

**Course Code: ESC106A**

**Course Title: Construction Materials and Engineering Mechanics**

**Lecture No. 19:**

**Equivalent Force system**

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# Lecture Intended Learning Outcomes

**At the end of this lecture, students will be able to:**

- Define equivalent force system
- Describe the concept of equivalent force system
- Solve the problems on replacing the force and couple moment system by an equivalent force



# Contents

Equivalent force system, problems on equivalent force system

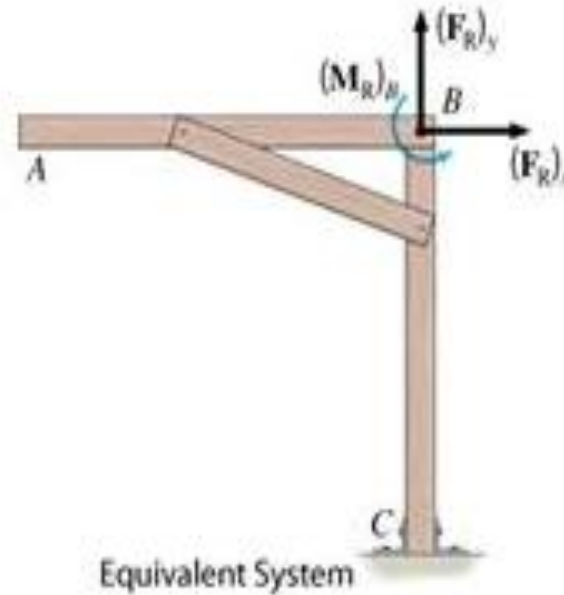
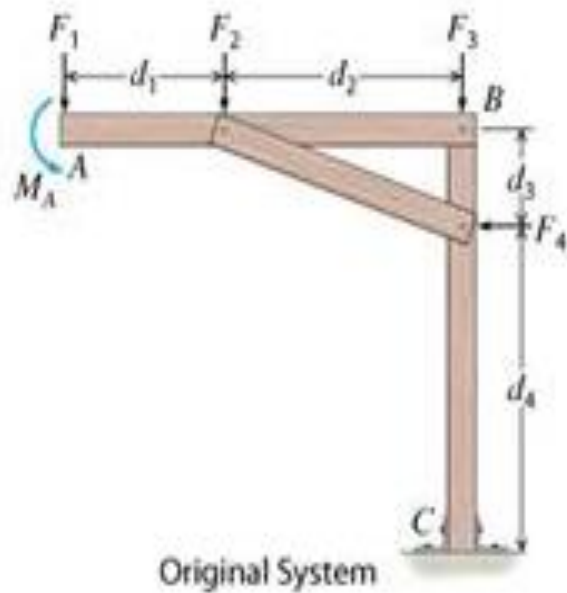


# Equivalent Force System

- An equivalent system for a given system of coplanar forces is a combination of a force passing through a given point and a moment about that point.
- The equivalent force is the resultant of the forces acting on that body and the moment is the sum of all the moments about that point.
- Hence equivalent system consists of :
  - A single force  $R$  passing through the given point
  - A single Moment  $M_R$

