UNIVERSITÀ di VERONA
Dipartimento di INFORMATICA

Industrial Plants
(S.S.D.-ING-IND/13)

Industrial Plants

(S.S.D. ING-IND/13)

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Program

1. **Introduction and Objectives**
2. **Fundamentals of Mechanics Applied to Industrial Plants**
3. Functional Design of Industrial Machines and Robots in a Smart Industry
4. Functional Elements of Dynamic of Machinery
5. Example of an Industrial Plant Project (IPP)

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Scheme of Industrial Plants

Industrial Plants
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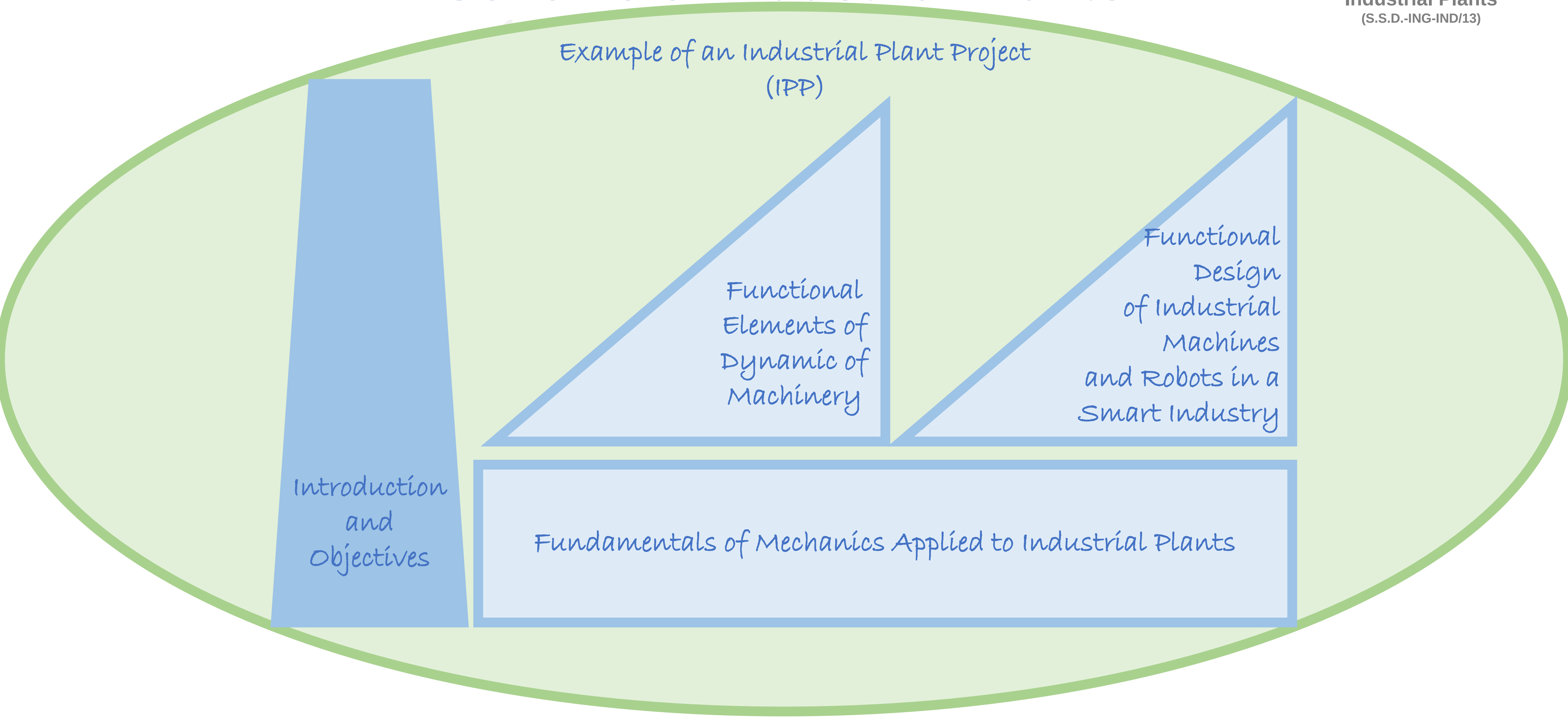
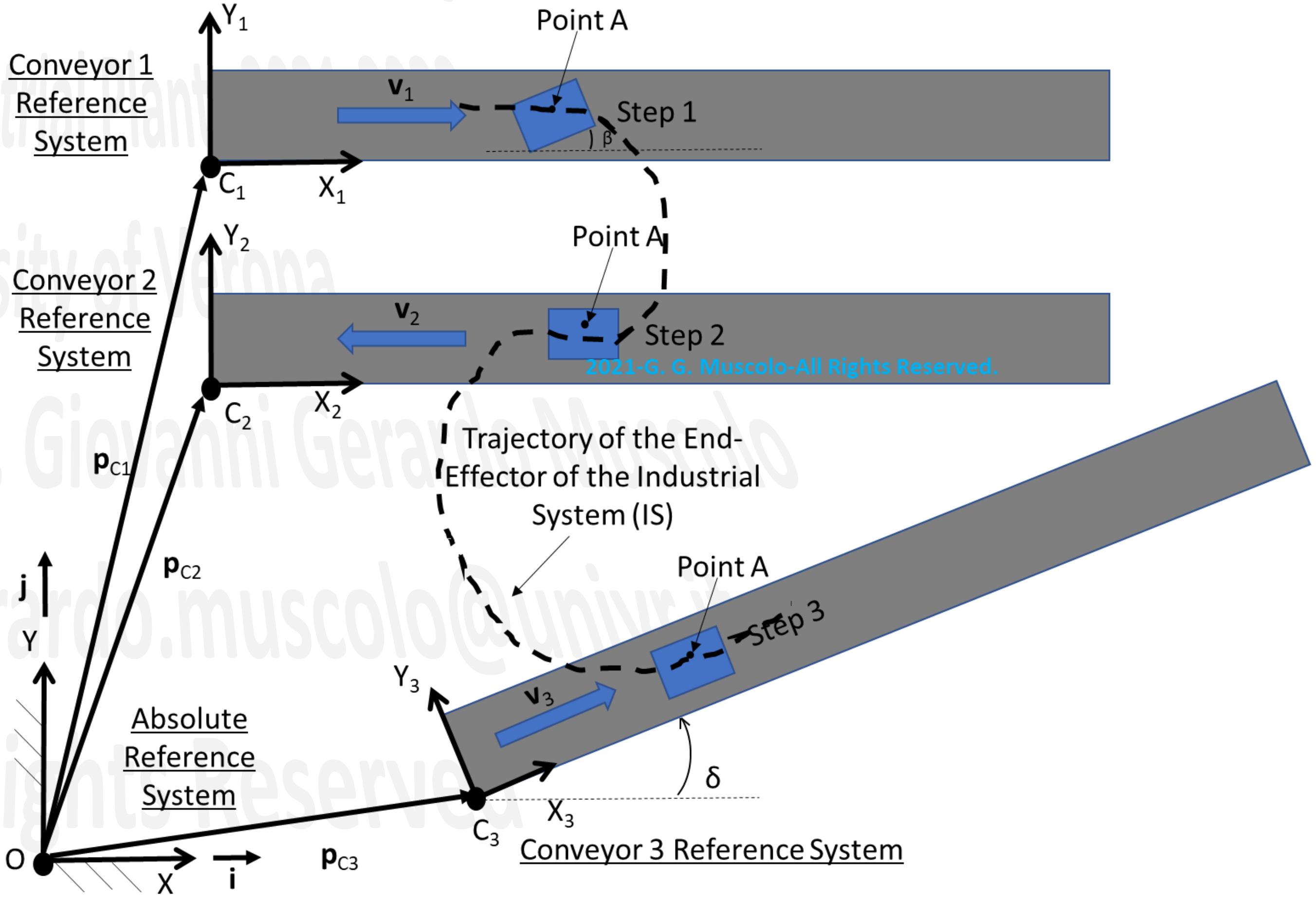


