UNIT -2

(A) BENDING MOMENT AND SHEAR FORCE DIAGRAM FOR BEAMS

Beam

- It is a structural member whose longitudinal dimension is large compared to the transverse dimension.
- The beam is supported along its length and is acted upon by a system of loads at right angles to its axis.
- Due to external loads and couples, shear force and bending moment develop any section of the beams.

Types of Beams

- SIMPLY SUPPORTED BEAM
- OVERHANGING BEAM
- CANTILEVER BEAM

Types of loads

- POINT LOAD OR CONCENTRATED LOAD
- UNIFORMELY DISTRIBUTED LOAD (UDL)
- COUPLES

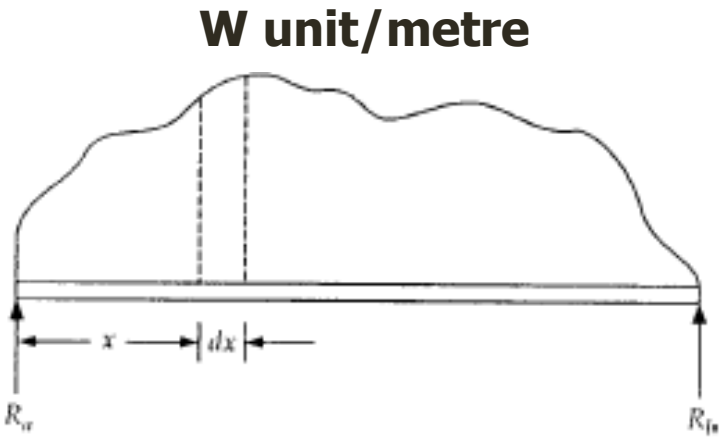
Shear force

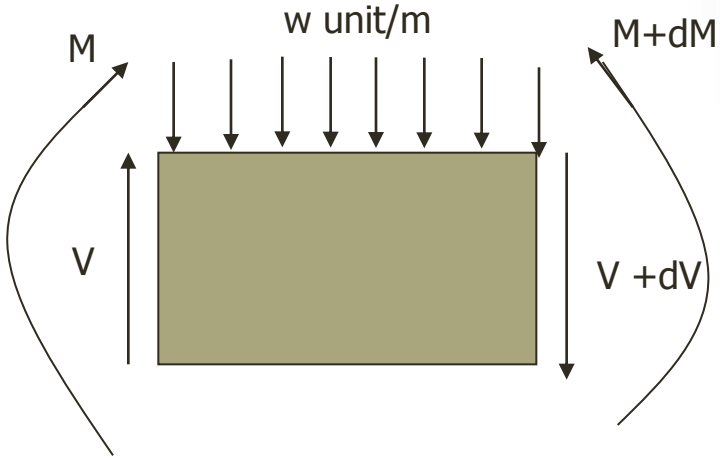
- "Shear force at a section in a beam is the force that is trying to shear off the section".
- It is obtained as algebraic sum of all the forces acting normal to the axis of beam ; acting either to the left or to the right of the section

Bending moment

- "Bending moment at a section in a beam is the moment that tends to bend the beam".
- It is obtained as algebraic sum of moment of all the forces about the section, acting either to the left or to the right of the section.

Relation between force, shear force, and bending moment

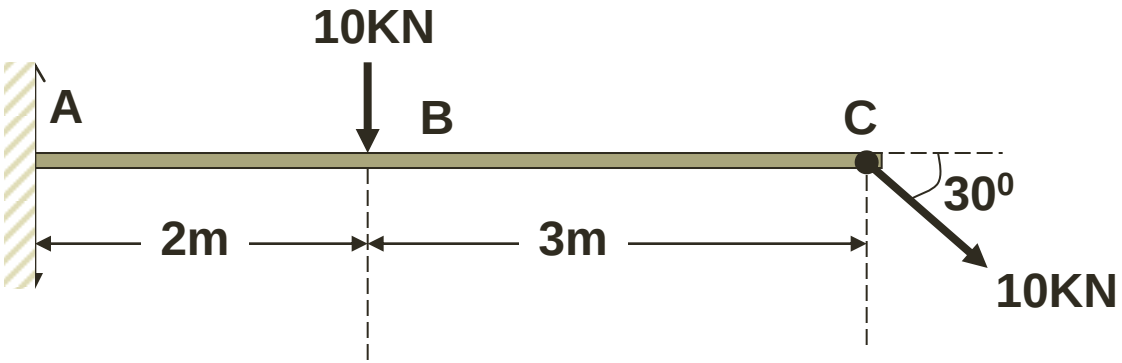




$$V = \frac{dM}{dx}$$

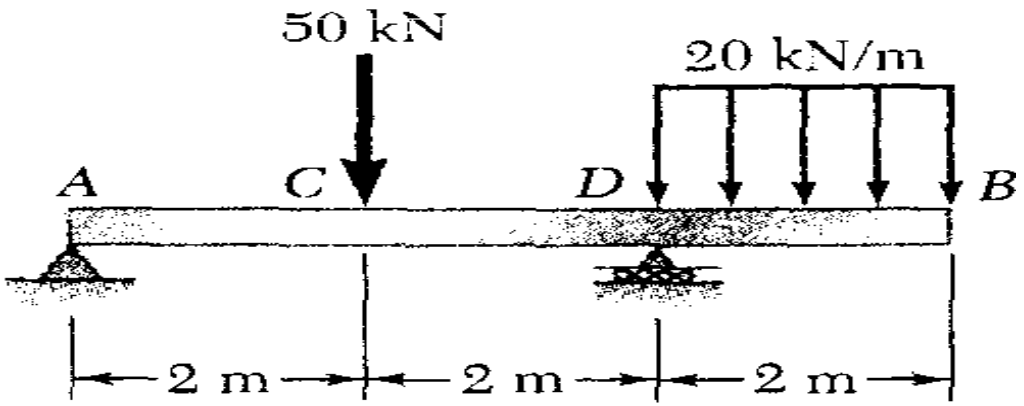
$$w = \frac{dV}{dx}$$

Problem -1



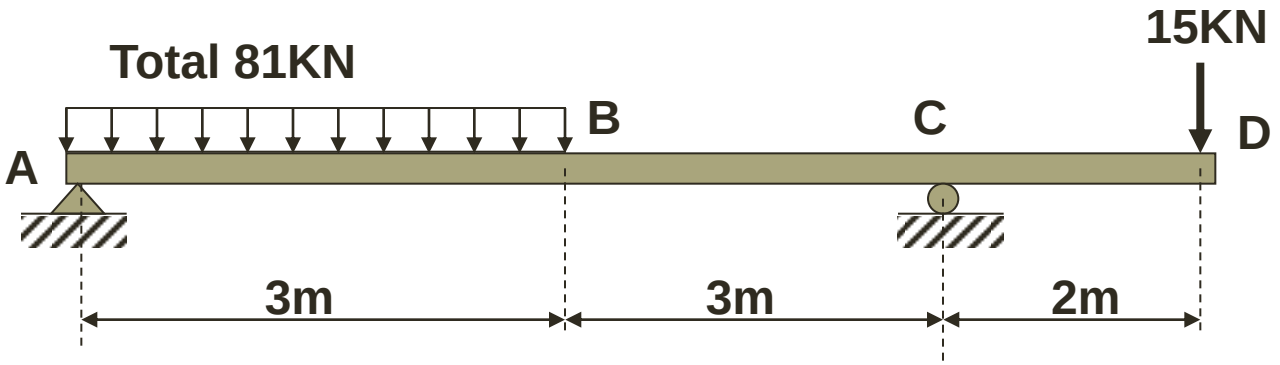
- For the beam and loading shown, draw the shear and bending-moment diagrams,

