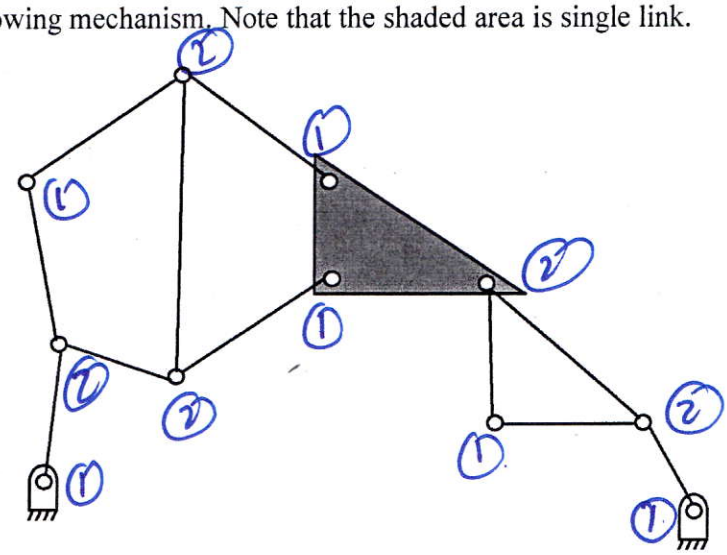
Typical Solution

Theory of Machines	First quiz	Eng. Laith R. Batarseh

Student Name: **Student ID number:**

Problem #1: find the mobility for the following mechanism. Note that the shaded area is single link.



$N = 13$

$P_1 = 16$

$P_2 = 0$

$M = 3(N-1) - 2P_1 - P_2$

$M = 3(13-1) - (2)(16)$

$= 36 - 32 = 4$

Typical Solutions.

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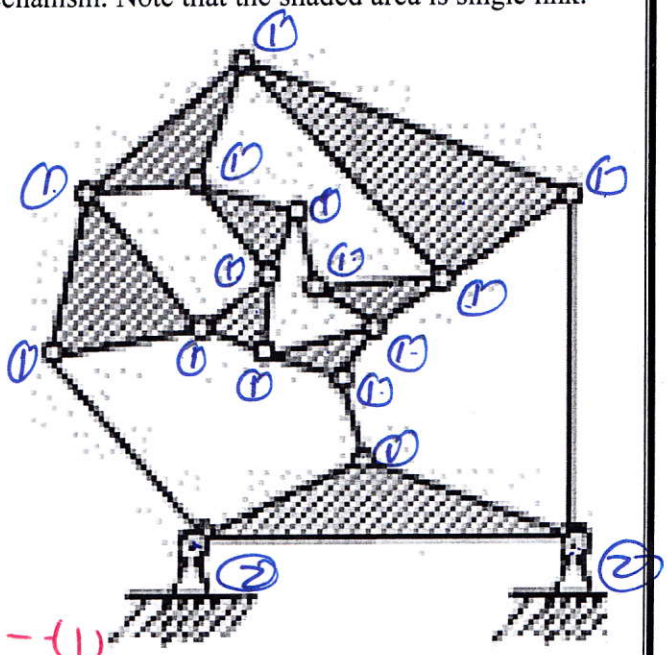

$N = 13$ --(2)

$P_1 = 18$ --(2)

$P_2 = 0$

$M = 3(N-1) - 2(P_1) - P_2$

$M = 3(13-1) - 2(18)$

$= 36 - 36 = 0$ --(1)

Typical

Theory of Machines	First quiz	Eng. Laith R. Batarseh

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Problem #1: find the mobility for the following mechanism. Note that the shaded area is single link.