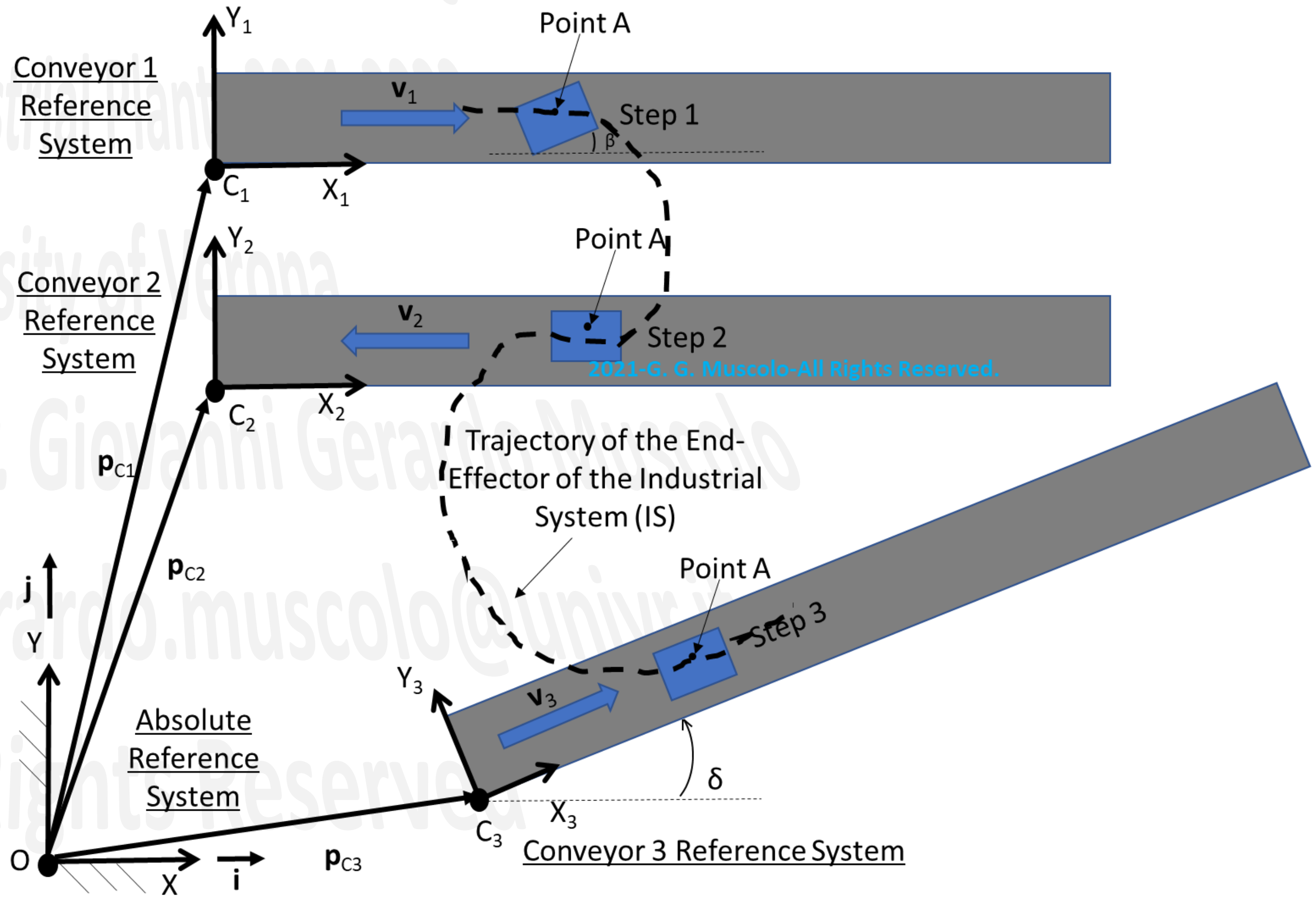
EXERCISE (kinematics):

a) Determine 5 solutions of the Industrial System (IS) for the pick & place of the rectangle from the conveyor 1 to the conveyor 3, passing from the conveyor 2, as shown in the figure (dashed line).



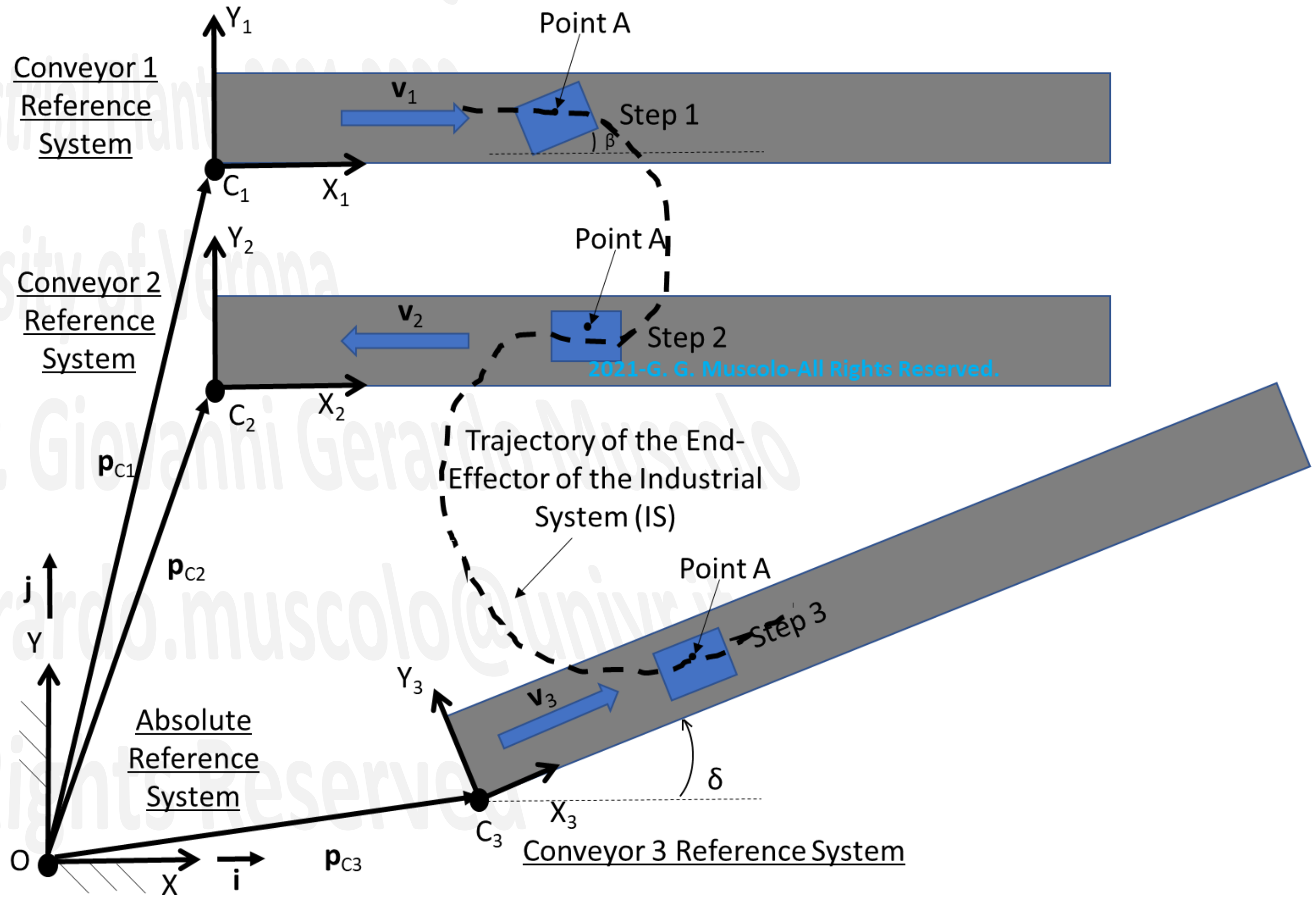
EXERCISE (kinematics):