Problem -2



- For the beam and loading shown, draw the shear and bending-moment diagrams,

Problem -3

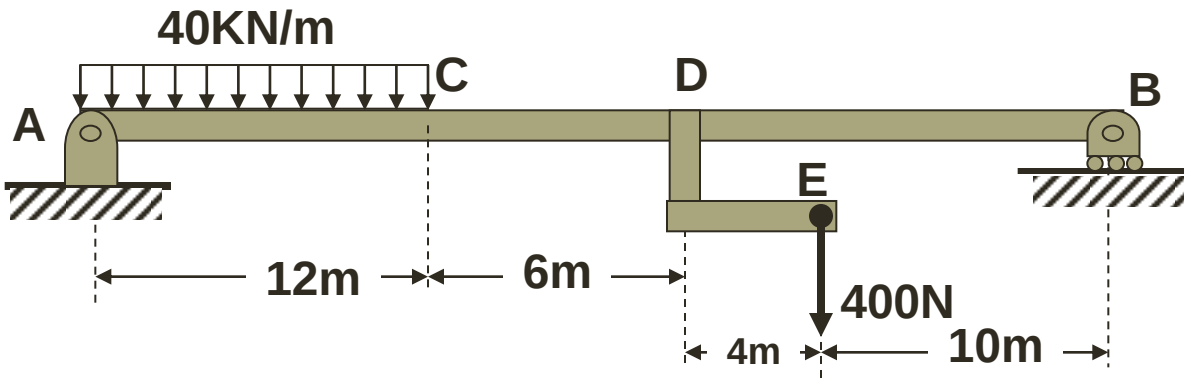


- For the beam and loading shown,

  (a) draw the shear and bending-moment diagrams,

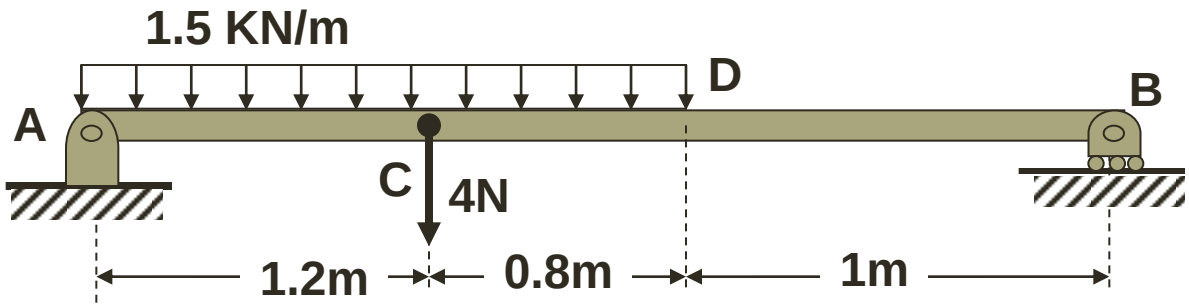
  (b) calculate maximum bending moment and position of zero bending moment

Problem -4



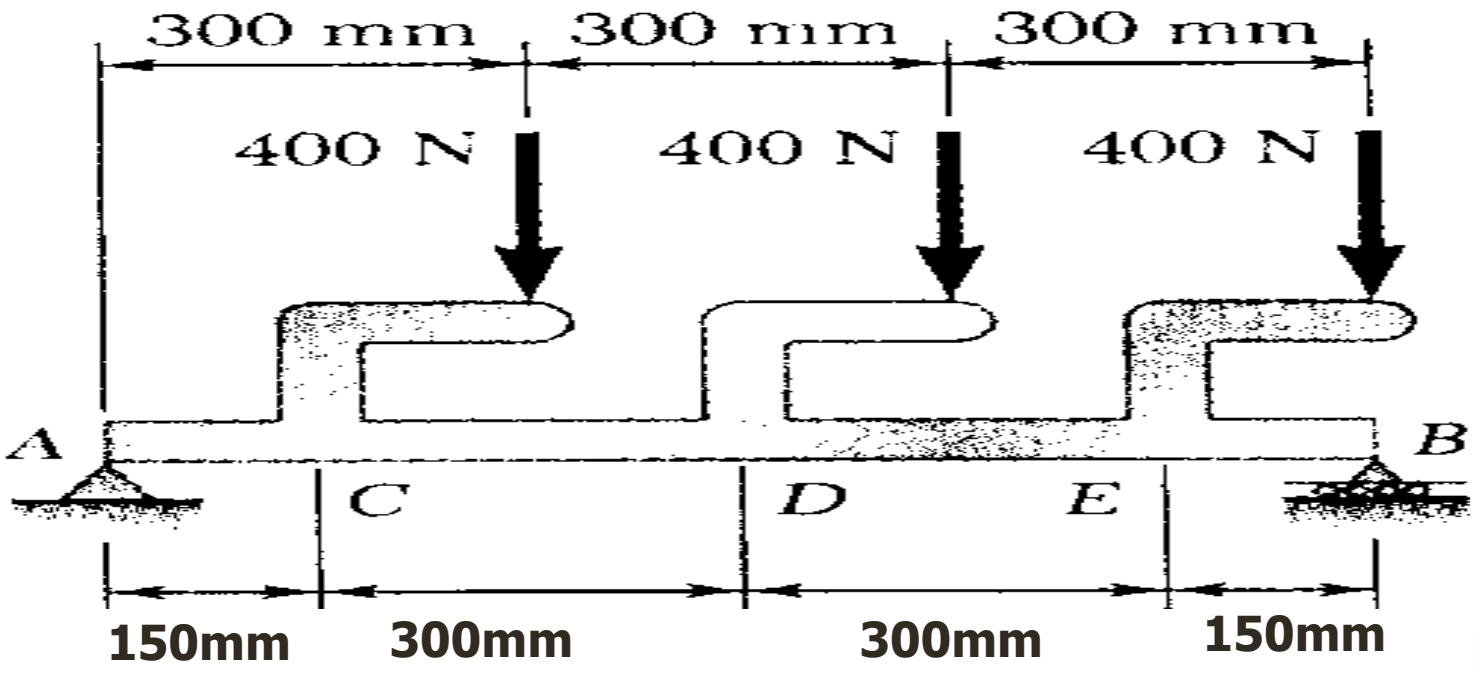
- For the beam and loading shown,
  - Find bending moment just before and after point D;
  - draw the shear and bending-moment diagrams

Problem -5



- For the beam and loading shown,
  (a) draw the shear and bending-moment diagrams
  (b) determine the maximum absolute values of the shear and bending moment.

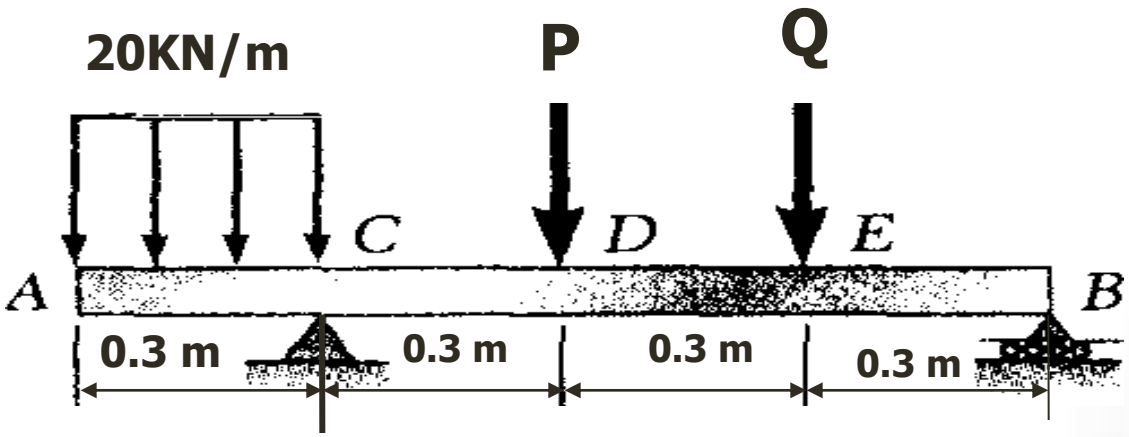
Problem -6



- For the beam and loading shown, draw the shear and bending-moment diagrams,

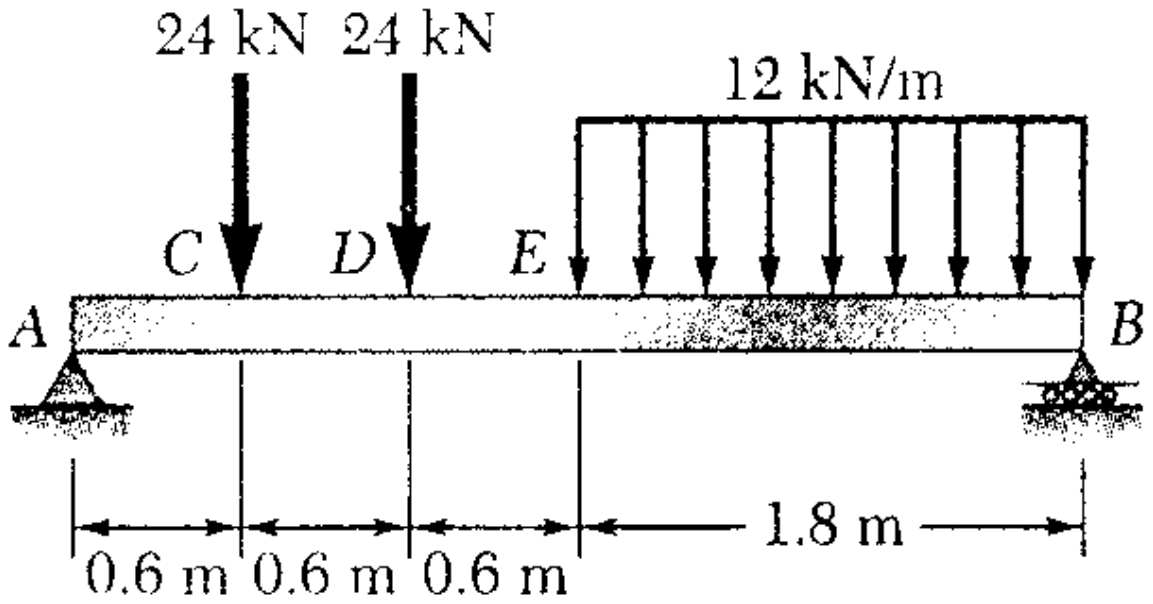
Problem -7

- The beam *AB* is subjected to the uniformly distributed load shown and to two unknown forces P and Q. Knowing that it has been experimentally determined that the bending moment is +800 Nm at *D* and + 1300 Nm at *E*,
  - (a) Determine P and Q,
  - (b) Draw the shear and bending moment diagrams of the beam.