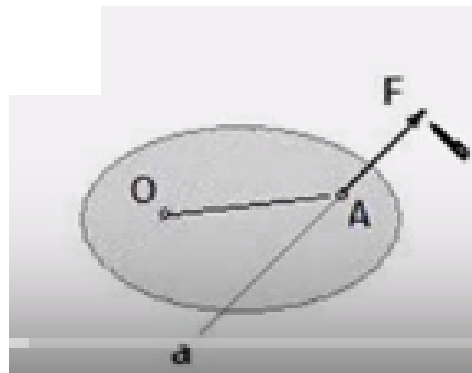


# Equivalent Force System



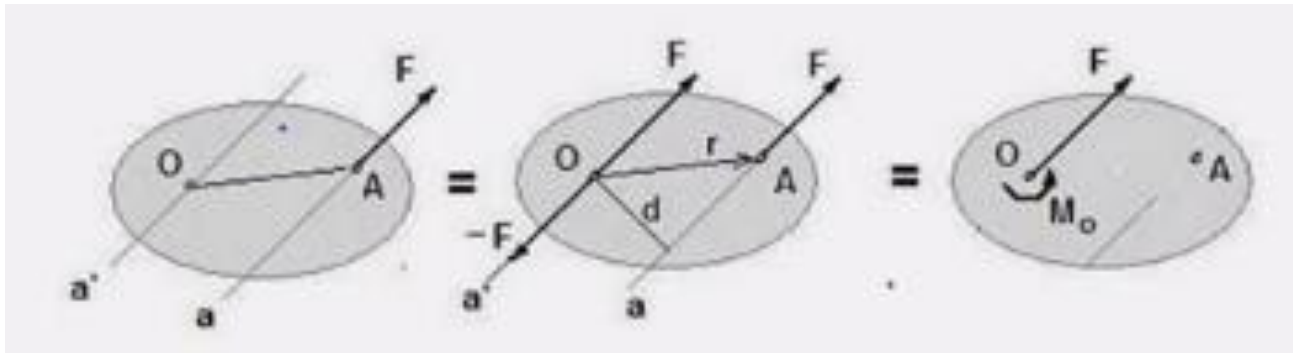
# Replacing a force with an equivalent force-couple system

- A force acting on a rigid body may be moved along its line of action without changing the effect on the body
- For some reason , we want the force  $F$  to act on point  $O$  (not on line of action of the force  $F$ ) of the body
- However , we cannot move it to an arbitrary point  $O$  without modifying the action of  $F$  on the rigid body



# Replacing a force with an equivalent force-couple system

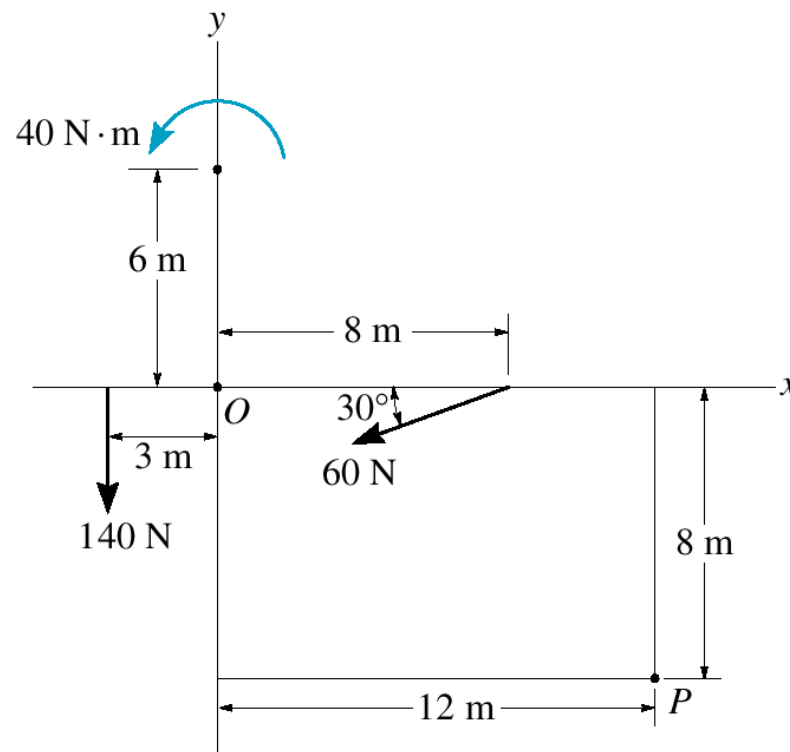
- Add two forces at O: One equal to  $F$  and the other equal to  $-F$



