Answer on Question # 75921- Physics-Mechanics-Relativity:

Question: A rotating disc of mass [m] 25 kg and radius [r] 150 mm, shown in Figure 1, is accelerated from 500 to 3000 rpm in a time of 25 seconds.
If there is a constant friction torque of 5 Nm, determine the following:
(a) The angular acceleration.
(b) The applied torque.
(c) The work done.
(d) The maximum power developed by the driving motor.

Solution: Given , mass of rotating disc (m) = 25 kg.

Radius (r) = 150 mm = 0.15 m

Angular velocities $\omega_1 = 500 \text{ rpm} = \frac{500\times 2\pi}{60}$ radian/sec.

and $\omega_2 = 3000 \text{ rpm} = \frac{3000\times 2\pi}{60}$ radian/sec.

Time = 25 sec.

Now, angular acceleration (α) = $\frac{\omega_2-\omega_1}{\text{Time}} = \frac{2\pi}{60\times 25}(3000-500) = \frac{10\pi}{3}$ radian/sec^2.

Again we know, moment of inertia of the discs about the centre (I) = $\frac{1}{2}\text{mr}^2 = \frac{1}{2}\text{x } 25\text{x}(0.15)^2$ = 0.28125 kg-metre^2.

So, applied torque (T) = I. α = 0.28125 x $\frac{10\pi}{3}$ = 2.945 N-m

Work done (W) = T x($\omega_2 - \omega_1$) x25 = 2.945 x $\frac{2\pi}{60}(3000-500)$x25= 19.275 KJ (approx).

Power developed by the driving motor (P) = T. ω_2= 2.945 x $\frac{3000\times 2\pi}{60}$ = 925.2 Watt (approx).

Answer: a. angular acceleration = $\frac{10\pi}{3}$ radian/sec^2.

b. Applied torque = 2.945 N-m.

c. Work done = 19.275 KJ (approx.)

d. Maximum power developed by the driving motor = 925.2 Watt (approx.)