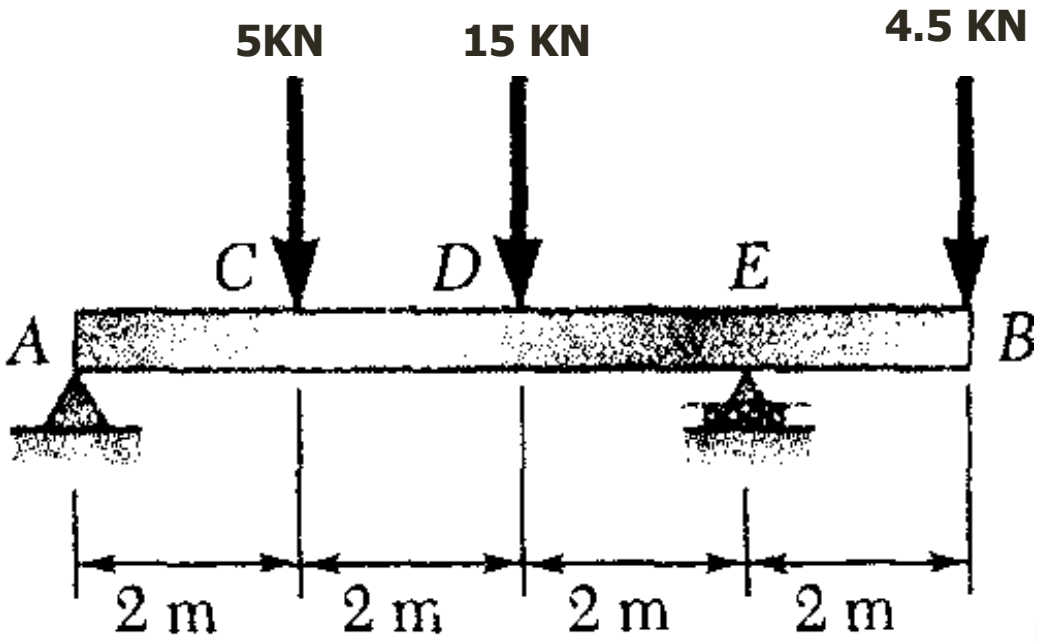
Assignment Problem

- For the beam and loading shown, draw the shear and bending-moment diagrams



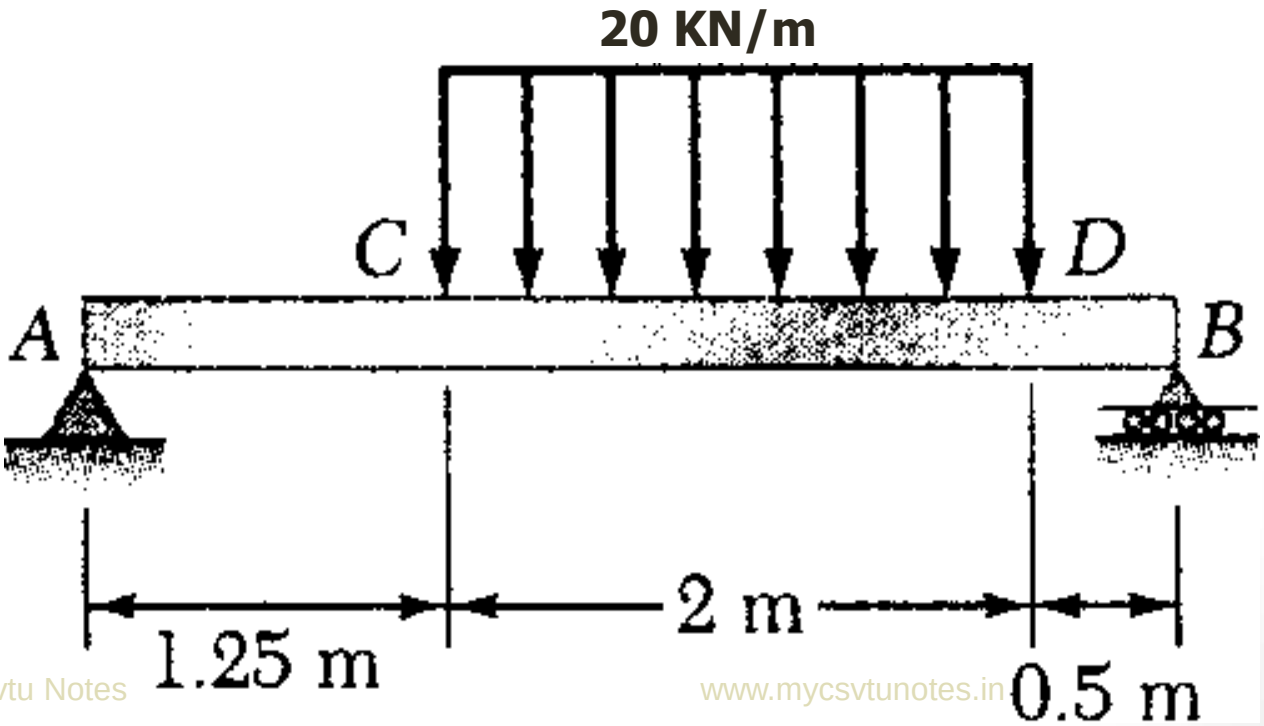
Assignment Problem

- For the beam and loading shown, draw the shear and bending-moment diagrams

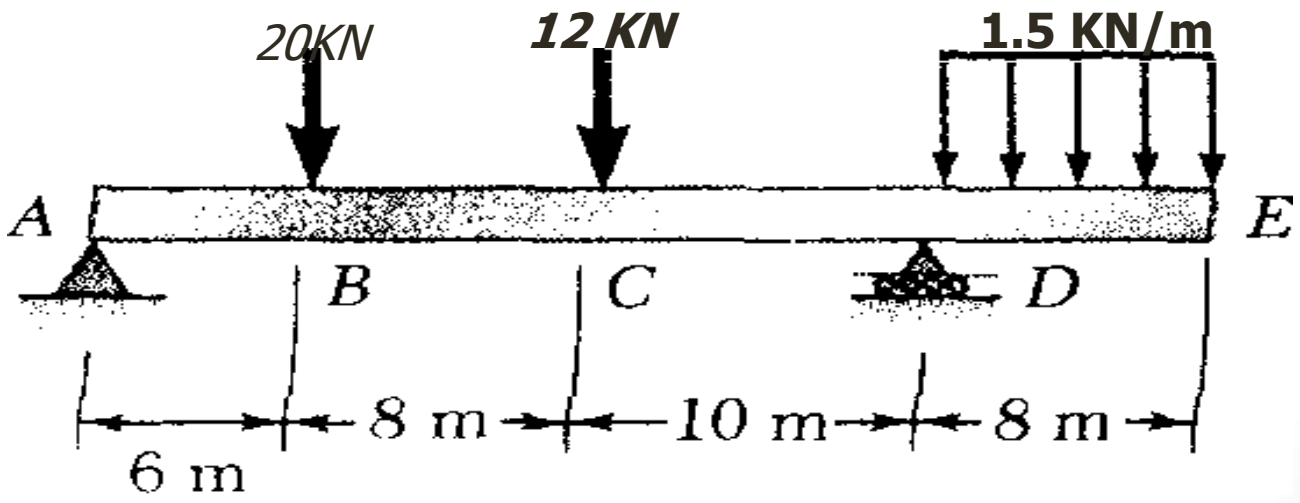


Assignment Problem

- For the beam and loading shown, draw the shear and bending-moment diagrams



Assignment Problem



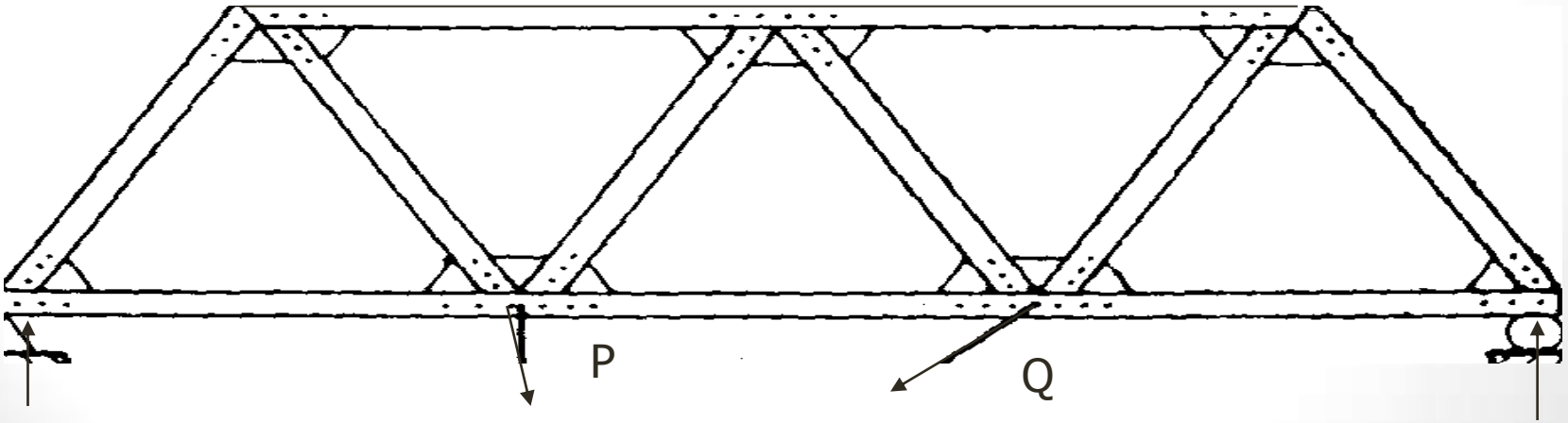
- For the beam and loading shown, draw the shear and bending-moment diagrams

UNIT 2

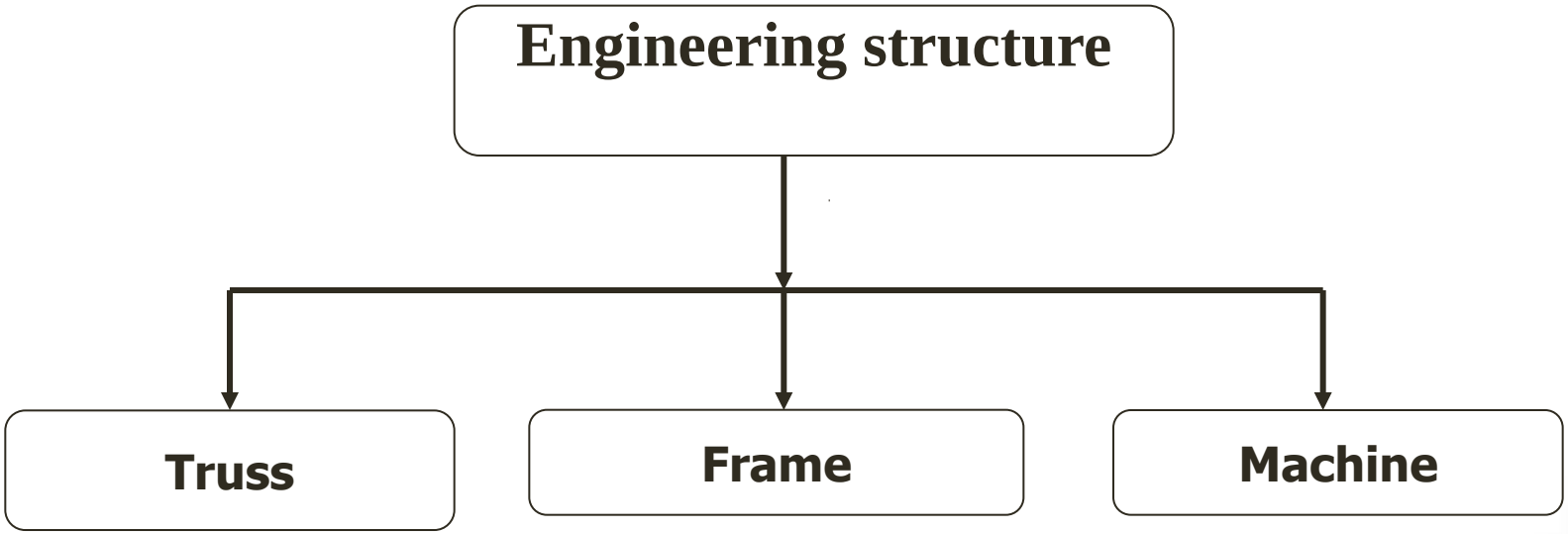
(B) Engineering structures: Trusses

Engineering structures

- These may be defined as any system of connected members built to support or transfer forces acting on them and to safely withstand these forces.



Classification of Engineering structures



Truss

- It is a system of uniform bars or members (of circular section, angle section, channel section etc.) joined together at their ends by riveting or welding and constructed to support loads. The members of a truss are straight members and the loads are applied only at the joint

Frame

- It is structure consisting of several bars or members pinned together and in which one or more than one of its members is subjected to more than two forces. They are designed to support loads and are stationary structures

Machine

- Machines are structures designed to transmit and modify forces and contain some moving members.

Analysis of plane trusses

Trusses are generally classified as:

- Plane truss & space truss :

  In a plane truss, all the members lie in single plane and the forces act along the plane of the truss. Bridge truss and roof trusses are the plane frames.

