ME 165
Basic Mechanical Engineering

Lecture 04

Rigid Bodies –Equivalent System of Forces

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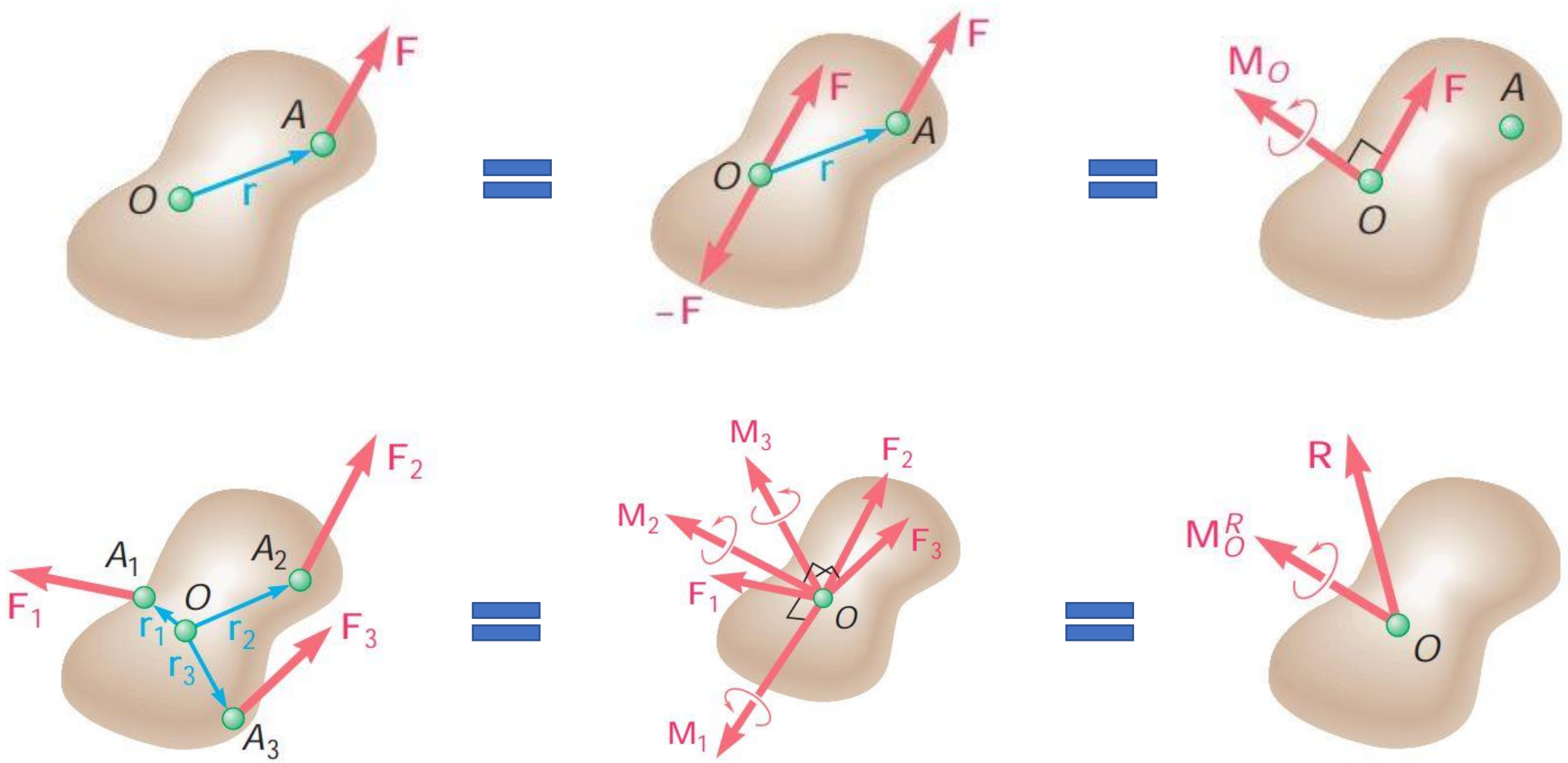
REDUCTION OF A SYSTEM OF FORCES TO ONE FORCE AND ONE COUPLE



