Chapter 11

Introduction

The general function of any machine is to **transmit motion and forces** to the components that perform the desired task

During the design of a machine, determining the driving forces is critical. In many cases, the **torque** required to operate the system is the main attribute in the actuator selection process.

11.1 Graphical Method

Inertia Force

$$F_O = -mA$$

Note: the inertia force acts in the **opposite** direction to the acceleration

and it's based on the acceleration of the centre of gravity of the link

Inertia Torque

$$I_O = -I\alpha$$

Note: the inertia torque is in the opposite direction to the angular acceleration

and it's based on the angular acceleration of the link

Force & Moment Balance

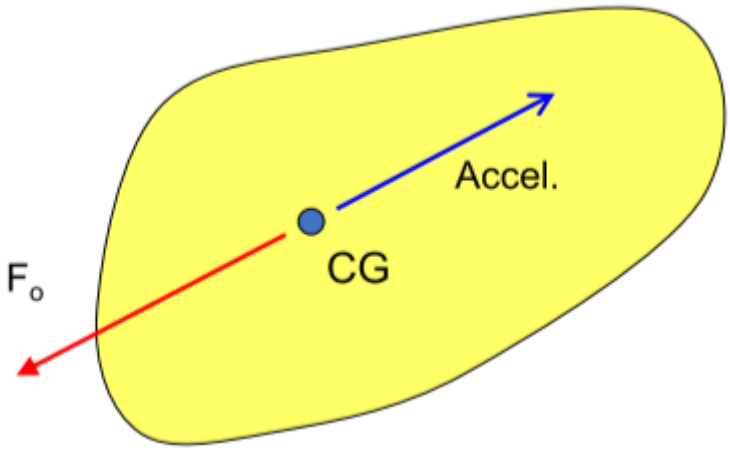
Statics

1. $\sum \text{Forces} = 0$
2. $\sum \text{Moments} = 0$
3. 二力反向等大

4. 三力汇交一点
5. 力偶作用与施加位置无关

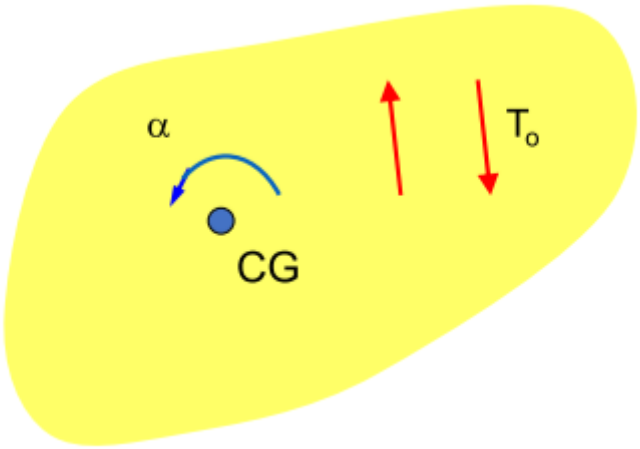
Dynamic

- Case 1: Pure Translation



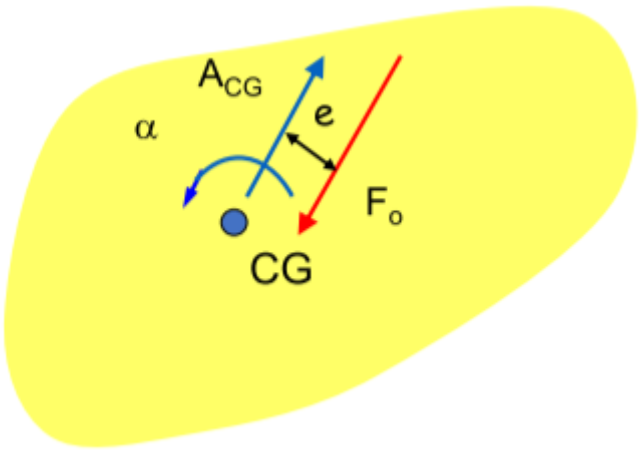
$$F_O = -mA_{CG}$$

- Case 2: Pure Rotation about C.G.



