AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHATRONICS ENGINEERING DEPARTMENT

Spring Semester, 2022

MCT 333: Mechatronic Systems Design

Sheet 2: Actuator Sizing

1. The specifications of a machine that utilizes a lead screw mechanism are:
    a. Ball screw: Diameter: 14 mm, length: 500 mm, pitch: 0.5 rev/mm, efficiency: 45%
    b. Mechanical data: Friction coefficient (μ): 0.1, load: 6 kg, orientation: inclined by 10° relative to horizontal. Taking into consideration that inertia ratio between the machine and the motor is 4:1
    c. Move profile: Type: 1/6- 2/3- 1/6 Trapezoid, distance: 8 mm, move time: 0.2 s, dwell time: 0.1 s

    Determine the peak and root mean square torques of a suitable motor to drive this machine.

2. Select the appropriate motors to drive the wheels of a vehicle whose specs are as follows:
    a- Total vehicle weight: 16 Kg
    b- Number of driving wheels: 2
    c- Weight on each drive wheel: 5 Kg
    d- Radius of wheels: 10 cm
    e- Desired top speed: 0.5 m/s
    f- Desired acceleration time: 1 sec
    g- Incline angle: 2 degrees
    h- Working surface: concrete (rolling resistance coefficient: 0.01)

3. Consider a rotary motion axis driven by an electric servo motor. The rotary load is directly connected to the motor shaft without any gear reducer (Figure 1). The rotary load is a solid cylindrical shape made of steel material, d=60 mm, l= 60 mm, ρ= 7800 kg/m^3.The desired motion of the load is a periodic motion (Figure 2). The total distance to be traveled is 1/4 of a revolution. The period of motion is t_{cyc}= 400 ms. and dwell portion of is t_{dw}= 100 ms. and the remaining part of the cycle time is equally divided between acceleration, constant speed and deceleration periods. Determine the required motor size for this application when the working temperature is 50°C.

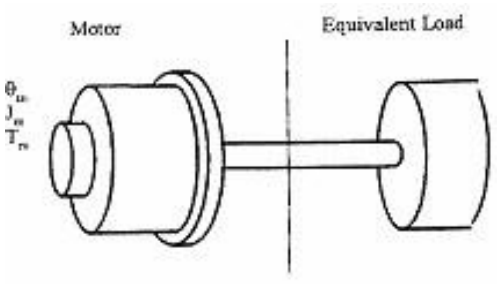

Figure 1

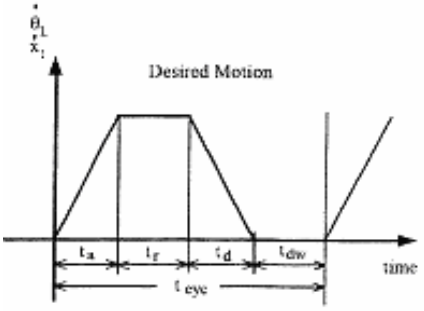

Figure 2

4. Fig. 3 shows a rotary motion axis driven by an electric servo motor directly. The rotary load is a solid cylindrical shape made of steel material, d= 50 mm, l= 60 mm, ρ= 7800 kg/m^3.The desired motion of the load is a periodic motion. The total distance to be traveled is 1/4 of a revolution. The period of motion is t_{cyc}= 250 ms. and dwell portion of it is t_{dw}= 100ms. And the remaining part of the cycle time is equally divided between acceleration with an exponential form; according to the following equation: k (e^{10t} −1), constant speed and deceleration with a linear form. Determine the peak and root mean square torques of a suitable motor for this application.