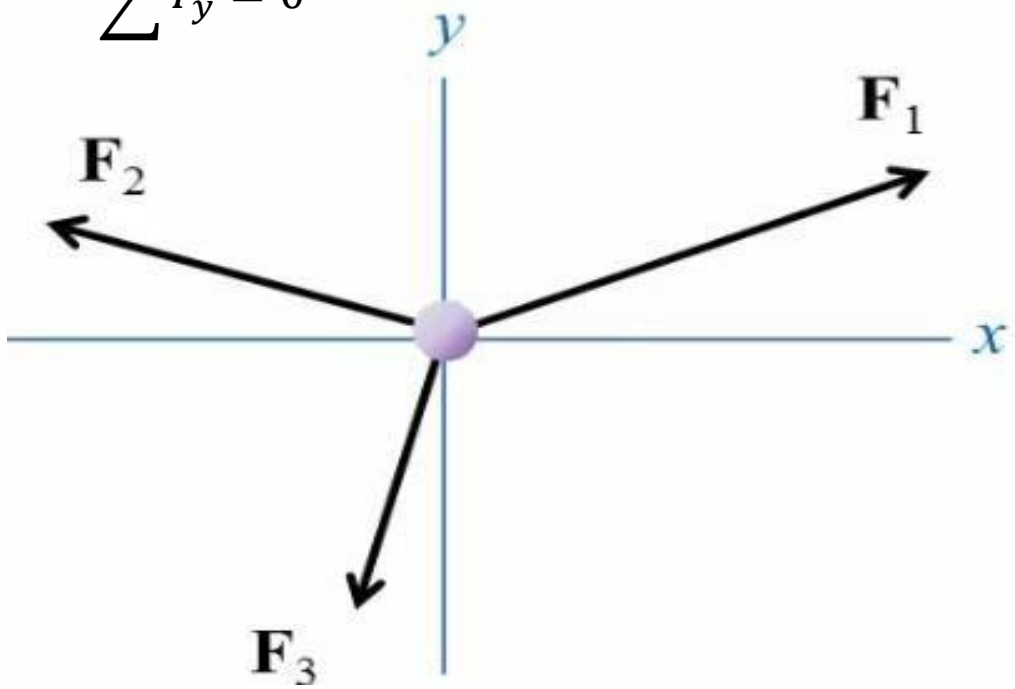
Particle Equilibrium

$$\overline{F_R} = \sum \overline{F} = 0$$

2D

$$\sum F_x = 0$$

$$\sum F_y = 0$$

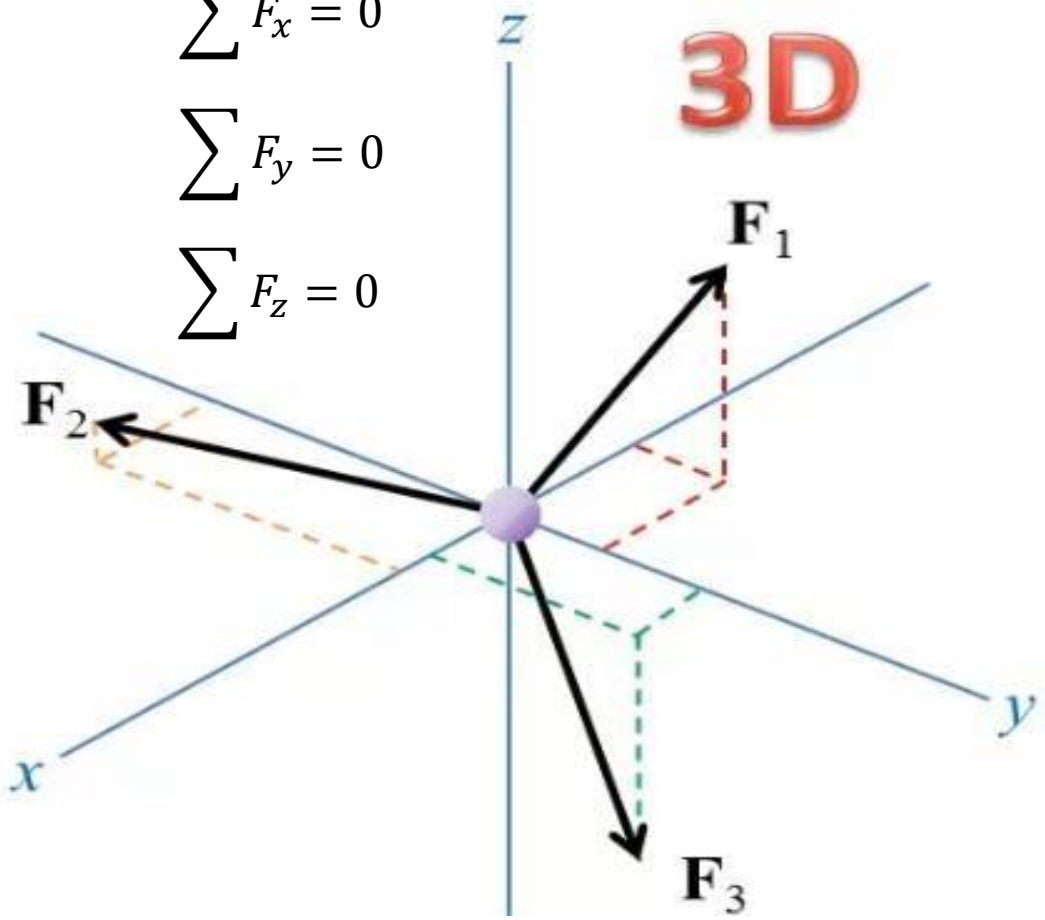


3D

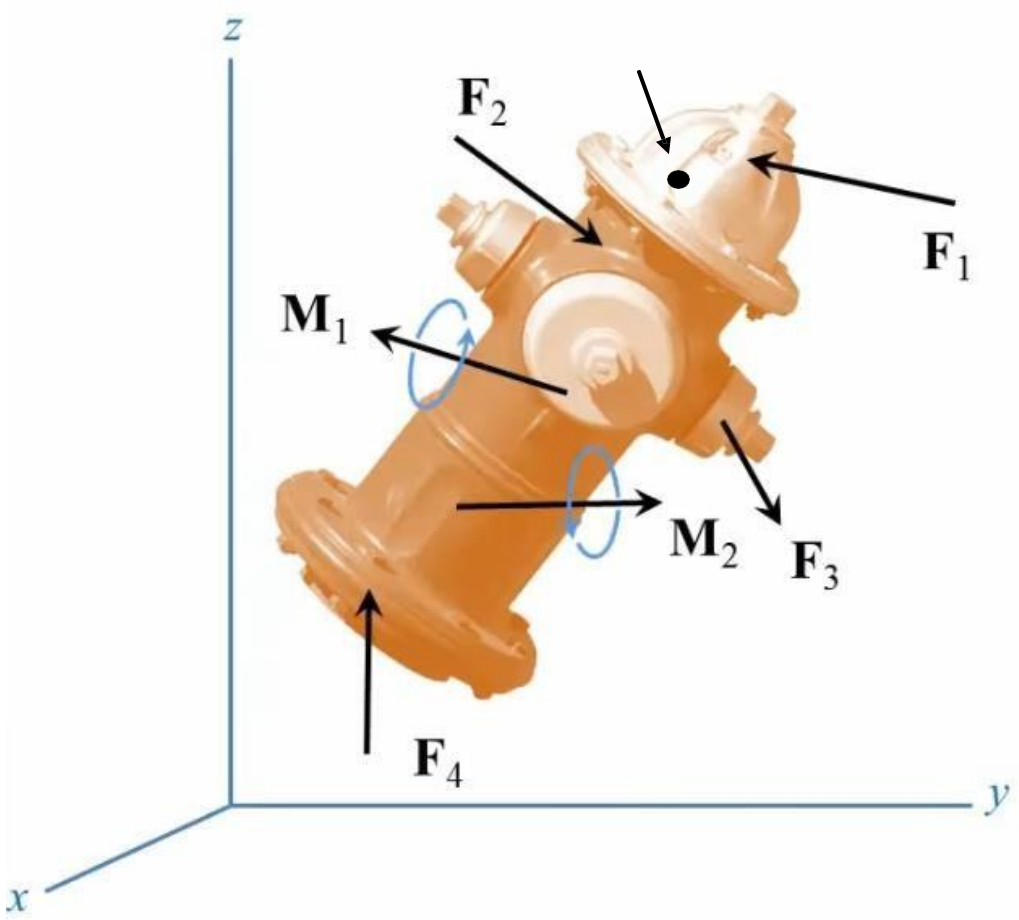
$$\sum F_x = 0$$

$$\sum F_y = 0$$

$$\sum F_z = 0$$



Rigid Body Equilibrium



$$\overline{F_R} = \sum \bar{F} = 0$$

$$\overline{M_{R,O}} = \sum \overline{M_{F,O}} + \sum \bar{M} = 0$$

Conditions for Rigid Body Equilibrium

$$\overline{\boldsymbol{F_R}} = \sum \overline{\boldsymbol{F}} = \mathbf{0}$$