- Then there is a force  $F$  at  $O$  and a couple of moment  $M = Fd$

# Problems on Equivalent Force System

1. Replace the force and couple moment system by an equivalent force and couple moment acting at point P



$$\Sigma M_{RP} = 2.68 \text{ kNm}$$

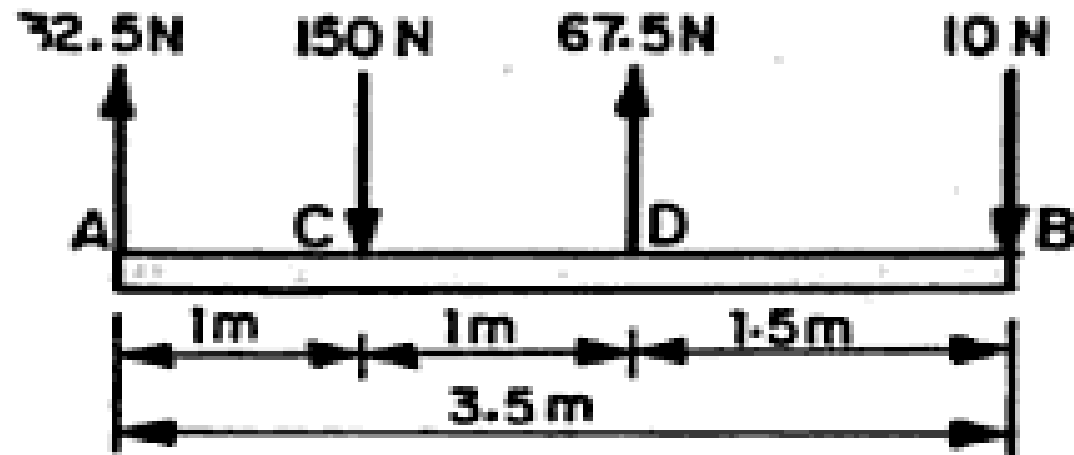




# Problems on Equivalent Force System

2. A system of parallel forces are acting on a rigid bar as shown in the figure. Reduce the given system

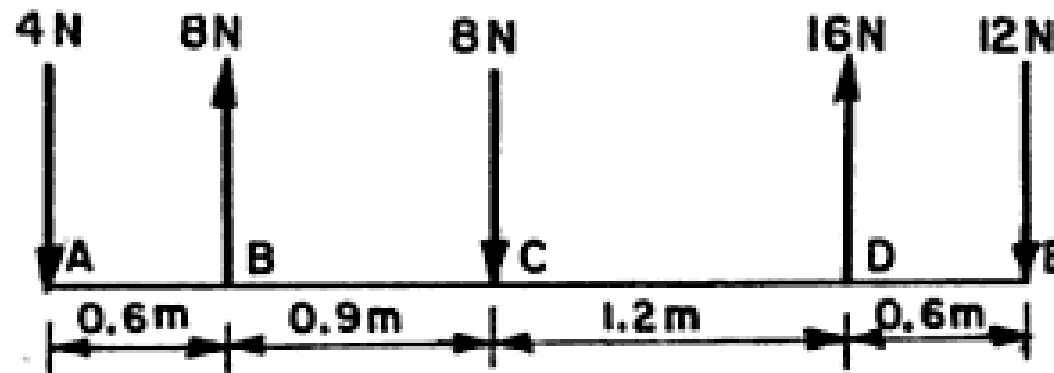
- a) a single force
- b) a single force and a couple at A
- c) a single force and couple at B



# Problems on Equivalent Force System

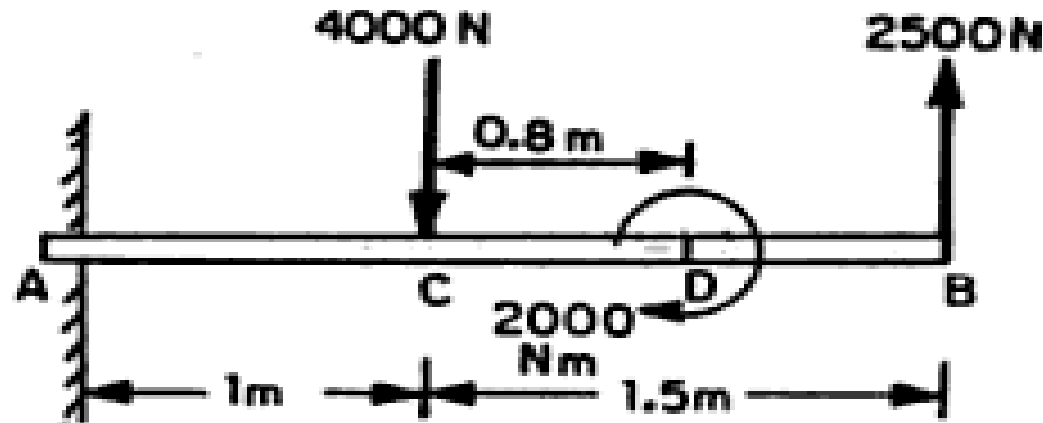
3. A system of parallel forces are acting on a rigid bar as shown in the figure. Reduce the given system

- a) A single force
- b) A single force and a couple at A
- c) A single force and couple at E



# Problems on Equivalent Force System

4. The figure shows two vertical forces and a couple acting on a horizontal rod which is fixed at A. Determine the Resultant of the system. Determine an Equivalent system through A



# Summary

- An equivalent system for a given system of coplanar forces is a combination of a force passing through a given point and a moment about that point
- The equivalent force is the resultant of the forces acting on that body and the moment is the sum of all the moments about that point
- Hence equivalent system consists of :
  - A single force  $R$  passing through the given point
  - A single Moment  $M_R$