example of solution a: one manipulator for pick & place operations is between conveyors 1 and 2 and another manipulator is between conveyors 2 and 3.



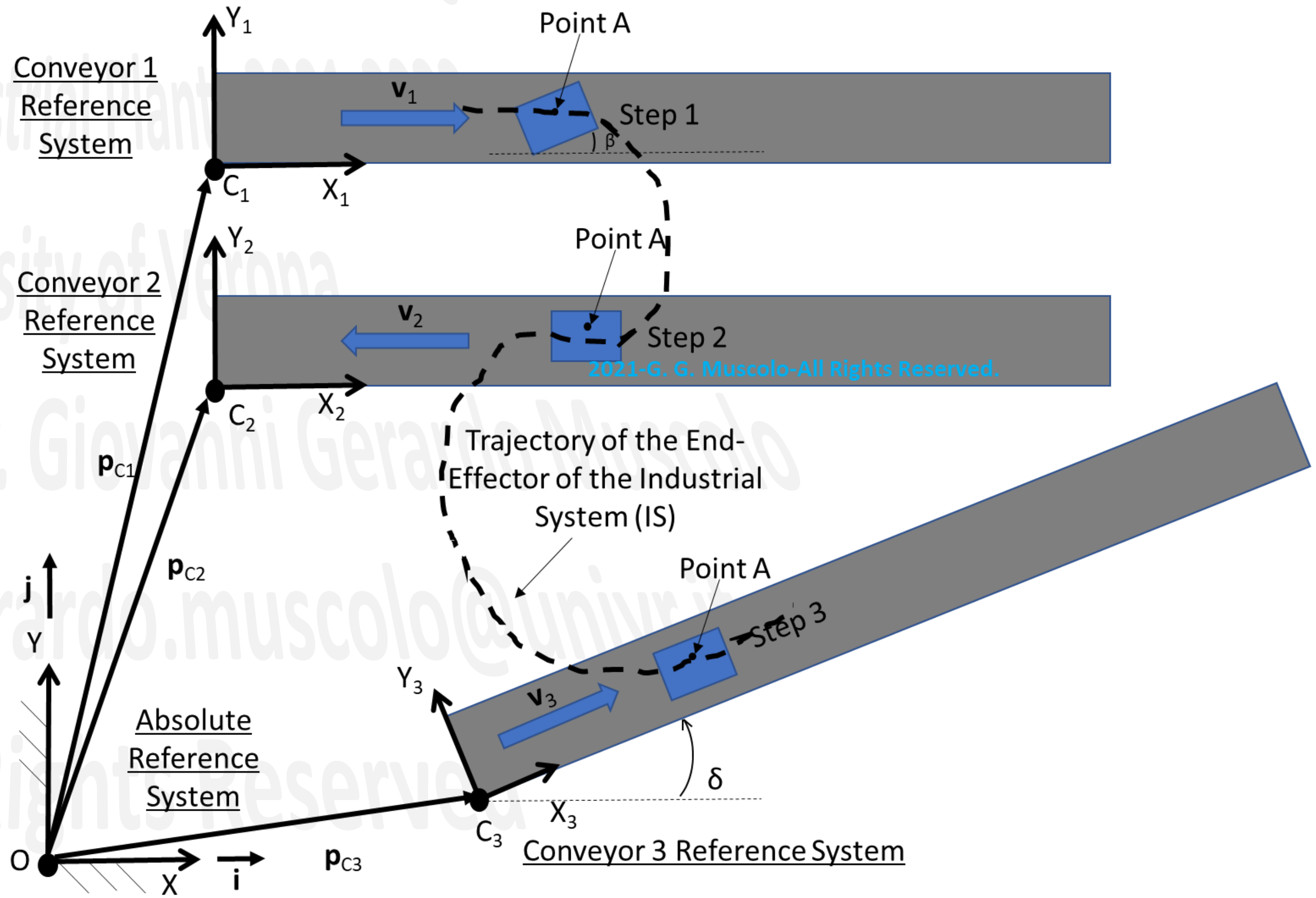
EXERCISE (kinematics):

b) Calculate the trajectory of the position, velocity and acceleration of the 5 proposed solutions.