$$T_O = -I\alpha$$

- Case 3: Curvilinear Plane Motion



$$F_O = -mA_{CG}$$

$$T_O = -I\alpha$$

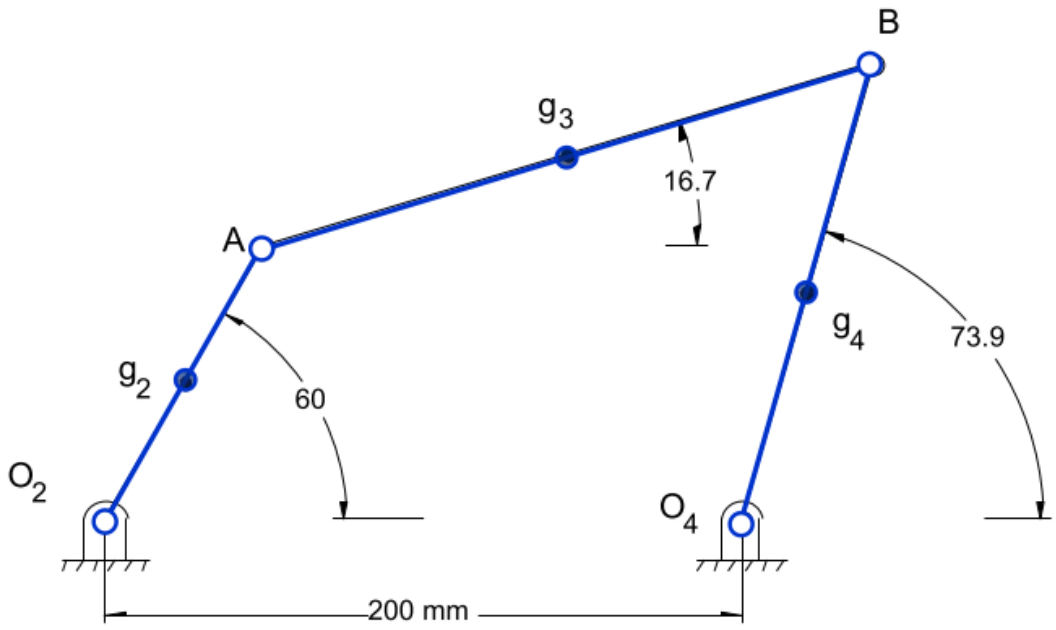
$$e = \frac{I\alpha}{F_O}$$

Superposition Method

Steps in the Analysis

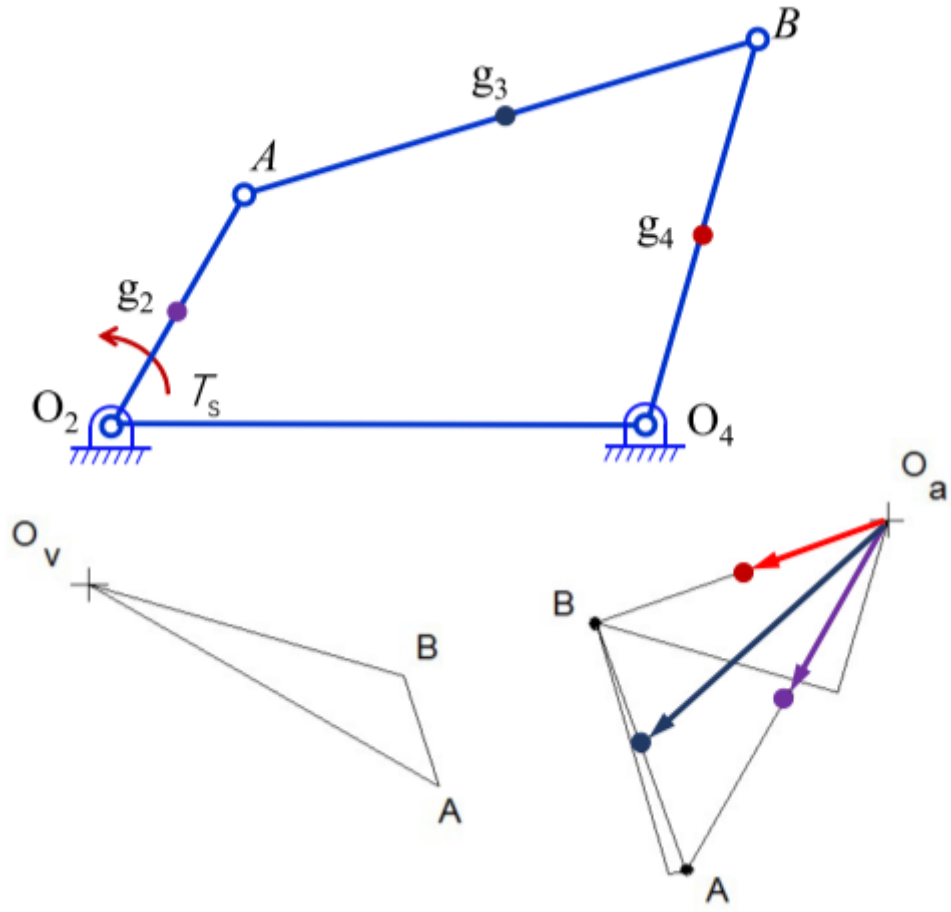
1. 算出个各杆件加速度及质心加速度
2. 利用质心加速度算出内力大小
3. 取出一杆，画受力图
4. 利用内力大小和三力汇交一点原则解出未知力
5. 记录剩余力对其余杆件的影响
6. 杆件上的力矩即由上述力产生
7. 取其他杆重复 3-6 的操作，直至所有杆件分析完毕