  A truss in which all the members do not lie in the same plane is known as a space truss. Tripod and suspension towers are the space truss.

- Statically determinate and statically indeterminate truss:

  The force analysis of the members of a statically determinate truss can be made applying the equations of statics only.

  Equations of static equilibrium not sufficient to determine the forces in statically indeterminate trusses there is need of considering their deformation

Basic Assumptions for the Perfect Truss

- **1.** The joints of a simple truss are assumed to be pin connections and frictionless. The joints, therefore, cannot *resist moments.*
- **2**. The loads on the truss are applied at the joints only.
- **3**. The members of a truss are *straight two force members* with the forces acting collinear with the centre line of the members.
- **4**. The weight of the members are negligibly small unless otherwise mentioned.
- **5**. The truss is statically determinate.

Mathematical Condition for Rigid or Perfect Truss

The structure is said to perfect if the number of members is just sufficient to prevent its distortion of shape when subjected to external loads.

$$m + 3 = 2j$$

where, m = number of members in the truss
j = number of joints in the truss

if **$m + 3 > 2j$,** it means that the truss contains more members than required to be just rigid and is over *rigid and statically indeterminate.*

if ***m*+ 3 < 2 j**, it means that the truss contains less members than required to be just rigid and is *collapsible or under rigid.*

Determination of axial forces in the members

The various methods are

- 1. Method of joints
- 2. Method of sections
- 3. Graphical method

Method of Joints

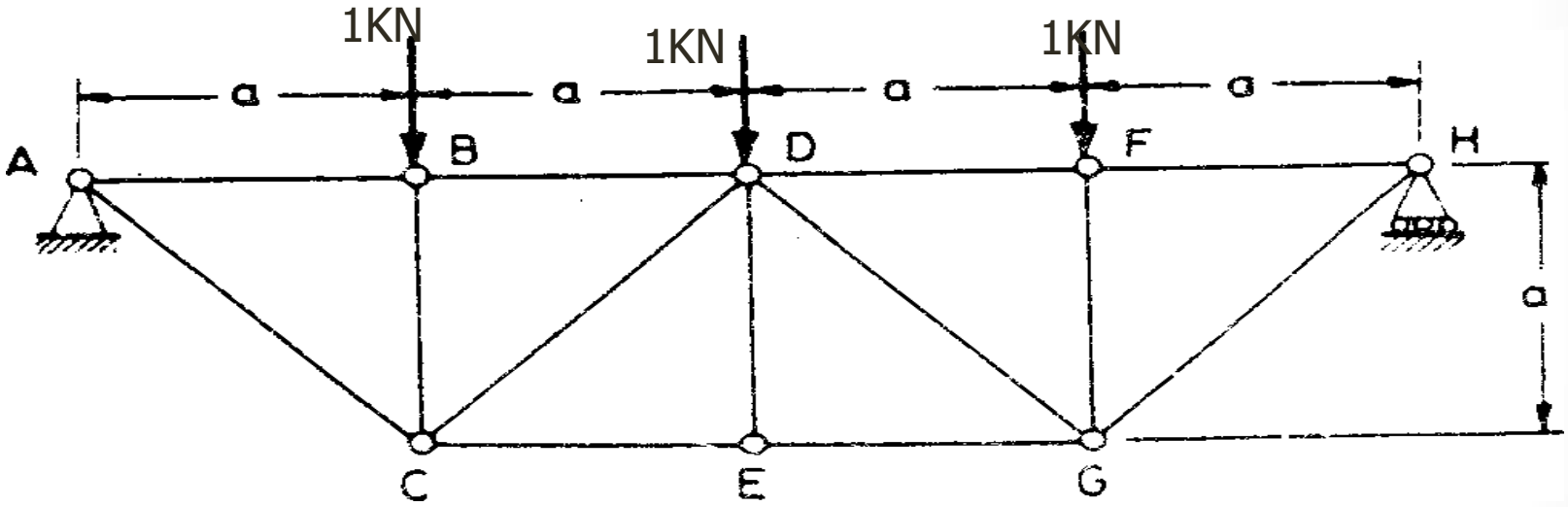
In this method the equilibrium of each joint is considered. The procedure is as follows