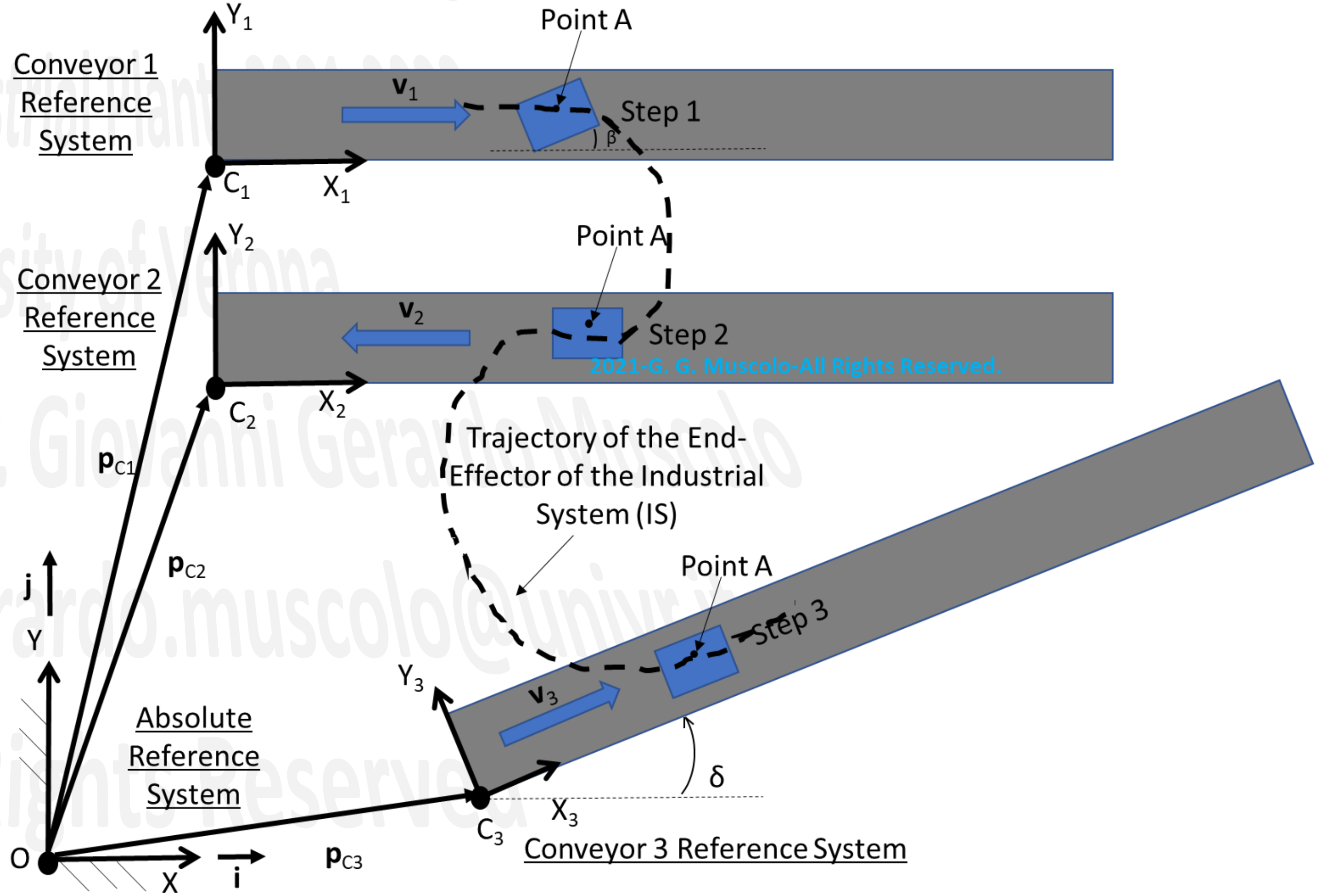
EXERCISE (kinematics):

c) Compare the 5 proposed solutions underlining advantages and disadvantages.



EXERCISE (kinematics):

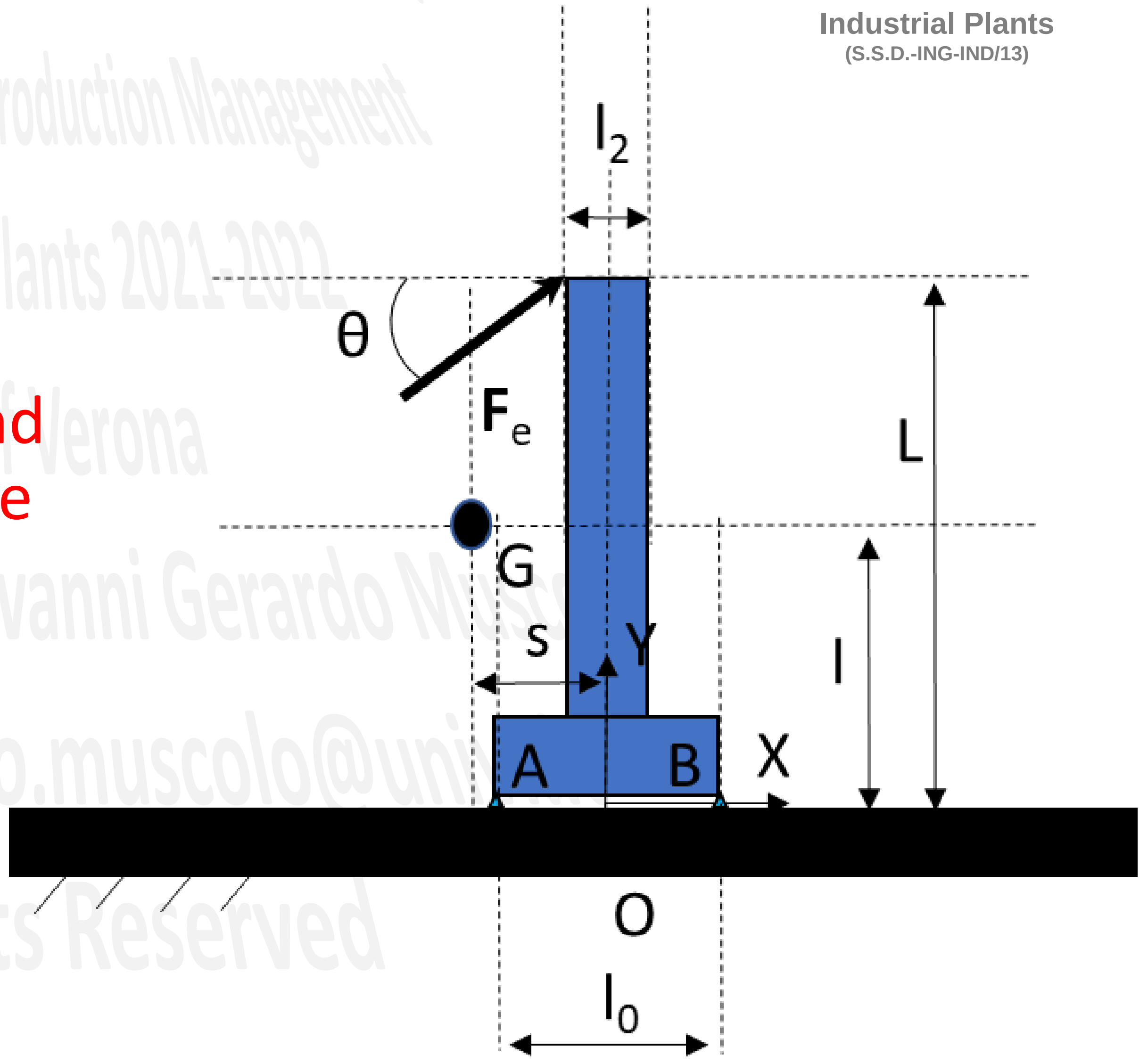
d) What is the final solution you will use?



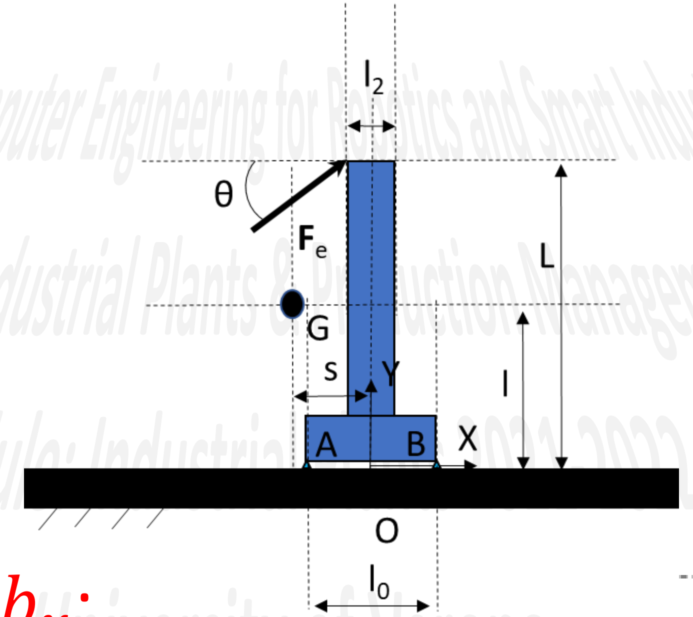
EXERCISE (dynamics):

A body with a base is on the frame and its total CoM is on G. An external force (F_e) interacts with it.