Example

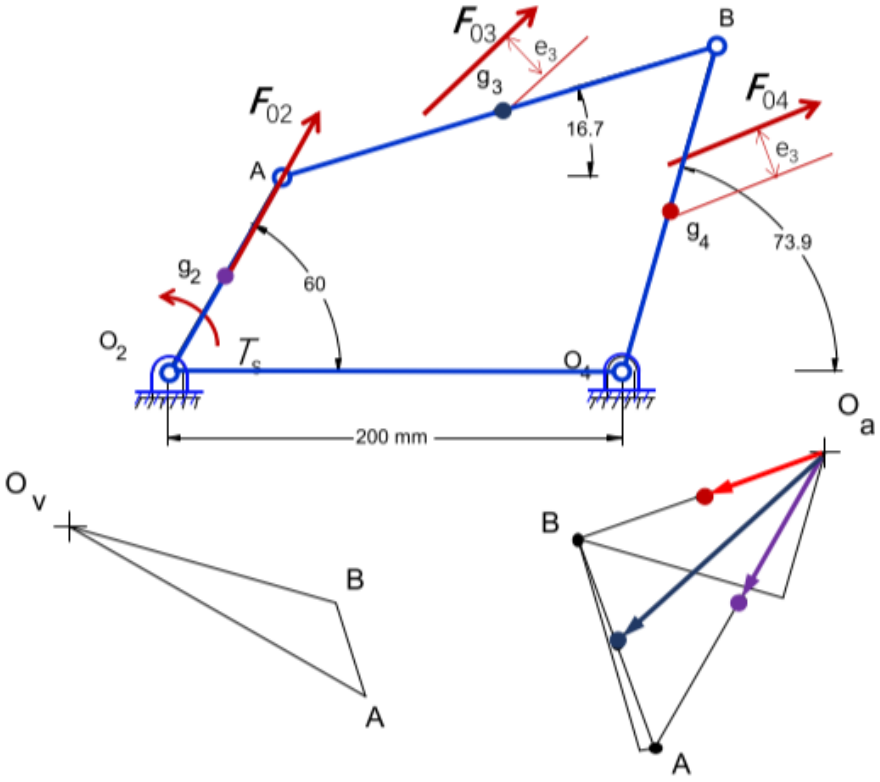


link	length	mass	I
2	100	0.5	0.0005
3	200	1.0	0.004
4	150	0.75	0.002

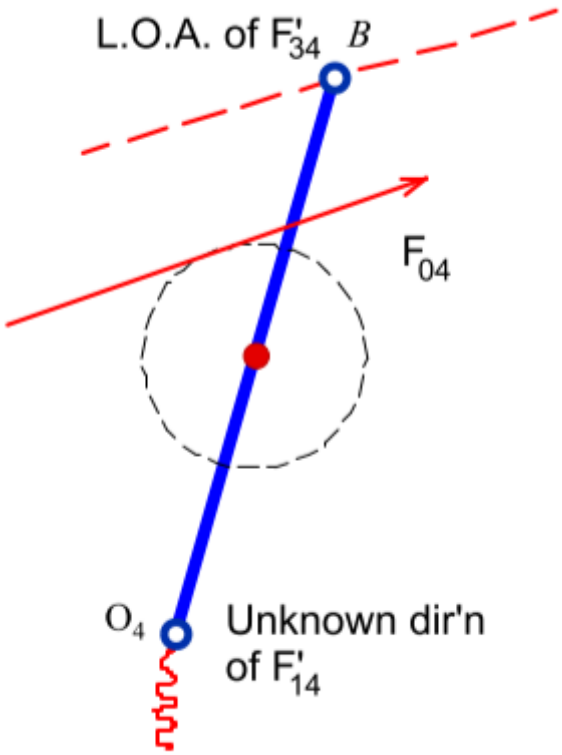
1. 利用作图法求出各点的加速度, 各连线的中点的加速度即为质心的加速度



