1. As shown in Figure 1, Link ABD is connected by pins to a collar at B and to crank DE. Determine (a) the angular velocity of link ABD (15%) and (b) the velocity of point A (15%), if the velocity of collar B is 40.6 cm/sec upward.

2. (15%) The robot shown in Figure 2 has five degrees of rotational freedom. The **X-Y-Z** axes are attached to the base ring, which rotates about the **Z**-axis at the rate ω_1. The arm O_1O_2 rotates about the **X**-axis at the rate $\omega_2 = \dot{\theta}$. So the coordinate system x-y-z with origin at O_2 rotates about the **X**-axis at the rate $\dot{\theta}$. The control arm O_2A rotates about axis O_1-O_2 at the rate ω_3 and about a perpendicular axis through O_2 which is momentarily parallel to the **X**-axis at the rate $\omega_4 = \dot{\beta}$. Finally, the jaws rotate about axis O_2-A at the rate ω_5. The magnitudes of all angular rates are constant. For the configuration shown, determine the magnitude ω of the total angular velocity of the jaws for $\theta = 60°$ and $\beta = 45°$ if $\omega_1 = 2$ rad/s, $\dot{\theta} = 1.5$ rad/s, and $\omega_3 = \omega_4 = \omega_5 = 0$. Also express the angular acceleration α of arm O_1O_2 as a vector.

3. (15%) For the same robot in Problem 2, but this time **X-Y-Z** axes are nonrotating. If $\omega_2 = \dot{\theta}$ =3 rad/s constant, ω_3 =1.5 rad/s constant, $\omega_1 = \omega_5 = 0$, $\overline{O_1O_2} = 1.2$ m, and $\overline{O_2A} = 0.6$ m, determine the velocity of the center A of the jaws for the instant when $\theta = 60°$. The angle β lies in the y-z plane and is constant at 45°.

4. In Figure 3, gear 1 is fixed to the pulley of radius *a*, from which the mass m is suspended at the end of a vertical massless cable. J_1 is the moment of inertia, with respect to the fixed center A, of the gear and pulley. J_2 is the moment of inertia with respect to fixed center B of the mating gear 2. N_1 and N_2 are the numbers of teeth in gear 1 and 2, respectively. (a) Find the angular acceleration of gear 1 (13%), (b) Find the tension in the cable (12%).

5. (15%) Shown in Figure 4, a tennis player strikes the tennis ball with her racket while the ball is still rising. The ball speed before impact with the racket is v_1=30 m/sec and after impact its speed is v_2=44 m/sec with direction as shown in the Fig. 2. If the 60-g ball is in contact with the racket for 0.1 sec, (a) If not considering the ball weight, determine the magnitude of the average force **R** exerted by the racket on the ball. (b)Find the angle made by **R** with the horizontal. (c)If the ball weight is considered, how does it affect the result of (a)?

見背面

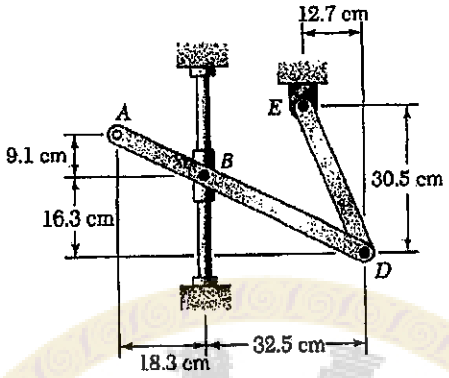

Figure 1 (for Problem 1)

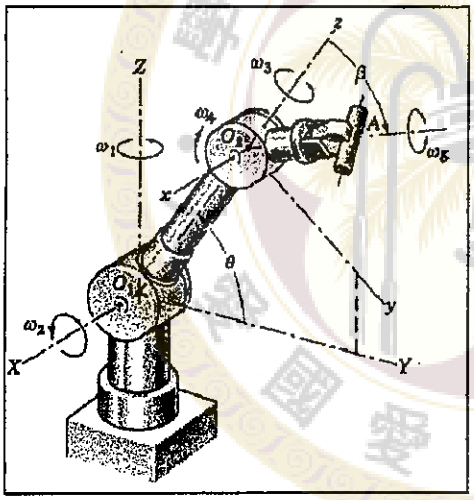

Figure 2 (for Problem 2 & 3)

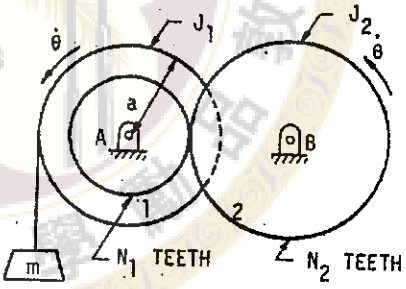

Figure 3 (for Problem 4)

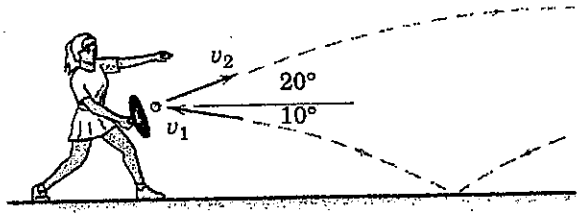

Figure 4 (for Problem 5)

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