The reaction forces must be included



EXERCISE (dynamics):

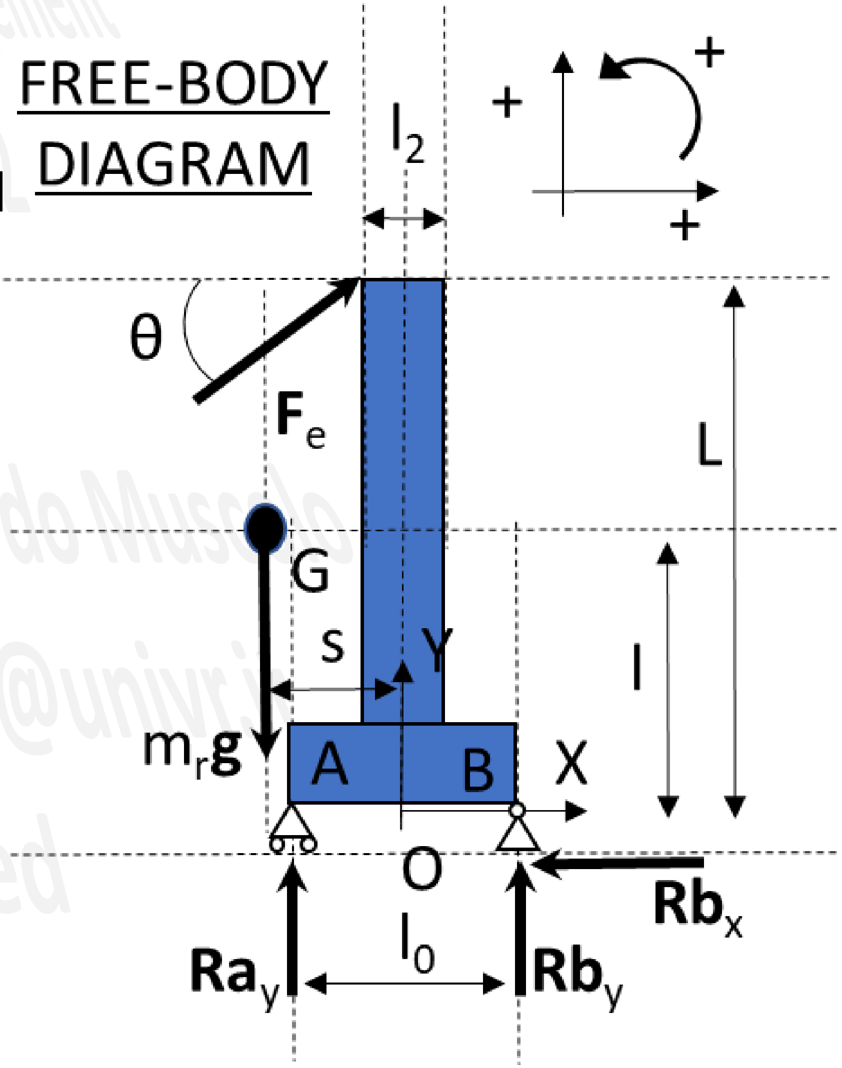


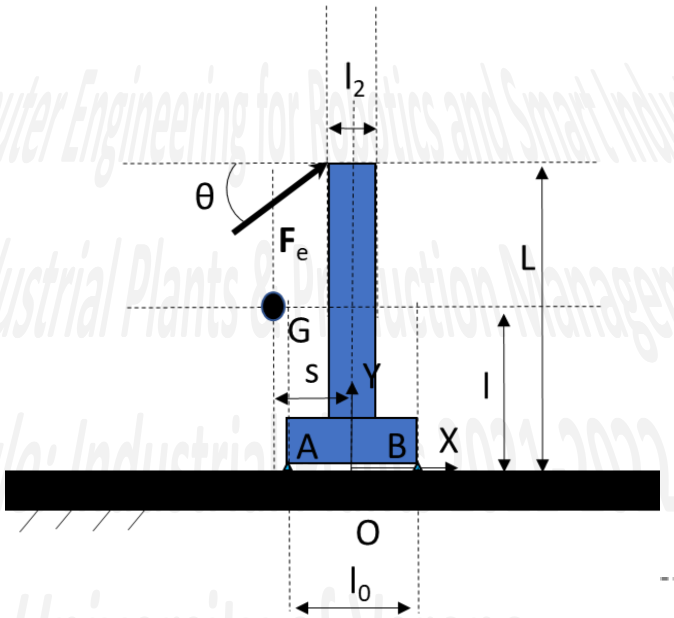
$$\sum F_X = 0 = F_e \cos(\theta) - Rb_x;$$

$$\sum F_Y = 0 = Ra_y + Rb_y - m_r g + F_e \sin(\theta);$$

$$\sum M_B = 0 = -Ra_y l_0 + \left(s + \frac{l_0}{2}\right) m_r g - F_e \cos(\theta)\,\mathrm{L} - F_e \sin(\theta)\left(\frac{l_0}{2} + \frac{l_2}{2}\right);$$

FREE-BODY DIAGRAM





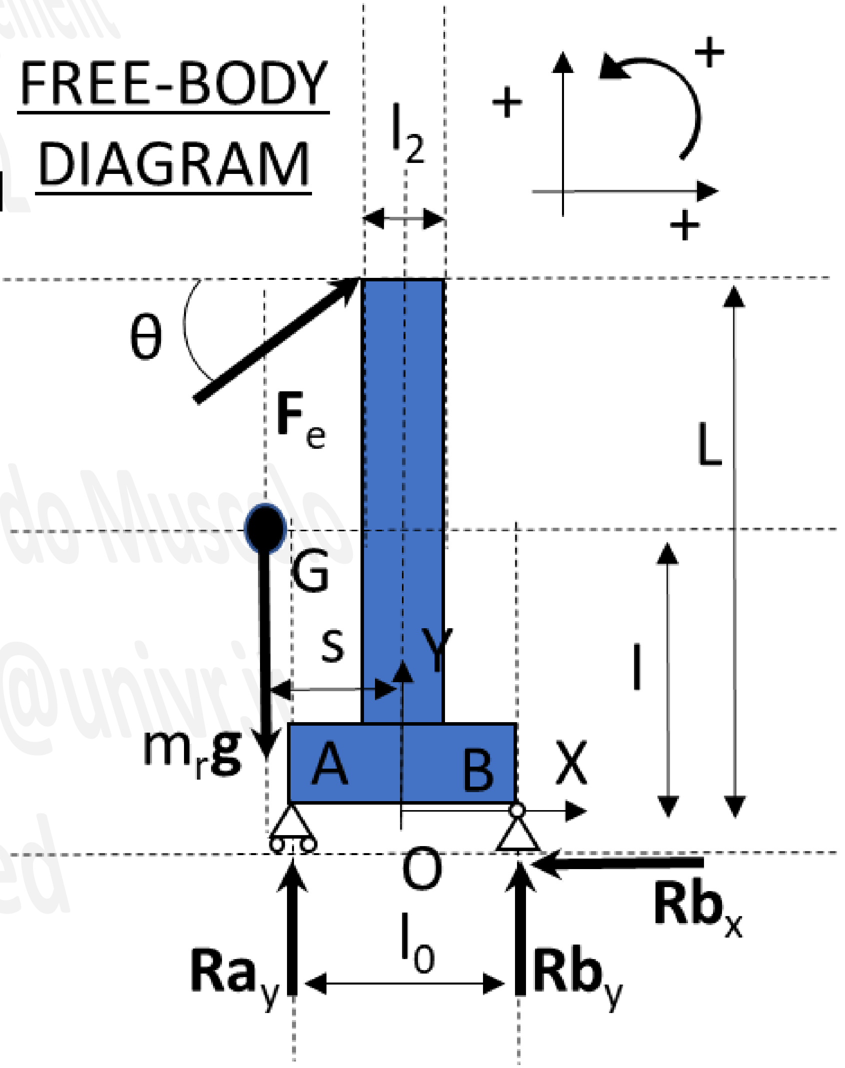
EXERCISE (dynamics):

