21-R-KM-ZA-08 Solution

Question: Pulley B is rigidly connected to pulley C. A motor gives pulley E and angular velocity of $\omega_E = 6t^2\ rad/s$ in the clockwise direction, where t is in seconds. The belt slips as a velocity of $slip_E = 0.1\ m/s$ on pulley E, and $slip_B = 0.5t\ m/s$ on pulley B. Assuming no slip between either belt on pulley A, find the magnitude of velocity of point D after $t = 0.6\ seconds$ have passed.

The following dimensions are known:
$r_A = 1\ m,\ r_B = 0.5\ m,\ r_C = 1.5\ m,\ r_D = 1.3\ m,\ r_E = 0.6\ m$

Solution: The angular velocity of E can be found by plugging in the time value. The velocity of a point P on pulley E in contact with the belt can be found using $v = \omega r$. The velocity of the belt is found by subtracting the slip on pulley E from the velocity of point P.

$$\omega_E(t = 0.6s) = 6t^2 = 6(0.6^2) = 2.16\ rad/s$$
$$v_P = \omega_E r_E = 2.16(0.6) = 1.30\ m/s$$
$$v_{Belt} = v_P - slip_E = 1.3 - 0.1 = 1.2\ m/s$$

Slip on pulley B is also found by plugging in the time value. The velocity of a point Q on pulley B in contact with the belt is calculated by subtracting the slip on pulley B from the velocity of the belt. This value is then used to calculate the angular velocity of B. As pulleys B and C are rigidly connected, we know that $\omega_B = \omega_C$. Finally, using ω_B and r_D, we can calculate v_D.

$$slip_B(t = 0.6s) = 0.5 * 0.6 = 0.3\ m/s$$
$$v_Q = v_{Belt} - slip_B = 1.2 - 0.3 = 0.9\ m/s$$
$$\omega_B = \frac{v_Q}{r_B} = \frac{0.9}{0.5} = 1.8\ rad/s = \omega_C$$
$$v_D = \omega_C r_D = 1.8(1.3) = 2.34\ m/s$$