- Consider the free-body diagram of the entire truss and compute the support reactions using the equations of equilibrium.
- Assume and mark the directions of the axial forces in the members on the diagram If in the solution the magnitude of a force comes out to be *negative* the assumed direction of the force in the member is simply *reversed*
    - continue

Method of Joints

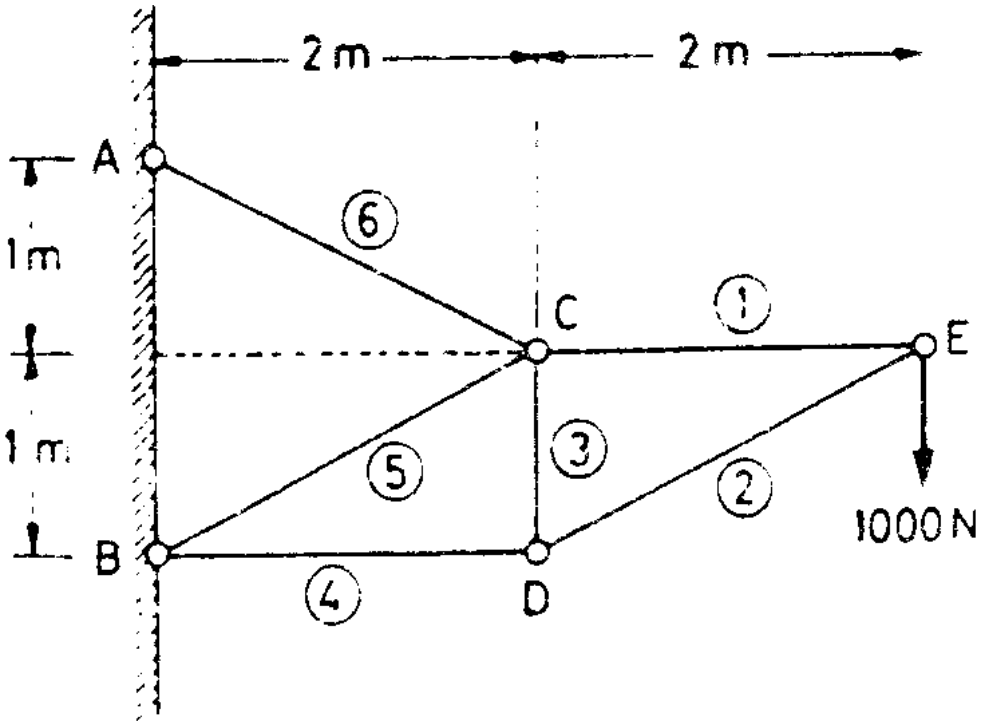
- Choose a joint and consider its free-body diagram. The forces acting on the joint represent a system of concurrent forces in equilibrium.
- start from a joint, where not more than two unknown forces appear.
- Similarly, consider the equilibrium of the remaining joints

Problem - 1



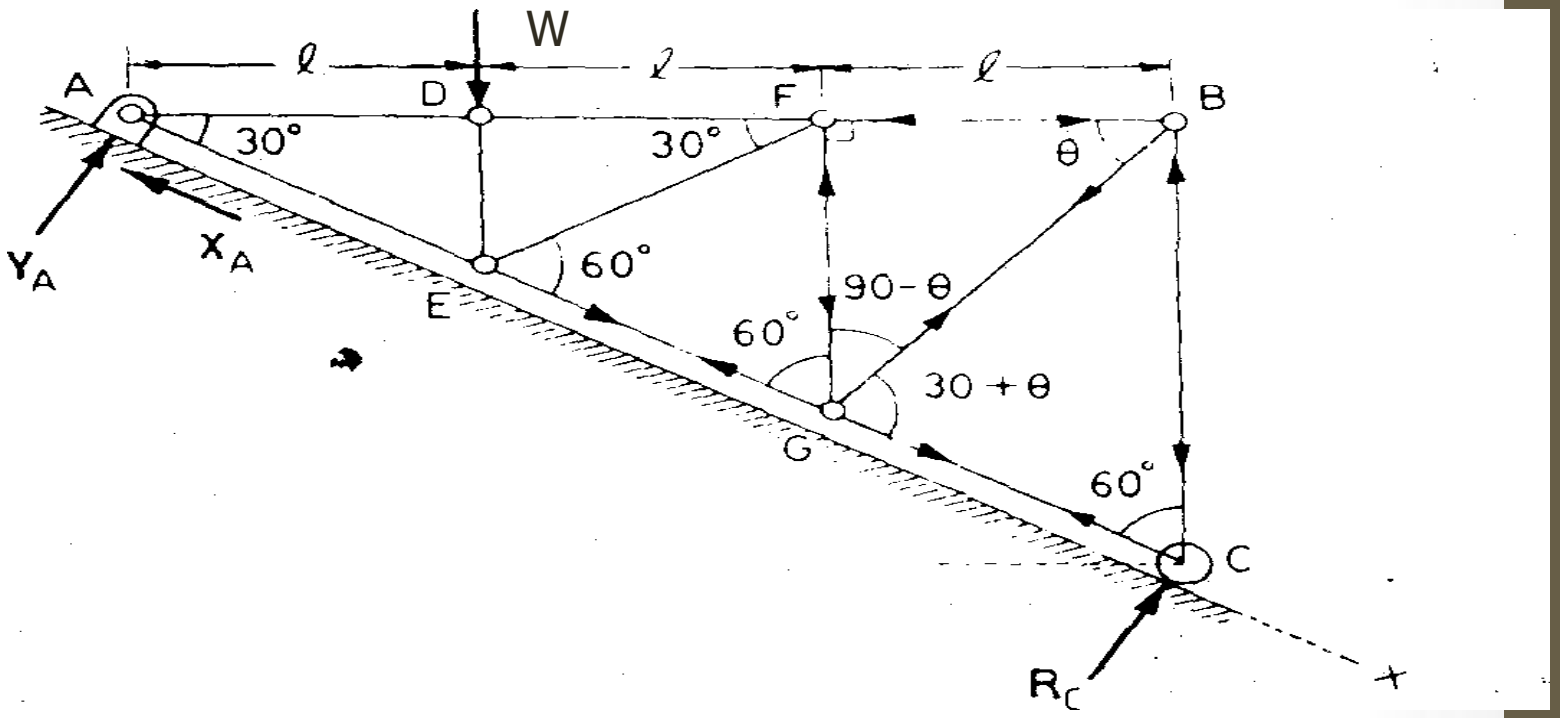
A truss is loaded and supported as shown in Fig. Find the axial forces in the member *BD. CD* and CE

Problem - 2



A cantilever truss is loaded as shown in Fig. Find the axial forces in all the members.