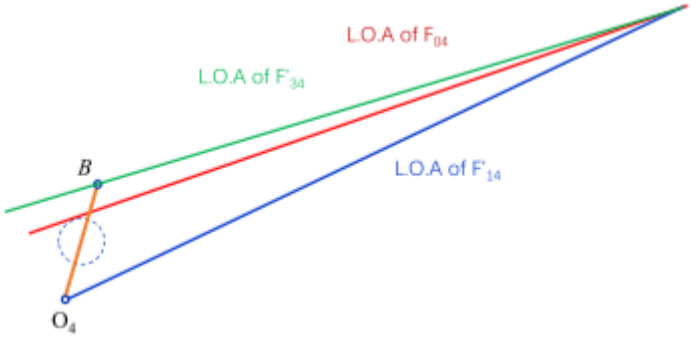
2. 利用上图求出杆件上的内力以及偏移距离



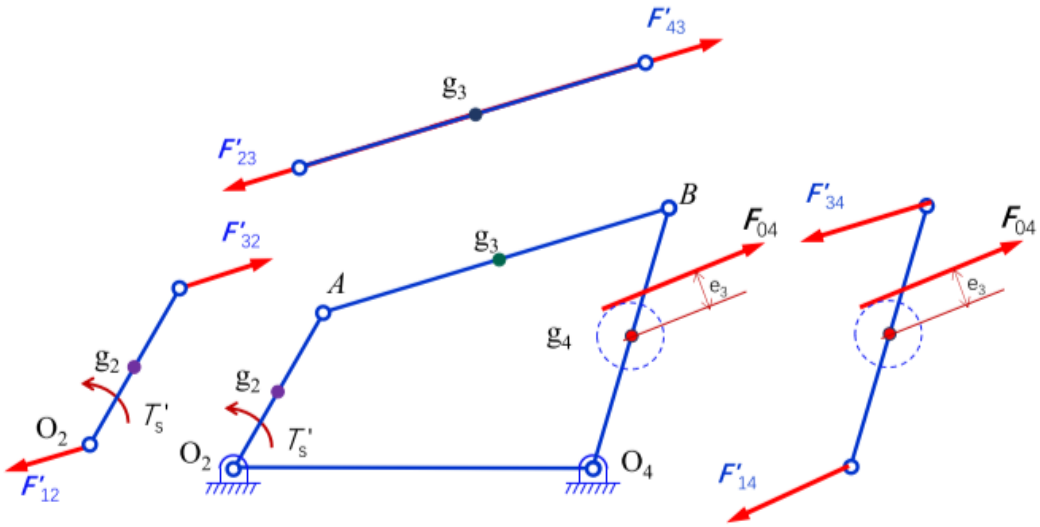
3. 选取杆4做分析，画出受力图



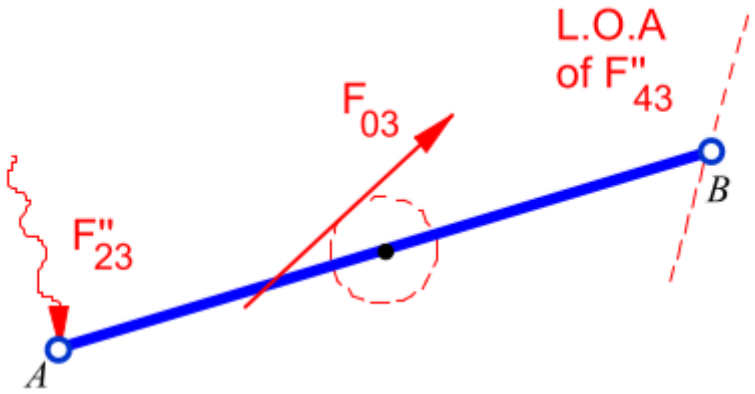
4. 可以发现只有F'_{14}未知方向和大小，利用三力汇交原则， 确定了各个力的大小和方向



