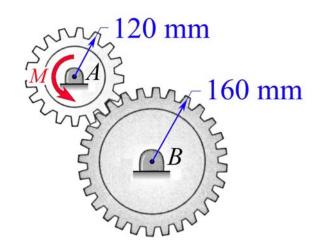The gears A and B shown have masses 6 kg and 12 kg and central radii of gyration 90 mm and 130 mm, respectively. During a time interval Δt, a constant torque $\mathbf{M} = 10$ N·m ↺ acts on gear A and the angular velocity of gear B is increased from 360 rpm ↻ to 720 rpm ↻. Determine (a) the value of Δt, (b) the magnitude F of the average tangential force of contact between these two gears.

120 mm

160 mm

$$\omega_{B1} = 360 \text{ rpm} = 12\pi \text{ rad/s}, \ \omega_{B2} = 720 \text{ rpm} = 24\pi \text{ rad/s} \quad ①$$

$$\omega_A = (r_B/r_A)\omega_B = (4/3)\omega_B, \ \omega_{A1} = 16\pi \text{ rad/s}, \ \omega_{A2} = 32\pi \text{ rad/s} \quad ①$$

Gear A: $MD_1 + ID_{1\to2} = MD_2 \quad ①$

$$6(0.09)^2(16\pi) + \left[10(\Delta t) - 0.12F(\Delta t)\right] = 6(0.09)^2(32\pi) \quad ②$$

Gear B: $MD_1 + ID_{1\to2} = MD_2 \quad ①$

$$12(0.13)^2(12\pi) + 0.16F(\Delta t) = 12(0.13)^2(24\pi) \quad ②$$

$$F(\Delta t) = 47.7836 \qquad \Delta t = 0.81769$$

$$\Delta t = 0.818 \text{ s} \quad ① \qquad F = 58.4 \text{ N} \quad ①$$