$$Rb_x = F_e \cos(\theta);$$

$$Rb_y = -Ra_y + m_r g - F_e \sin(\theta);$$

$$Ra_y = \frac{1}{l_0}\left[\left(s + \frac{l_0}{2}\right) m_r g - F_e \cos(\theta)\,\mathrm{L} - F_e \sin(\theta)\left(\frac{l_0}{2} + \frac{l_2}{2}\right)\right];$$

FREE-BODY DIAGRAM



EXERCISE (dynamics):

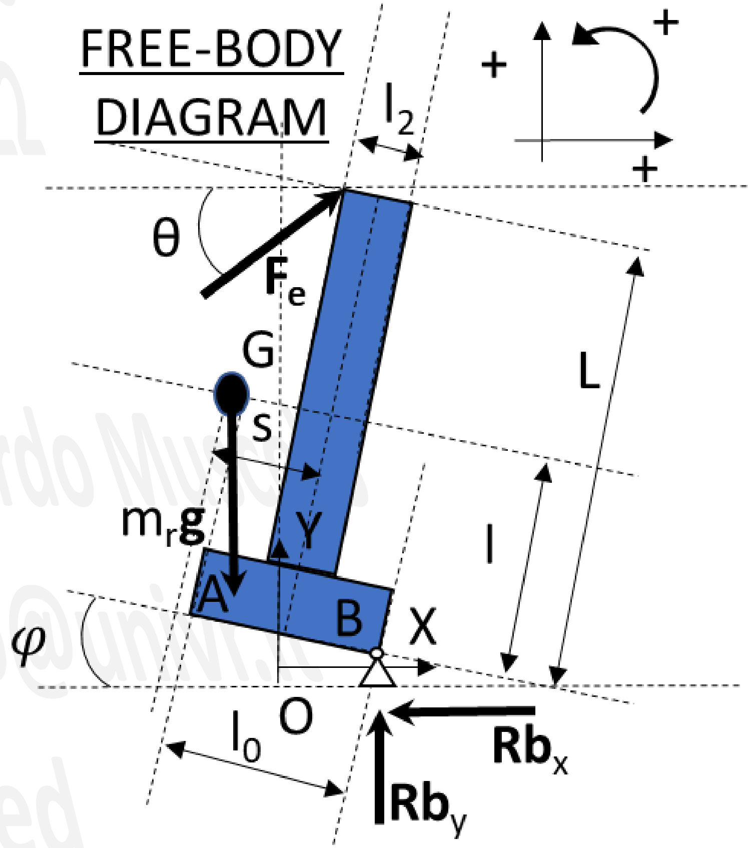
CASE 1

$$\sum F_X = 0 = F_e \cos(\theta) - Rb_x;$$

$$\sum F_Y = 0 = Rb_y - m_r g + F_e \sin(\theta);$$

$$\sum M_B = 0 = \left(s + \frac{l_0}{2}\right) m_r g cos(\varphi) - l m_r g sin(\varphi) - F_e \cos(\theta + \varphi)\,\mathrm{L} - F_e \sin(\theta + \varphi)\left(\frac{l_0}{2} + \frac{l_2}{2}\right);$$

CASE 1



EXERCISE (dynamics):

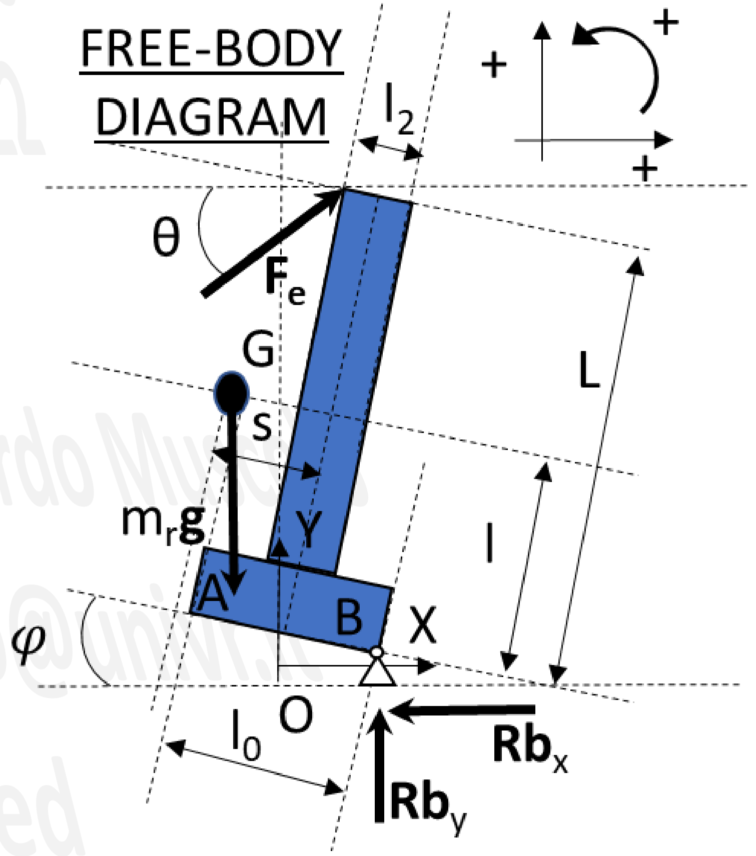
CASE 1

CASE 1

$$Rb_x = F_e\cos(\theta);$$

$$Rb_y = m_r g - F_e\sin(\theta);$$

$$\left(s\cos(\varphi) + \frac{l_0}{2}\cos(\varphi) - l\sin(\varphi)\right) m_r g = F_e\left[\cos(\theta+\varphi)\,L + \sin(\theta+\varphi)\left(\frac{l_0}{2} + \frac{l_2}{2}\right)\right];$$



EXERCISE (dynamics):