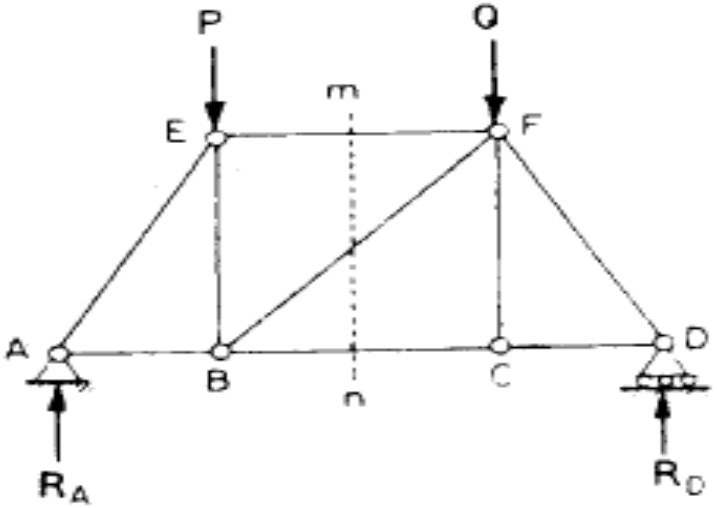
Problem -3

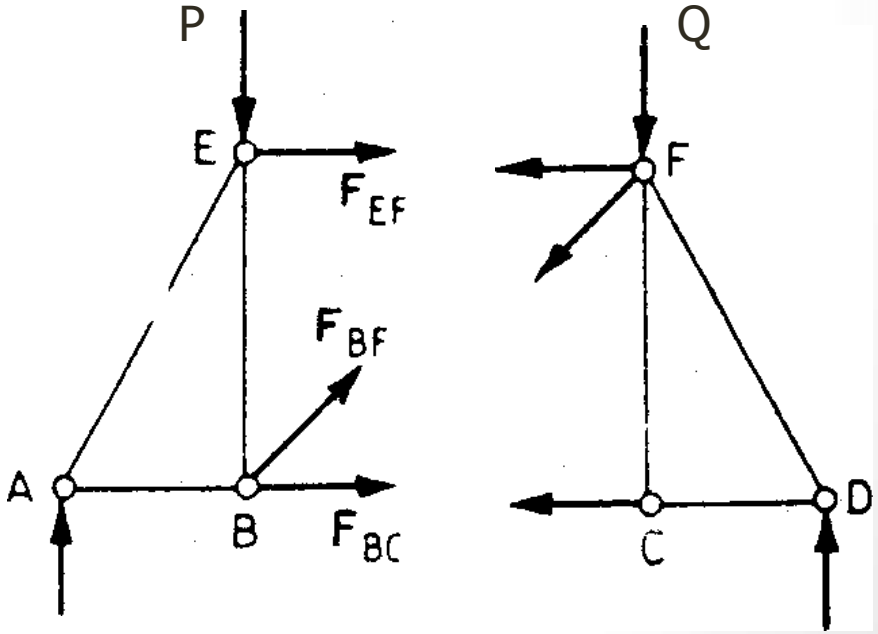


Find the axial forces in the members *BC, BG, BF, GC, GF* and *GE* of the truss supported and loaded as shown. Use the method of joints.

Method of Sections

- In this method, the equilibrium of a portion of the truss is considered which is obtained by cutting the truss by some imaginary section.



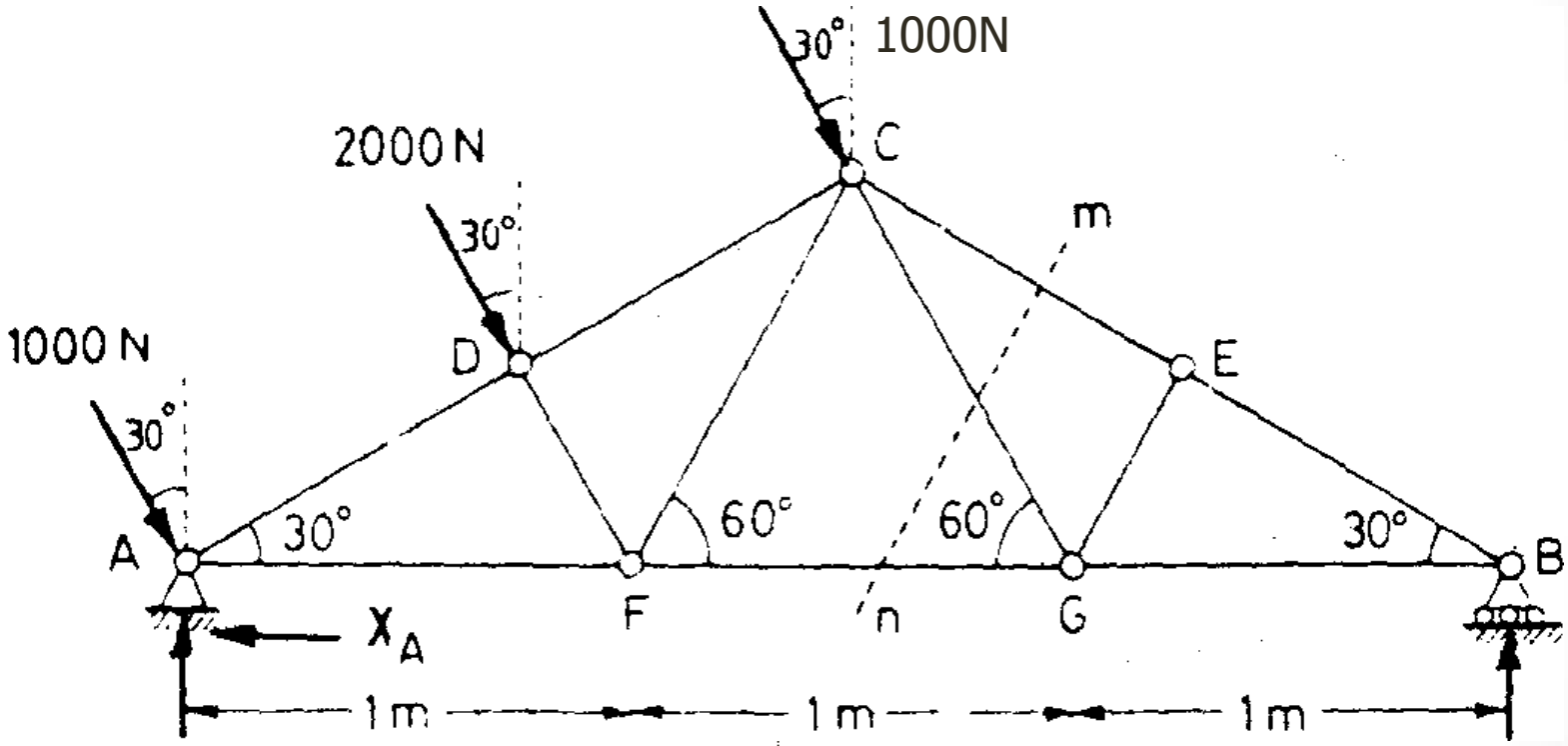


Method of Sections

Following points should be noted while using the method of sections:

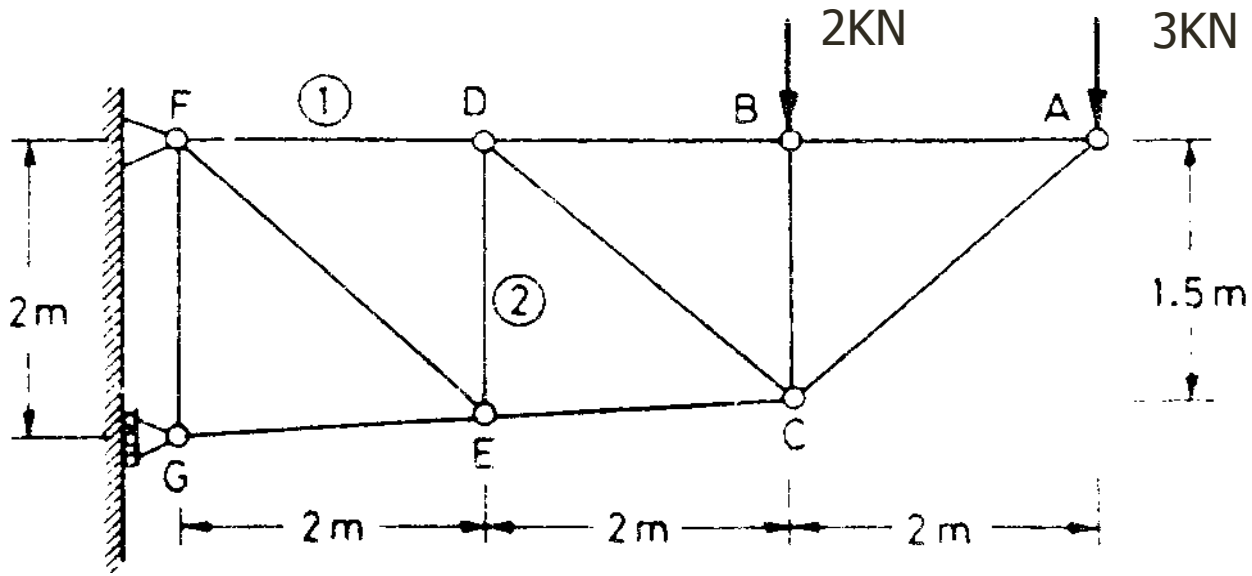
- 1. The section should be passed through the members and not through the joints.
- 2. A section should divide the truss into two clearly separate and unconnected portions.
- 3. A section should cut only three members since only three unknowns can be determined from the three equations of equilibrium. However, in special cases more than three members may be cut by a section.
- 4. When using the moment equation, the moment can be taken about any convenient point.

