner, that the intensity of loading varies linearly or uniformly over each unit distance of the beam, then such a load is termed as UVL.

In applying conditions of equilibrium, a given UVL should be replaced by an equivalent point load or total load acting through the centroid of the loading diagram (right angle triangle). The magnitude of the equivalent point load or total load is equal to the area of the loading diagram

Conversion from UVL to point load



4) Differentiate statically determinate and indeterminate structures with examples for each

Statically Determinate beams:

A structure is said to be statically determinate when the equilibrium equations are utilized to determine all the forces in the structure.

Statically determinate beams are those in which reactions can be found out by using equilibrium equations $\Sigma H = 0$, $\Sigma V = 0$ and $\Sigma M = 0$. Simply supported beams, cantilever beams and overhanging with two supports are all called as statically determinate beams.

Statically Indeterminate beams:

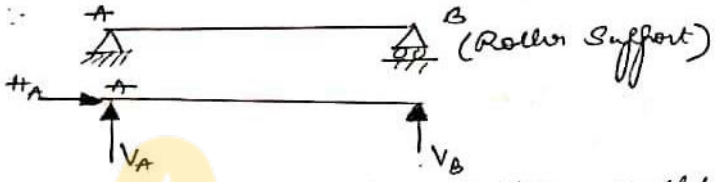
A structure is said to be statically indeterminate when there are more unknown forces then available equilibrium equations.

Statically indeterminate beams are those in which reactions cannot be found out by using equilibrium equations $\Sigma H = 0$, $\Sigma V = 0$ and $\Sigma M = 0$. The fixed beams and continuous beams are called as statically indeterminate beams.

Difference between Statically determinate and indeterminate beams can be identified as follows

Statically Determinate Structure :-

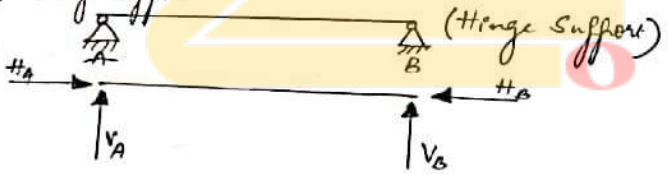
Example :-



- We know that there are 3 equation of static equilibrium
  $\Sigma H = 0$, $\Sigma V = 0$ & $\Sigma M = 0$
- From Above Figure there are 3 Unknown forces i.e H_A, V_A & V_B which can be found using equations of equilibrium.

Statically In-Determinate Structure :-

Example :-



- We know that there are 4 & 3 equation of equilibrium conditions ($\Sigma H = 0$, $\Sigma V = 0$ & $\Sigma M = 0$)
- From above Figure $\Rightarrow$ Unknown Forces = 4 (H_A V_A & H_B V_B) which cannot be found using equation of equilibrium

5) Explain the different types of plane truss

The Engineering structures are mainly classified in to three types. They are:

I) Trusses

ii) Frames

iii) Machines

Plane Trusses are those structures in which all members are lying in single plane. Plane trusses are made of several bars or members connected together at the joints by riveting or welding to form a rigid formwork and also support stationary loads or moving loads. Individual members Of a truss is a two force member subjected to either tension or compression. The forces are acting only on the joints.

Classification of Trusses

The truss are classified into three types which are shown in figures

a) Rigid truss or perfect truss
b) Non-rigid truss or deficient truss
c) Over rigid truss or redundant truss

a) Rigid truss or perfect truss

A rigid truss is one in which the number of members are sufficient to resist the external loads and in which deformation is very small. The relationship between the number of members and number of joints is given by

$M=2j-3$

$5=2x4-3=5$

Hence it is rigid truss

b) Non-rigid truss or deficient truss

A non-rigid truss is one in which the number of members are less than that required for a perfect truss. The relationship between the number of members and number of joints is given by

$M<2j-3$

$4<2x4-3$

$4<5$

Hence it is non-rigid truss

c) Over rigid truss or redundant truss

An over rigid truss is one in which the number of members are more than that required for a perfect truss. The relationship between the number of members and number of joints is given by

M>2j-3

6>2x4-3

6>5

Hence it is an over-rigid truss.

6. List the assumptions made in the Analysis of Trusses.

Ans: The following are the assumptions made in the analysis of Statically Determinate Trusses

a) The members of trusses are straight
b) The cross-section of members in uniform
c) Forces are acting only on joints
d) All members are pin-jointed members
e) All members are rigid
f) All members of trusses are two force members subjected to either equal and opposite tension or compression.

7. List the steps followed in the analysis of truss by the method of joints

Ans:

Method of joints

Analysis of truss mainly consists of calculations of support reactions and determination of internal forces induced in the internal members of a truss.

The method of joints or joint method is a method in which the equilibrium of individual joints are considered and this method is useful in finding the forces in all members of a truss.

The various steps involved in the method of joints are as follows.

1. Check whether the given truss is statically determinate or indeterminate
2. Calculate the support reactions by considering the equilibrium of entire truss
3. Now, consider a joint with minimum number of unknowns (maximum of 2 unknowns because only two conditions of equilibrium are available namely $\sum F_x=0$ and $\sum F_y=0$).
4. Initially assume that all members under consideration are in tension (arrow head away from the joint is positive).
5. Apply the condition of equilibrium and by solving the equilibrium, determine the unknown Forces in the members
6. If the result works out to be positive then our assumption is right, if it is negative then our assumption is wrong and it indicates that particular member is under compression so that reverse the direction of force while considering it in the next joint.

7. Same procedure has to be followed for other joints to determine the internal forces in the remaining members of a truss.

8. Note down the results in a tabular format in the table given below.

Sl.No	Members	Magnitude of force(N)	Nature of force (Compression or Tension)

8. List the steps followed in the analysis of truss by the method of sections

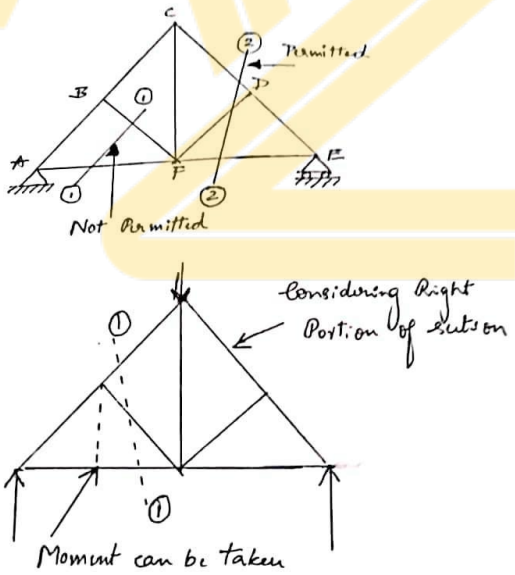
Ans;

Method of sections

Method of section is the method in which a section line has to be passed through the members in which the internal forces need to be calculated see Figure a and Figure b. This method is suitable when it is necessary to find the forces induced in a few or selected members of a truss

Some of the points to be remembered in using the method of section are as follows:

1. The section line should be a complete.



2. The section line should pass though the members but not through the joints.

3.The section line can pass through maximum of three members because only three conditions of equilibrium are available.

4.The section line can pass through the four members in a situation where three members are meeting at a common point.

5.The moment equation of equilibrium can be applied about a point may be beyond the portion under consideration

6.Consider either left portion or right portion whichever is easy for analysis as both portions are under equilibrium.