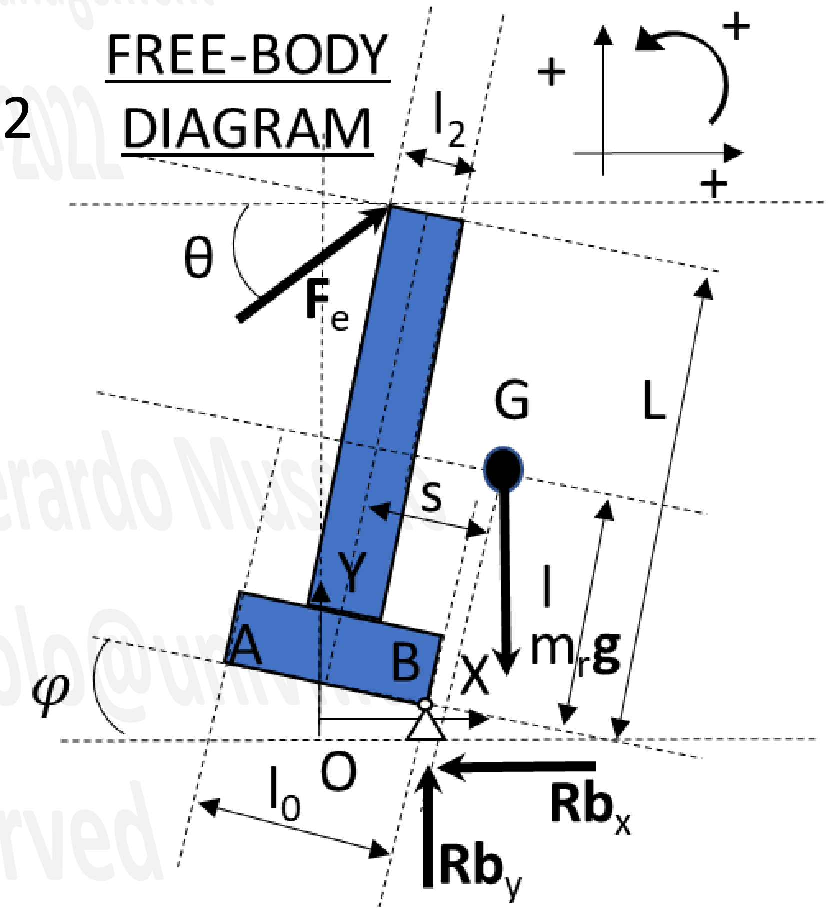
CASE 2

$$\sum F_X = 0 = F_e\cos(\theta) - Rb_x;$$

$$\sum F_Y = 0 = Rb_y - m_r g + F_e\sin(\theta);$$

$$\sum M_B = 0 = -\left(s - \frac{l_0}{2}\right) m_r g\cos(\varphi) - l m_r g\sin(\varphi) - F_e\cos(\theta+\varphi)\,L - F_e\sin(\theta+\varphi)\left(\frac{l_0}{2} + \frac{l_2}{2}\right);$$

CASE 2



EXERCISE (dynamics):

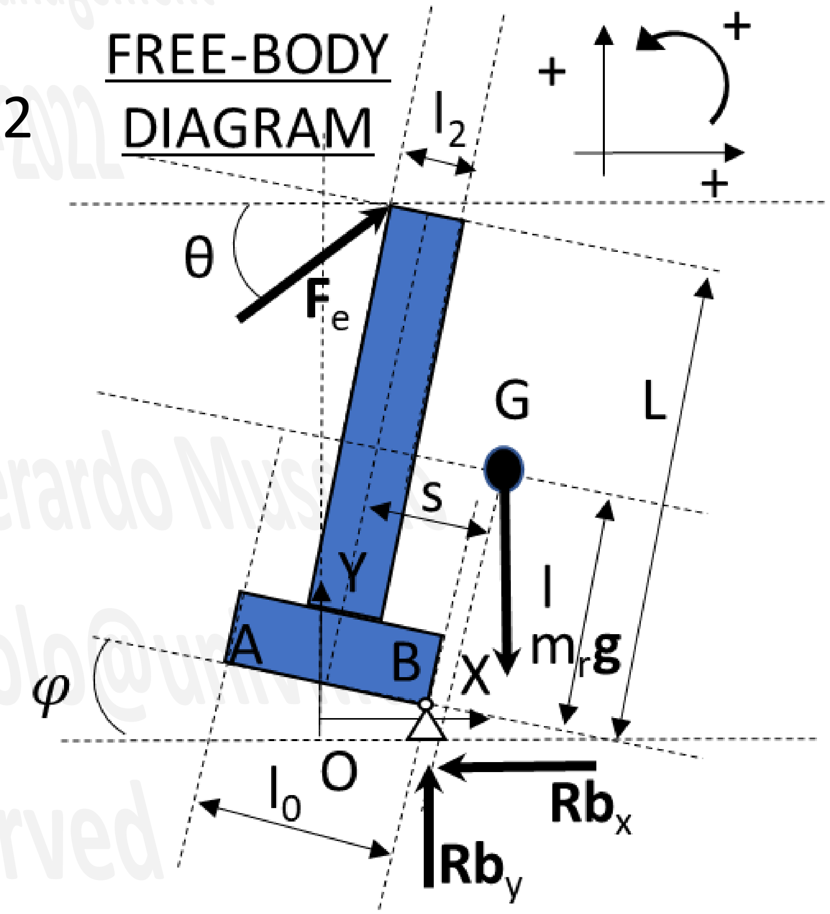
CASE 2

$$Rb_x = F_e \cos(\theta);$$

$$Rb_y = m_r g - F_e \sin(\theta);$$

$$\left[\left(-s+\frac{l_0}{2}\right)cos(\varphi) - \mathrm{l}sin(\varphi)\right] m_r g = F_e\left[\cos(\theta+\varphi)\,\mathrm{L} + \sin(\theta+\varphi)\left(\frac{l_0}{2}+\frac{l_2}{2}\right)\right];$$

CASE 2



EXERCISE (dynamics):

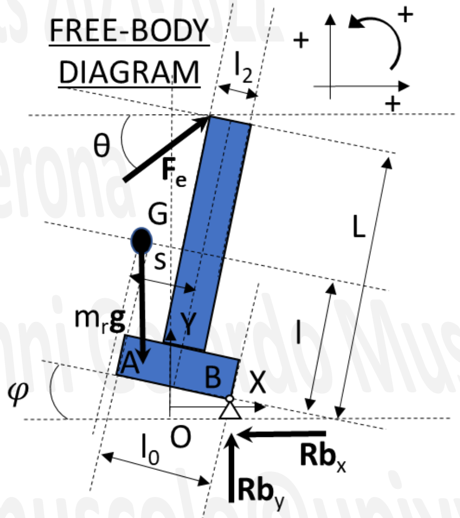
CASE 1

$$\left[\left(s+\frac{l_0}{2}\right)cos(\varphi) - \mathrm{l}sin(\varphi)\right]m_r g =$$
$$F_e\left[\cos(\theta+\varphi)\,\mathrm{L} + \sin(\theta+\varphi)\left(\frac{l_0}{2}+\frac{l_2}{2}\right)\right];$$