Problem - 4



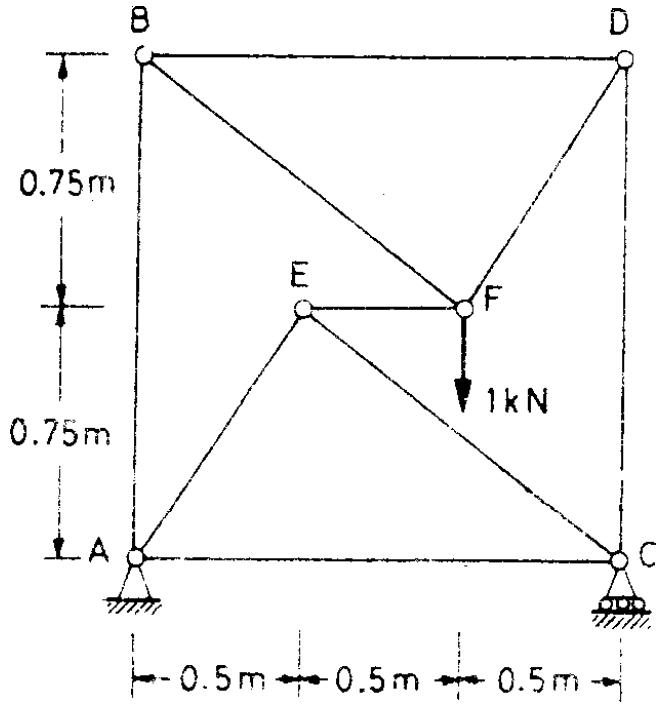
A truss is loaded and supported as shown. Determine the axial forces in the members CE, *CG* and *FG.*

Problem - 5



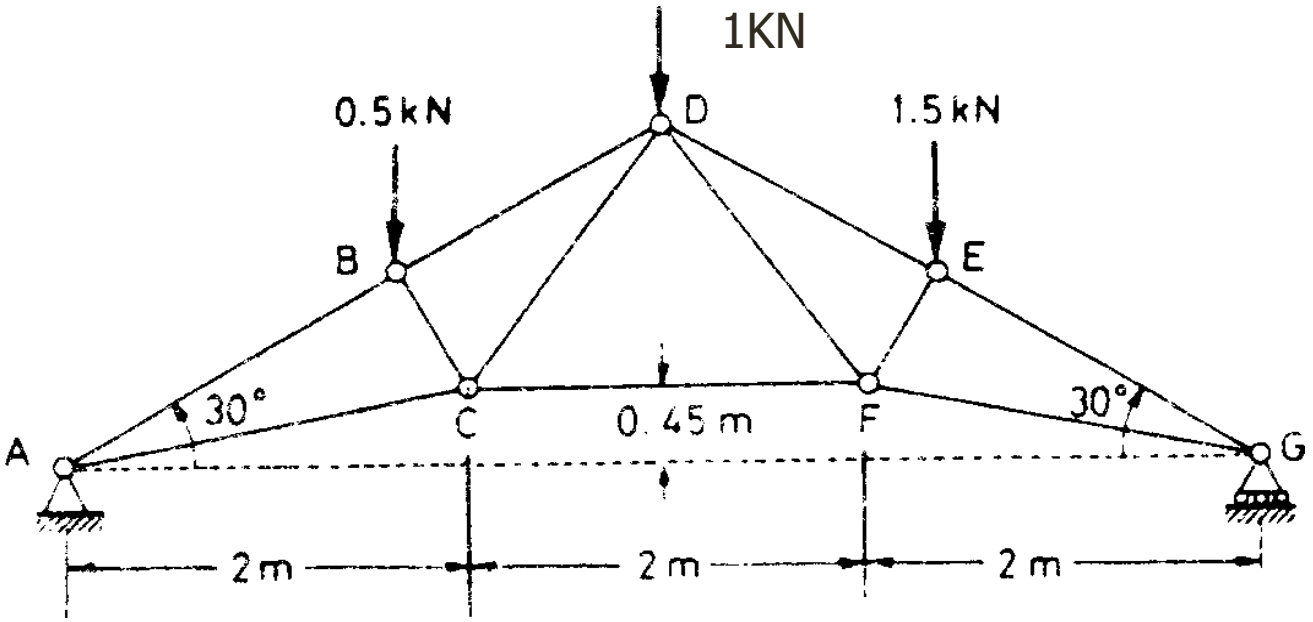
A truss is supported and loaded as shown fig. Find the axial forces in the members *1* and 2.

Problem - 6



- A truss is loaded and supported as shown in Fig. Find the axial forces in the members AB, *EF* and CD.

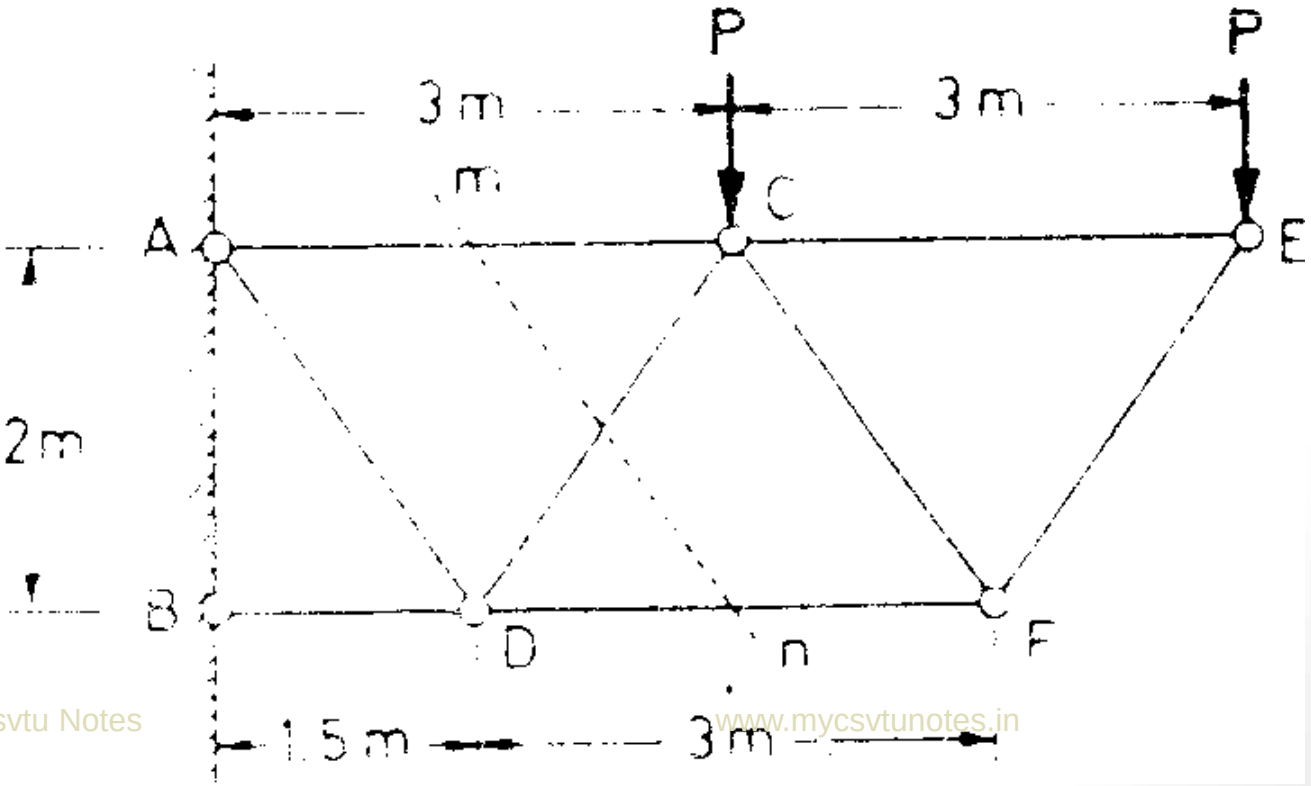
Problem - 7



- A roof truss is supported and loaded as shown in Fig. Find the axial forces in the members *BD* and *CF*.