$N = 12$

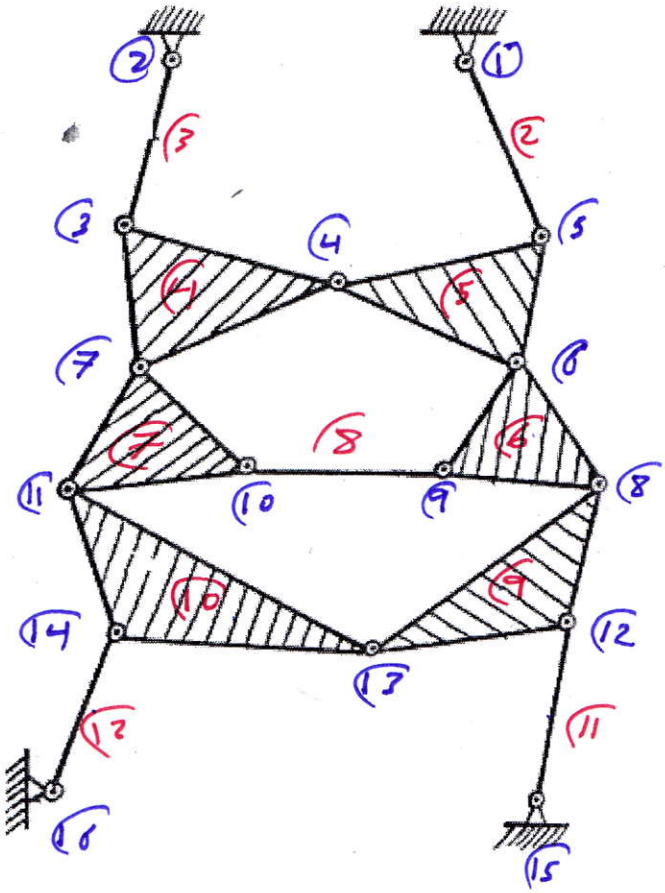
$P_1 = 16$

$P_2 = 0$

$M = 3(N-1) - 2P_1 - P_2$

$= 3(12-1) - 2(16)$

$= 33 - 32 = 1$



Theory of machines	Second quiz	Eng. Laith R. Batarseh

Student Name: **Student ID number:**

Problem: derive the follwing position vector equation to find the velocity ω_3 and $\dot{S}$ if all the angles are known, ω_2 is input and link d_1 is fixed :

$$d_1 U_{\theta 1} + d_3 U_{\theta 3} = S U_0 + d_2 U_2$$

Derive with respect to time:-

$$0 + d_3 \omega_3 i U_{\theta_3} = \dot{S} U_0 + d_2 \omega_2 i U_{\theta_2}$$

To Find ω_3, dot with iU_0 :-

$$d_3 \omega_3 \cos(\theta_3 - 0) = d_2 \omega_2 \cos(\theta_2 - 0)$$

$$\Rightarrow \omega_3 = \omega_2 \frac{d_2 \cos(\theta_2)}{d_3 \cos(\theta_3)}$$

To Find $\dot{S}$, dot with iU_{θ_3}:-

$$0 + 0 = \dot{S} \cos(\theta_3 - 0) + d_2 \omega_2 \sin(\theta_3 - \theta_2)$$

$$\Rightarrow \dot{S} = - \frac{d_2 \omega_2 \sin(\theta_3 - \theta_2)}{\cos(\theta_3)}$$

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Problem: derive the follwing position vector equation to find the velocity ω_3 and $\dot{S}$ if all the angles are known, ω_2 is input and link d_1 is fixed :

$$d_1 U_{\theta 1} + d_2 U_2 = d_3 U_{\theta 3} + S U_{90}$$

Drive with respect to time:

$$0 + d_2 \omega_2 \dot{U}_{\theta 2} = d_3 \omega_3 \dot{U}_{\theta 3} + \dot{S} U_{90}$$

To Find ω_3, Dot with $\dot{U}_{90}$

$$\Rightarrow d_2 \omega_2 \cos(\theta_2 - 90) = d_3 \omega_3 \cos(\theta_3 - 90)$$

$$\Rightarrow \omega_3 = \omega_2 \frac{d_2 \cos(\theta_2 - 90)}{d_3 \cos(\theta_3 - 90)} = \omega_2 \frac{d_2 \cos(90 - \theta_2)}{d_3 \cos(90 - \theta_3)}$$

To Find $\dot{S}$, dot with $U_{\theta 3}$

$$\Rightarrow d_2 \omega_2 \sin(\theta_3 - \theta_2) = 0 + \dot{S} \cos(\theta_3 - 90)$$

$$\Rightarrow \dot{S} = \omega_2 \frac{d_2 \sin(\theta_3 - \theta_2)}{\cos(\theta_3 - 90)}$$

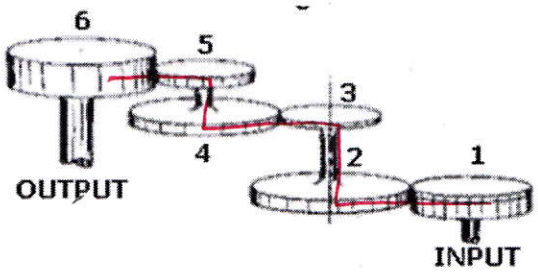
$$\cos(90 - \theta_3)$$

Theory of machines	Third quiz	Eng. Laith R. Batarseh

Student Name: **Student ID number:**

Problem: consider the following gear train
If gear (1) is input and has velocity equal 100 RPM. **Find the output gear velocity**.

Gear	Teeth
1	50
2	75
3	15
4	45
5	20
6	30



Solu:-

$$\frac{\omega_6}{\omega_1} = \left(-\frac{\omega_2}{\omega_1}\right)\left(\frac{\omega_3}{\omega_2}\right)\left[-\frac{\omega_4}{\omega_3}\right]\left[\frac{\omega_5}{\omega_4}\right]\left[-\frac{\omega_6}{\omega_5}\right]$$

$$\frac{\omega_6}{\omega_1} = -\frac{\omega_2\,\omega_4\,\omega_6}{\omega_1\,\omega_3\,\omega_5} = \frac{N_1\,N_3\,N_5}{N_2\,N_4\,N_6}$$

$$\Rightarrow \omega_6 = -\omega_1 \frac{N_1 N_3 N_5}{N_2 N_4 N_6} = -100\,\frac{(50)(15)(20)}{(75)(45)(30)} = -14.81\ \text{RPM}$$

on 14.81 RPM opposite to ω_1