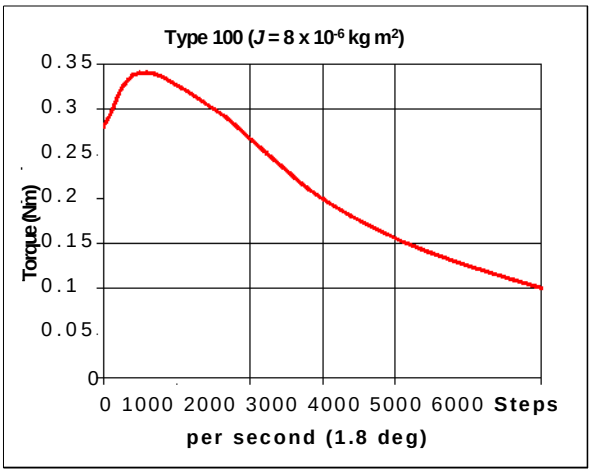
Department of Mechanical, Materials and Manufacturing Engineering

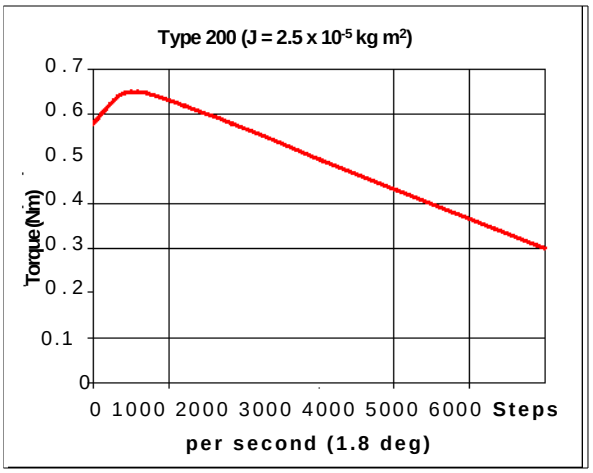
The University of Nottingham

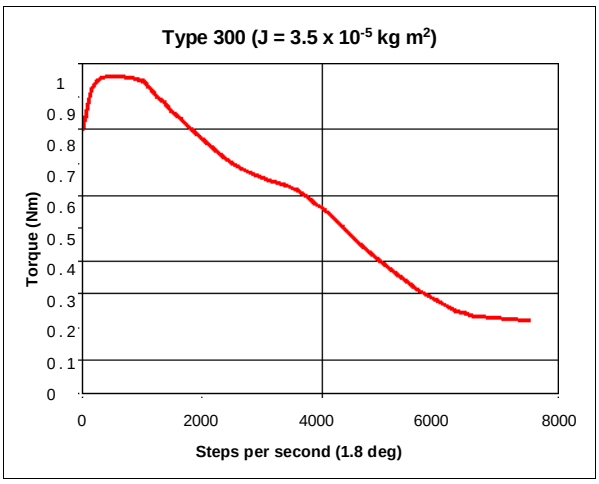
Computer Engineering and Mechatronics MMME3085

Exercise sheet 7: Stepper motor dynamics

The following characteristics can be assumed for type 100, 200 and 300 motors from a fictitious manufacturer.



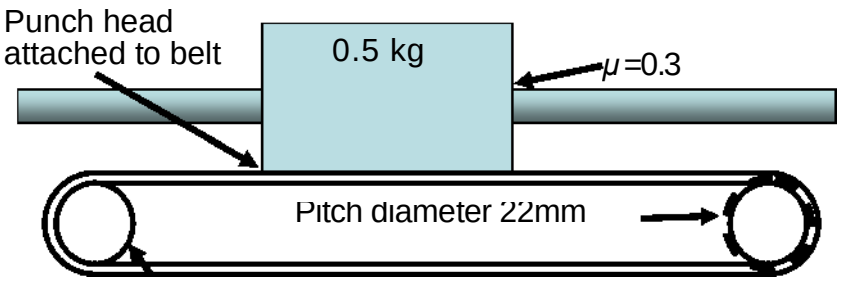




(Characteristics very loosely based on those from McLennan stepper motors).

1. A stepper motor is required to provide a steady torque of 0.2 Nm when rotating at 25 rev/sec. If a reserve factor on torque of 2 is applied, which motor would you use, from the options given above?

(Ans: type 300 – just!)



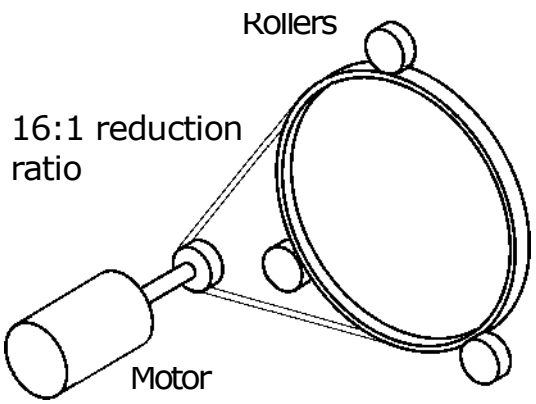
Motor connected to this pulley

2. A machine for punching holes to a particular pattern has a head which is driven tangentially from a stepper motor via a pair of pulleys. The inertia of the system referred to the stepper motor axis (excluding the inertia of the stepper motor itself) is $6.05\xi10^{5}$ kg m^2. The maximum speed of the motor required is 28.93 rev/s (or 181.8 rad/s) and the angular acceleration required during ramping-up is 3636 rad/s^2.

a) Calculate the total inertia the motor needs to accelerate if a size 200 motor is to be tried.
(Answer: $8.55\xi10^{5}$ kg m^2)

b) Calculate the maximum torque the motor must supply. Is a size 200 motor up to the job? Where do you go next?
(Answer: 0.327 Nm)

3. A piece of laboratory apparatus consists of an optical filter carrier which is driven from a stepper motor. There is negligible bearing friction. The total effective moment of inertia of the ring, pulley and its three rollers, referred to the axis of the motor, is $1.0205\text{x}10^{-4}$ kg m^2



a) If a type 100 stepper motor is to be used for driving it, what is the total moment of inertia the motor must accelerate?

b) Using the above motor, what is the shortest time within which the carrier can complete a movement of 180°, assuming constant acceleration from rest over 90° followed by constant deceleration over 90°? (Use trial and error: start with 1s and 0.5s total movement time. Note that just as $s=ut + (1/2)at^2$, similarly $\theta = \omega t + (1/2)\alpha t^2$). What is the limiting factor – speed or acceleration?)

Answers: (a) 0.025 kg m^2 (b) 1.149x10 ^{5} kg m^2 (c) 0.02612 kg m^2 (d) 1.0205 $\times 10^{-4}$ kg m^2 (e) 1.1005$\times 10^{-4}$ kg m^2 (f) In the order of 0.5-0.6 s depending on allowable factor of safety, limited by acceleration.