5. Consider a machine with a rotary motion axis driven by an electric servo motor; see Figure 3. The machine is connected to the motor shaft through timing belt. The following specifications summarize the system: The timing belt reduction ratio: 2:1, the rotary load is a solid cylindrical shape made of steel material, d= 100 mm, l= 60mm, ρ= 7800 kg/m^3, the equivalent viscous damping coefficient of the bearings on machine shaft is 1.5N.m.s/rad. The desired speed motion profile of the load is sinusoidal (half a sine cycle) with a dwell portion. The total distance to be traveled is 3/4 of a revolution. The period of motion is t_{cyc}= 120 ms. and dwell portion of it is t_{dw}= 20ms. Determine a suitable motor size to drive this machine. Taking into consideration that inertia ratio between the machine and the motor is 5:1.

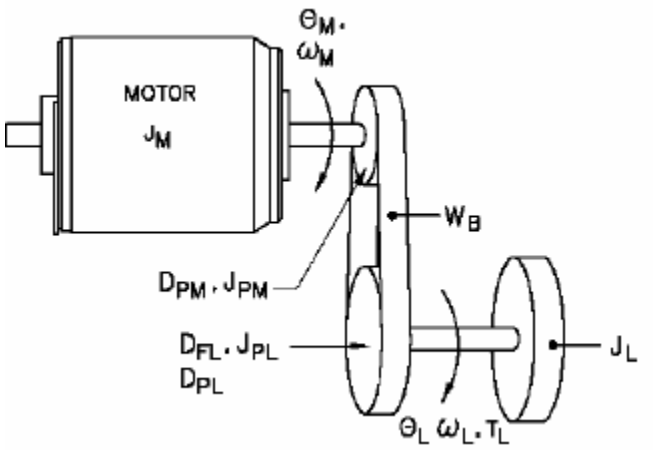

Figure 3

6. A conveyor; shown in Figure 4; is used to transfer bags 15 kg in a production line. The conveyor main roller is connected to main servomotor through a gear box with the following specifications: Roller diameter=300mm, Roller length=1000mm, gear box reduction ratio=50:1, orientation=20° to the horizontal plane, conveyor belt weight=10 kg, working temperature=35°C, maximum number of bags on conveyor at the same time=10 bags. The motion profile: Type: 1/10 - 4/5 - 1/10 –Trapezoid, distance =500mm, move time=30s, dwell time=3s. Determine the peak and root mean square torque of the servo motor.

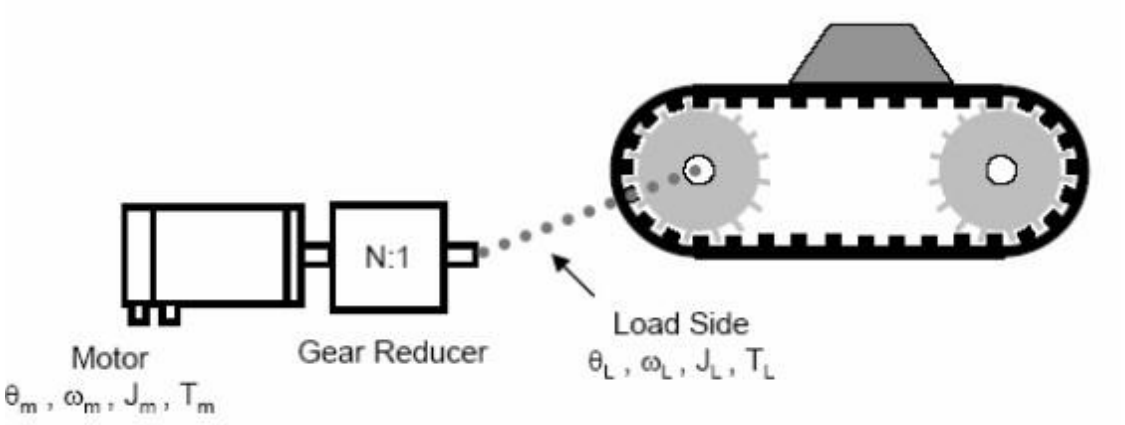
N:1
Load Side
θ_L , ω_L , J_L , T_L
Motor
θ_m , ω_m , J_m , T_m
Gear Reducer

Figure 4