Faculty of Engineering	**Philadelphia University**	Mechanical Eng. Dep.
Course name: Automatic control	**Second Quiz**	Course number:620333 class(1)
Instructor: Eng. Laith Batarseh	**Tuesday 17/4/2018**	Allowed time: 10 minutes

Student Name: **Student ID number:**

Problem: consider the following loop closure equation

$$d_1 U_{180} + S U_{90} = d_3 U_{\theta 3} + d_2 U_{\theta 2}$$

If $d_1 = 1.2$ m, $d_2 = 0.4$m and $d_3 = 1.0$ m, find $\dot{S}$ at θ_2=30 degree and ω_2=150 RPM. $\theta_3 = 60^\circ$

Solution:

Velocity Eq:-

$$0 + d_2 w_2 U_{\theta 2} + \dot{S} U_{90} = d_3 w_3 U_{\theta 3} \quad \text{---} \quad (1)$$

Dot Eq (1) by $U_{\theta 3}$:-

$$d_2 w_2 \sin(\theta_3 - \theta_2) + \dot{S} \cos(\theta_3 - 90) = 0$$

$$\dot{S} = - \frac{d_2 w_2 \sin(\theta_3 - \theta_2)}{\cos(\theta_3 - 90)} \; ; \; w_2 \text{ in (rad/s)}$$

$$= - \frac{(0.4)\left(\frac{2\pi}{60}\right)(150)\sin(60-30)}{\cos(60-90)} = 3.63 \; \frac{m}{s}$$

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Student Name: Typical. **Student ID number:**

Problem: consider the following loop closure equation

$$d_1 U_{180} + d_2 U_{\theta 2} + S U_{90} = d_3 U_{\theta 3}$$

If $d_1 = 1.5$m, $d_2 = 0.2$m and $d_3 = 0.8$m, find ω_3 at θ_2=60 degree and ω_2=600 RPM. $\theta_3 = 30^\circ$

Solution

Velocity Equation :-

$$0 + d_2 w_2 i_{\theta_2} + \dot{s} i_{90} = d_3 w_3 i_{\theta_3} \quad ---(1)$$

To Find w_3, dot Eq (1) by i_{90} :-

$$\pm d_2 w_2 \cos(\theta_2 - 90) + 0 = d_3 w_3 \cos(\theta_3 - 90)$$

$$\Rightarrow w_3 = \frac{d_2 w_2 \cos(\theta_2 - 90)}{d_3 \cos(\theta_3 - 90)} \; ; \; w_2 = \frac{2\pi}{60} 600 = 62.83 \frac{rad}{s}$$

$$= \frac{(0.2)(62.83)\cos(60 - 90)}{(0.8)\cos(30 - 90)} = 27.2 \frac{rad}{s}$$

OR 260 RPM

Faculty of Engineering | **Philadelphia University** | Mechanical Eng. Dep.

Theory of machines | **section #2** | **Allowed time: 10 min**

Eng. Laith R. Batarseh | **second quiz** | **Wednesday 18/4/2018**

Student Name: Typical Solution. **Student ID number:**

Consider the following loop closer equation for a four bar mechanism:

$$d_2U_{\theta 2} + d_3U_{\theta 3} - d_1U_{\theta 1} = d_4U_{\theta 4}.$$

Assume link (1) $d_1U_{\theta 1}$ is ground. Find ω_3 and ω_4 if

$\theta_1 = 0$	$\theta_2 = 60$ degree	$\theta_3 = 30$ degree	$\theta_4 = 90$ degree	$\omega_2 = 600$ RPM

$d_1 = 1m \quad d_2 = 0.2m \quad d_3 = 0.8m \quad d_4 = 0.3m$

Solution :-

Derive with Repect to time

$$d_2\omega_2 i U_{\theta 2} + d_3\omega_3 i U_{\theta 3} = d_4\omega_4 i U_{\theta 4} \quad \text{---(1)}$$

To Find (ω_3) Dot Eq(1) by $U_{\theta 4}$:

$$d_2\omega_2 \sin(\theta_4 - \theta_2) + d_3\omega_3 \sin(\theta_4 - \theta_3) = 0$$

$$\Rightarrow \omega_3 = -\frac{d_2\omega_2 \sin(\theta_4 - \theta_2)}{d_3 \sin(\theta_4 - \theta_3)} = -\frac{(0.2)(600)\sin(90-60)}{0.8\sin(90-30)} = \boxed{86.6 \text{ RPM}}$$ Ans

To Find (ω_4), Dot Eq(1) by $U_{\theta 3}$:

$$d_2\omega_2 \sin(\theta_3 - \theta_2) + 0 = d_4\omega_4 \sin(\theta_3 - \theta_4)$$

$$\omega_4 = \frac{d_2\omega_2 \sin(\theta_3 - \theta_2)}{d_4 \sin(\theta_3 - \theta_4)} = \frac{(0.2)(600)\sin(30-60)}{(0.3)\sin(30-90)} = \boxed{230.9 \text{ RPM}}$$