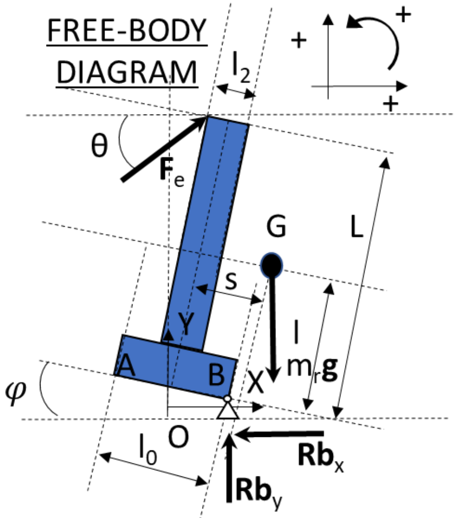
CASE 2

$$\left[\left(-s+\frac{l_0}{2}\right)cos(\varphi) - \mathrm{l}sin(\varphi)\right]m_r g =$$
$$F_e\left[\cos(\theta+\varphi)\,\mathrm{L} + \sin(\theta+\varphi)\left(\frac{l_0}{2}+\frac{l_2}{2}\right)\right];$$

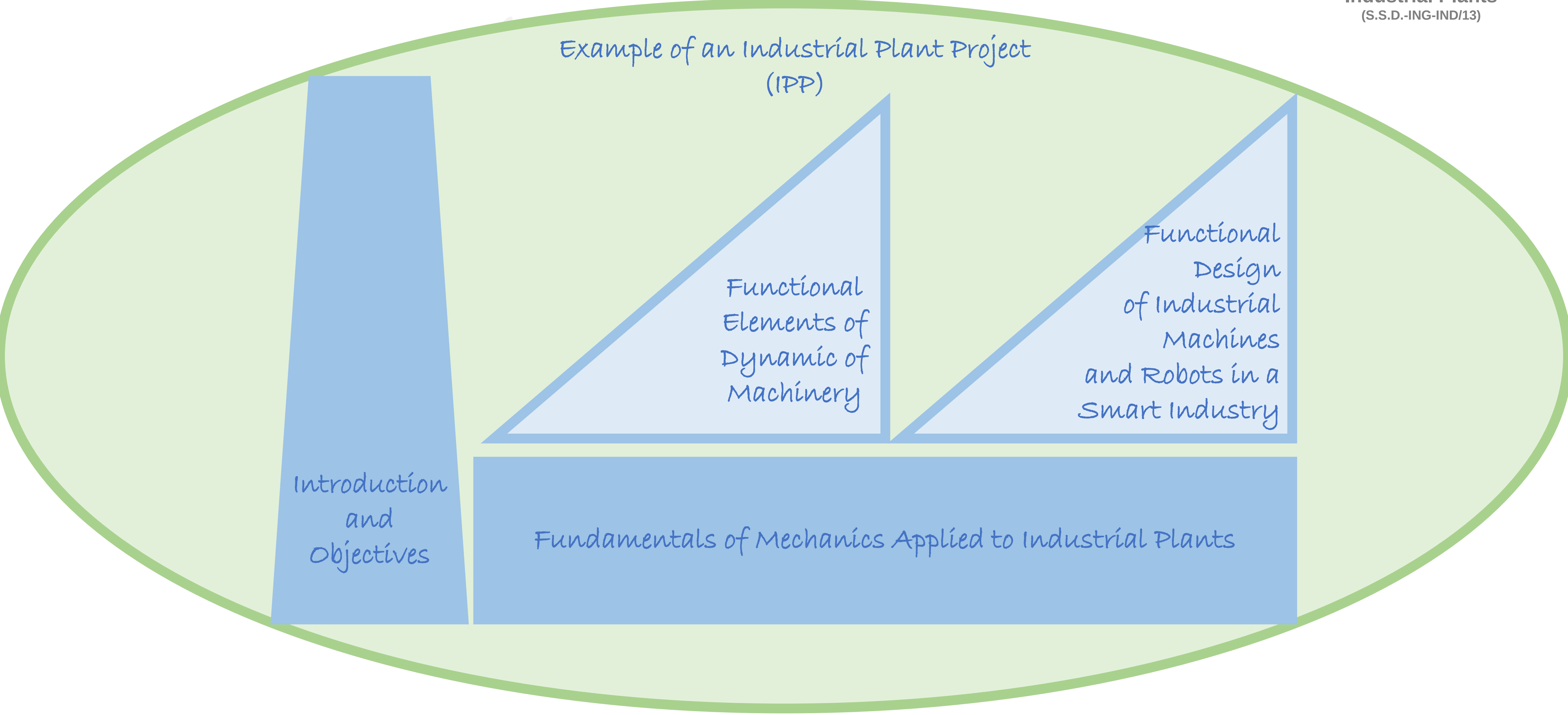
CASE 1



CASE 2



Scheme of Industrial Plants



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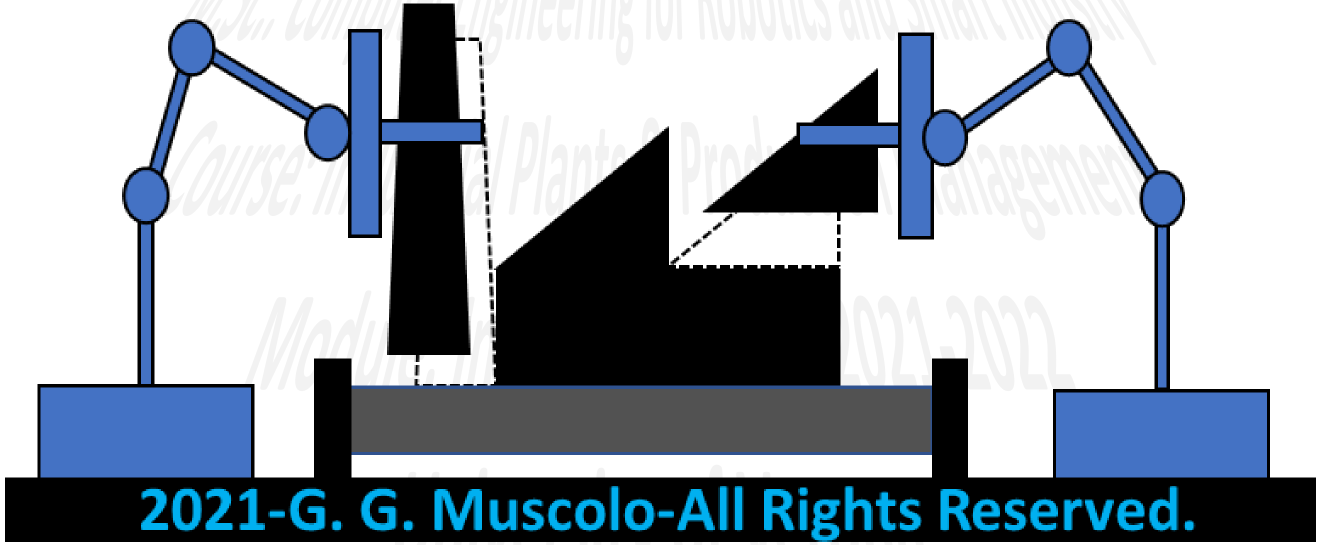

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