$$\overline{\boldsymbol{M_{R,O}}} = \sum \overline{\boldsymbol{M_{F,O}}} + \sum \bar{\boldsymbol{M}} = \mathbf{0}$$

2-D Problems:

$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum M_A = 0$$

or

$$\sum F_x = 0 \quad \sum M_A = 0 \quad \sum M_B = 0$$

or

$$\sum M_A = 0 \quad \sum M_B = 0 \quad \sum M_C = 0$$

3-D Problems:

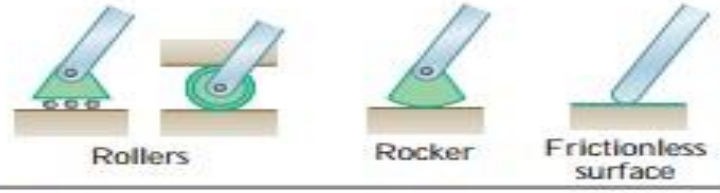
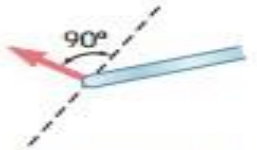
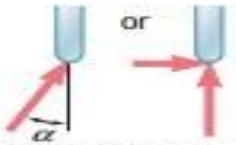
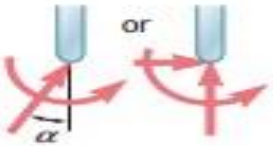
$$\sum F_x = 0 \quad \sum F_y = 0 \quad \sum F_z = 0$$

and

$$\sum M_A = 0 \quad \sum M_B = 0 \quad \sum M_C = 0$$

Equilibrium of Rigid Bodies in 2-D

Reactions at Supports and Connections for 2-D Structure

Support or Connection	Reaction	Number of Unknowns
 Rollers; Rocker; Frictionless surface	 Force with known line of action	1
 Short cable; Short link	 Force with known line of action	1
 Collar on frictionless rod; Frictionless pin in slot	 Force with known line of action	1
 Frictionless pin or hinge; Rough surface	 Force of unknown direction	2
 Fixed support	 Force and couple	3