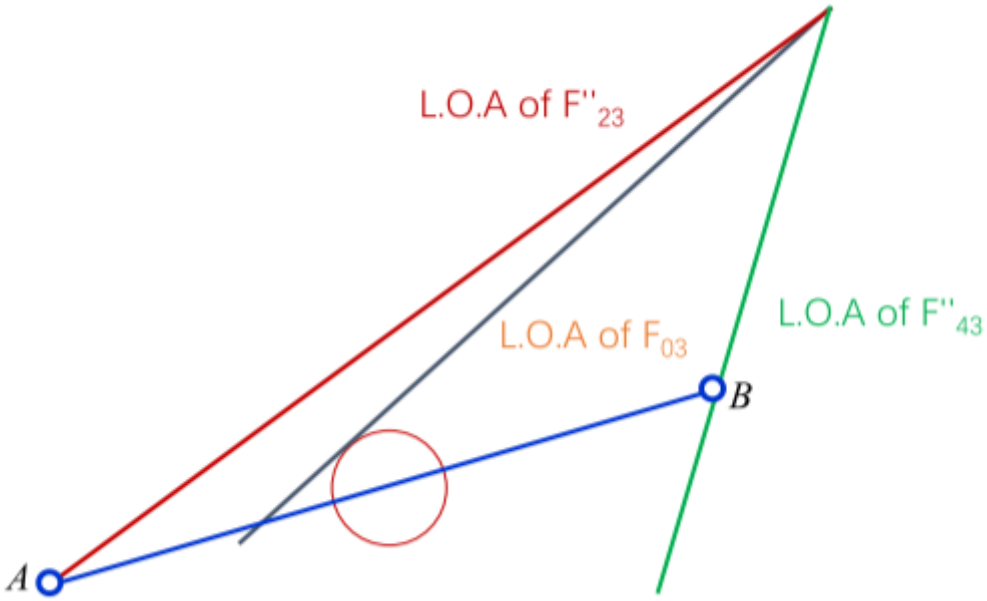
5. 将剩余力施加到杆2、3上



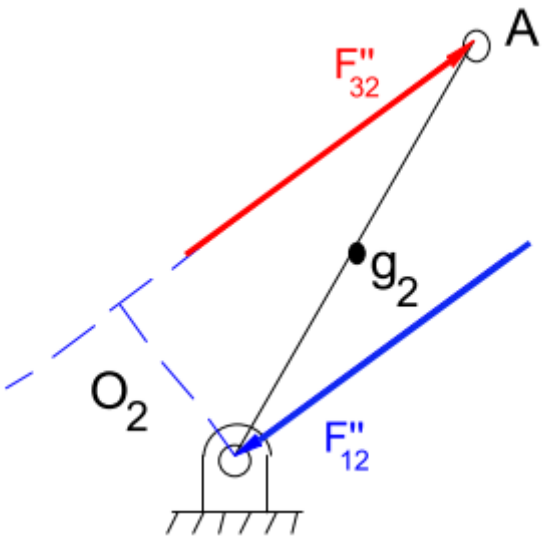
6. 取杆件3做分析，画出受力图



7. 发现只有F_{23}''未知大小和方向，利用三力汇交原则，确定各个力的大小和方向

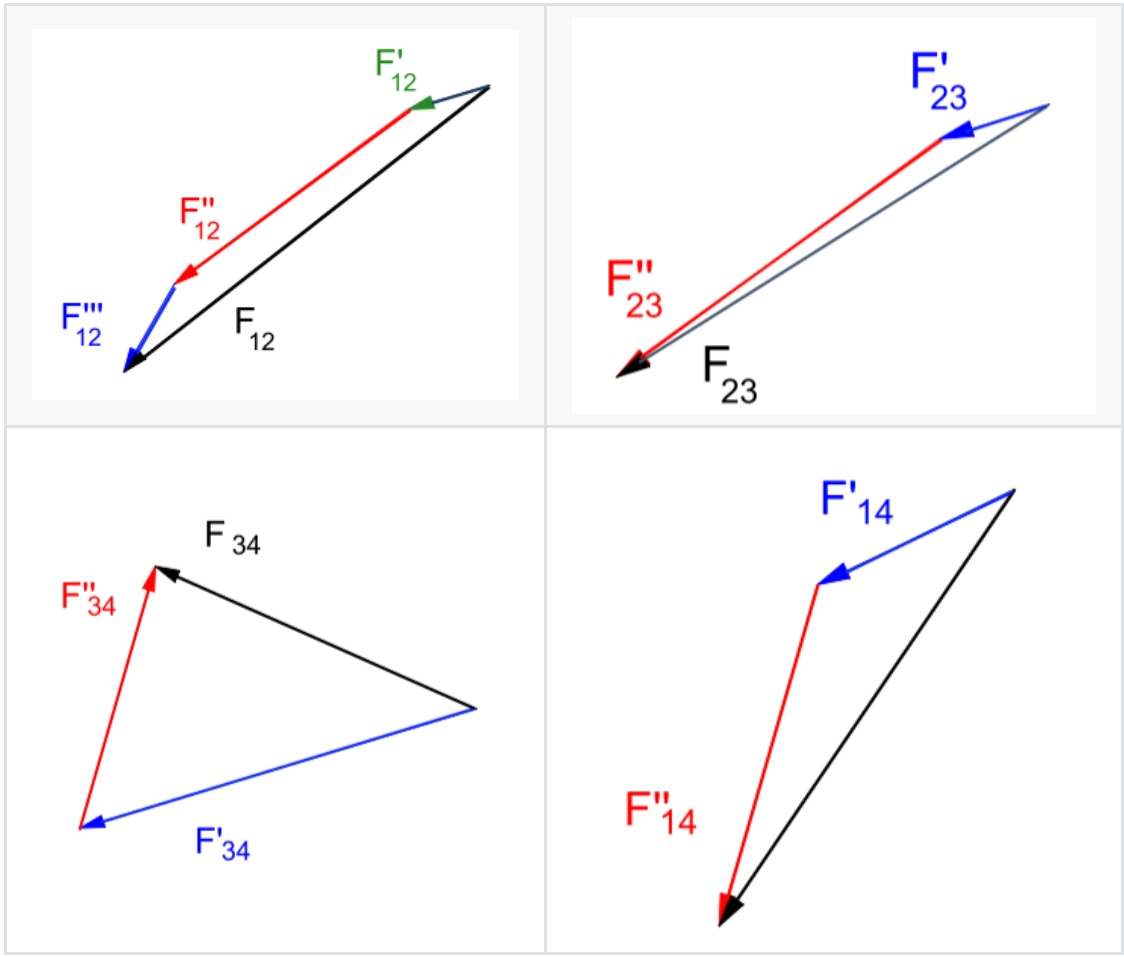


8. 将剩余力施加到杆2上



9. 取杆2分析，发现其只受到内力作用，取其内力的反向等大的力为F_{12}''

10. 将各点上的剩余力叠加，得到各点受力大小和方向



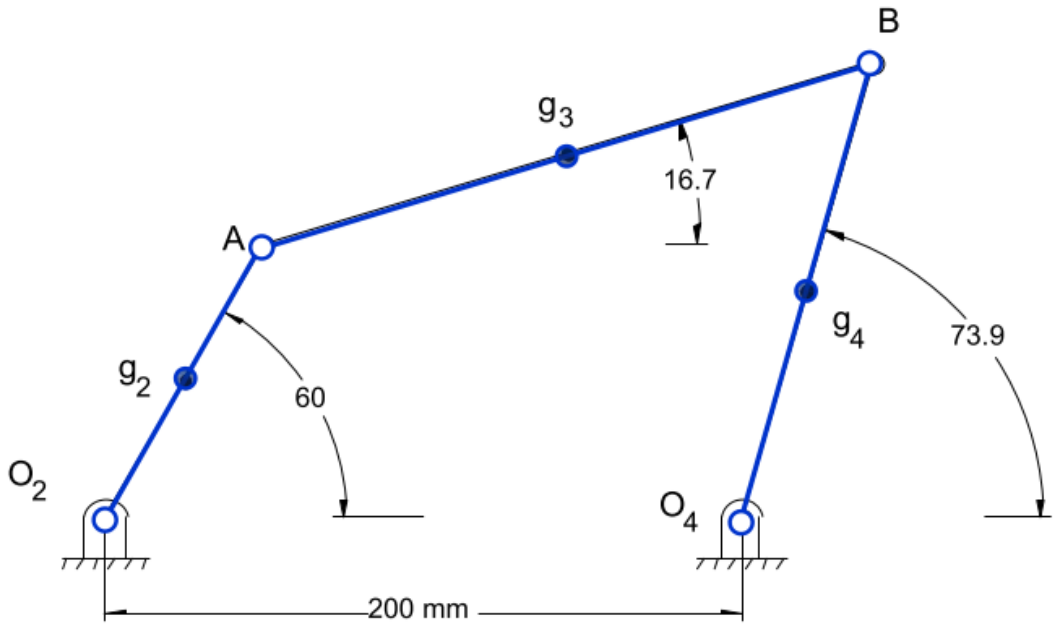
11.2 Analytical Method of Superposition

Notes

it's not necessary to offset the inertia force in this method

instead the sum forces and moments equal to 0 equations are developed and solved simultaneously for the unknowns, considering links on at a time again

Example



link	length	mass	I
2	100	0.5	0.0005
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4	150	0.75	0.002

1. 利用上表和图中条件给出各杆件的运动速度和加速度，并且算出内力和扭矩
2. 选取杆4作为研究对象，利用合转矩为0计算出F'_{34}的大小，利用合力为零计算得出F'_{14}
3. 计算剩余力对2、3杆件的影响
4. 选取杆3作为研究对象，同样利用合转矩为0计算出F''_{34}的大小，再利用合力为0计算得出F''_{23}
5. 计算其对杆件2的影响
6. 取杆件2，利用合力为0计算得出F'''_{12}的大小
7. 各杆件上的力相加得出结果

11.3 Matrix Method

nah, whatever

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