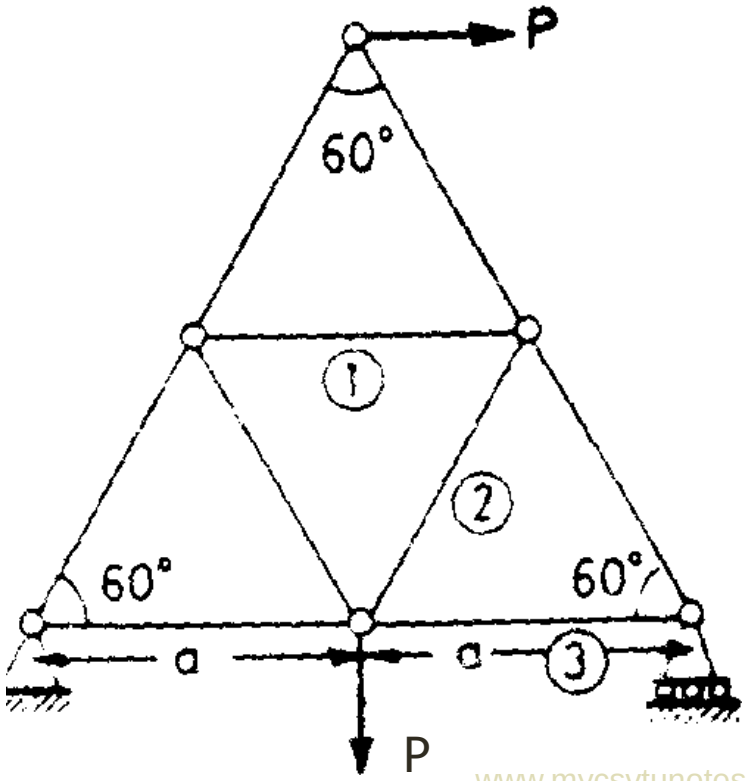
Problem -8

- A cantilever truss is loaded and supported as shown. Find the value of loads P which would produce an axial force of magnitude 3KN in the member AC



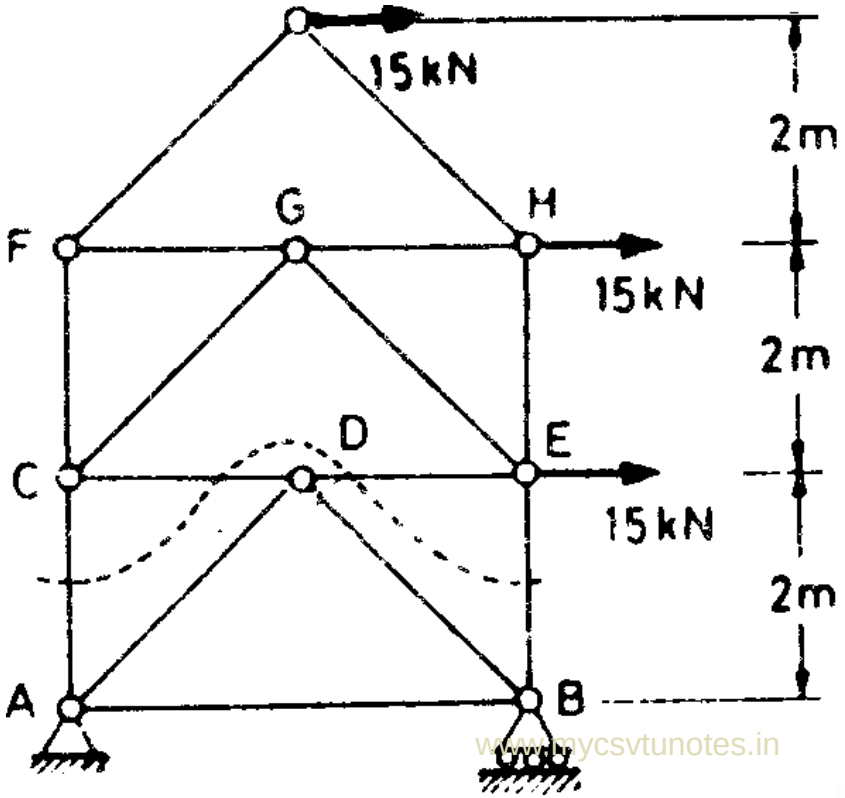
Problem - 9

- A truss is loaded and supported as shown in Fig. Find the axial forces in the members 1, 2 and 3.



Problem - 10

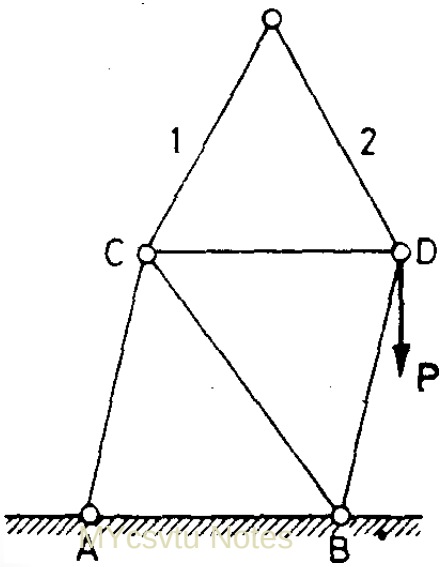
- Determine by the method of sections the axial force in the member *EB* of the truss shown in Fig.



Zero force member

Following points should be noted while determine the **Zero force member**

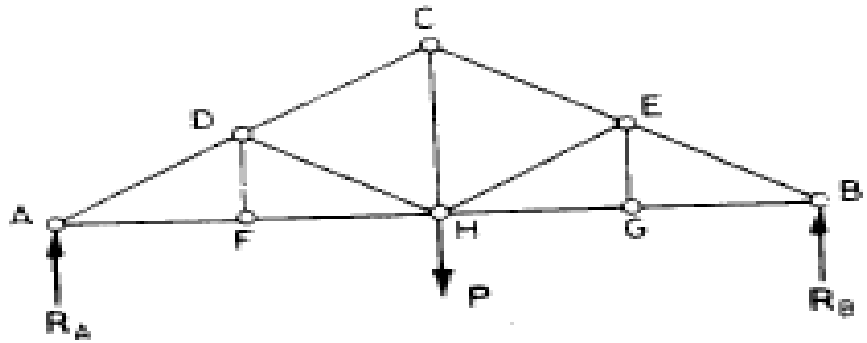
- 1. When two members meeting at a joint are not collinear and there is no external force acting at the joint, then the forces in both the members are zero

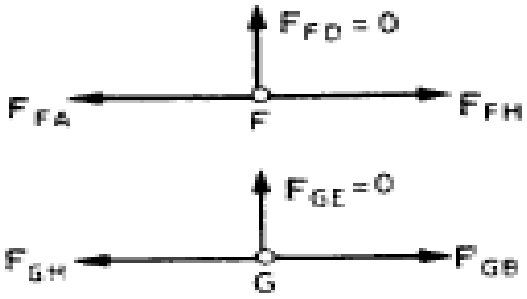


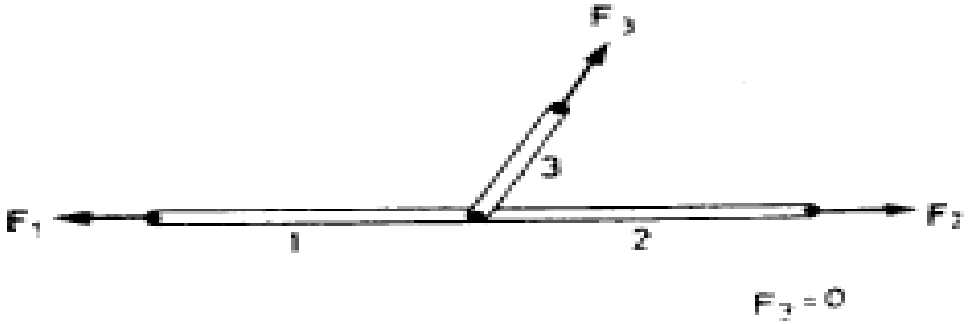
F1=0 F2=0

Zero force member

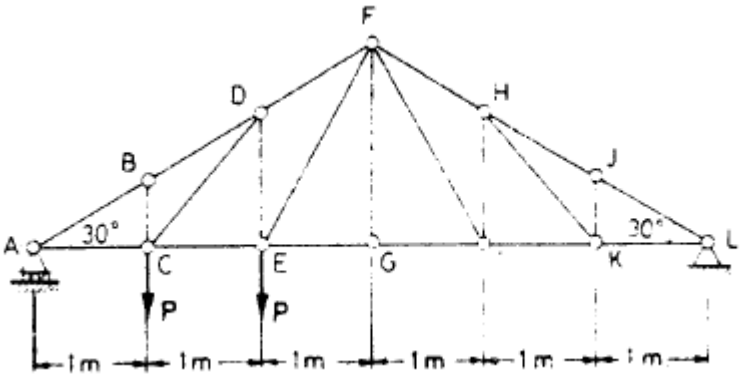
- 2. When there are three members meeting at a joint, of which two are collinear and third be at an angle and if there is no load at the joint the force in the third member is zero







Problem 11



- A truss is loaded and supported as shown. Find out the members in which the axial forces are zero

Graphical Method