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Selected Chapters from Textile and Single-purpose Machines

Drive systems in the construction of single-purpose machines IV.

Content

- Brushless motors
- Methods used for speed control of an brushless motor
- Design of a servodrive

Brushless motors

The EC motor has a **stator winding** and the **rotor is usually fitted with permanent magnets**.
Brushless motor is basically a hybrid that combines the advantageous characteristics of DC motors and ASM motors.
The electronic motor unit switches the stator windings (this replaces the mechanical commutator) depending on the required motor characteristics.
Due to the fact that the EC motor incorporates an **electronic unit** with a powerful microprocessor, the speed control solution **does not require additional equipment** and therefore almost does not increase the cost of the drive solution. In addition to speed control, the microprocessor-controlled electronic unit also provides **protection against overheating**, **overload and polarity reversal.**

Use- brushless motor

- cordless industrial trucks,
- agricultural mobile technology,
- cordless tools,
- means of transport of all kinds,
- handling and propulsion units in traction,
- army and aircraft propulsion systems
- and many others.
- Utility properties of EC motors are not yet generally known to the technical public. They are already the most successful in modeling technology and vehicles. EC motors have a very good efficiency especially in comparison with induction motors.

Regulation / control of brushless motors

- **Static control** - Control requires only a current control loop
- **Trapezoidal control-** This is the most common method of motor driving.

-It uses rotor position information, which is obtained by signals from Hall probes or induced voltages.

-The controller must contain two control loops, one for regulating the **current** flowing through the motor and the other for regulating the **motor** speed.

- **Sinus control** - By changing the parameters of the sine waveform, the motor **speed** and **torque** can be controlled. The disadvantage is the more complex design of the frequency converter compared to the trapeze control method. The method requires measuring each phase current and the control algorithm is more complex to implement.

- The advantage is a smooth motor output torque

Comparison of DC and brushless motors

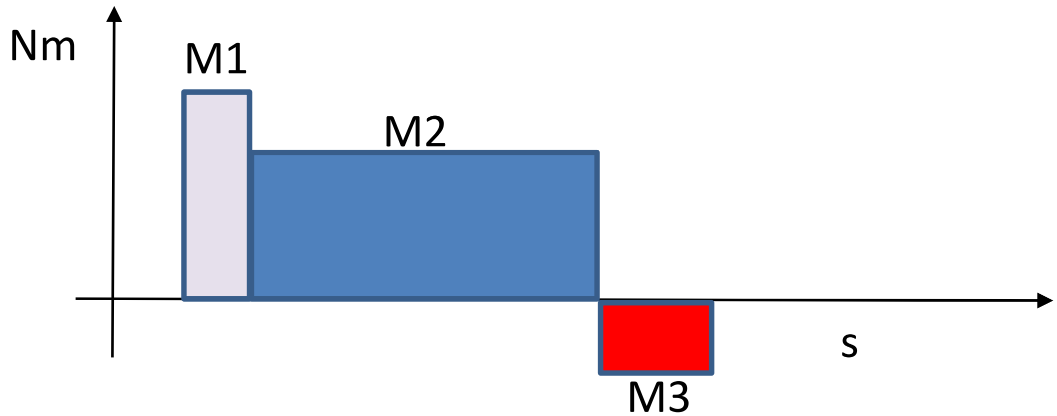
- The heat losses of the EC occur in the stator winding and therefore the heat transfer to the surroundings is higher and for this reason the motor has better conditions for cooling
- The electronic commutation at the EC does not limit the motor at high speeds
- Longer life for EC motors due to the absence of a mechanical commutator
- Mechanical commutation on DC motors is often a source of sparking, which can cause the motor to run
- Torque depends on speed

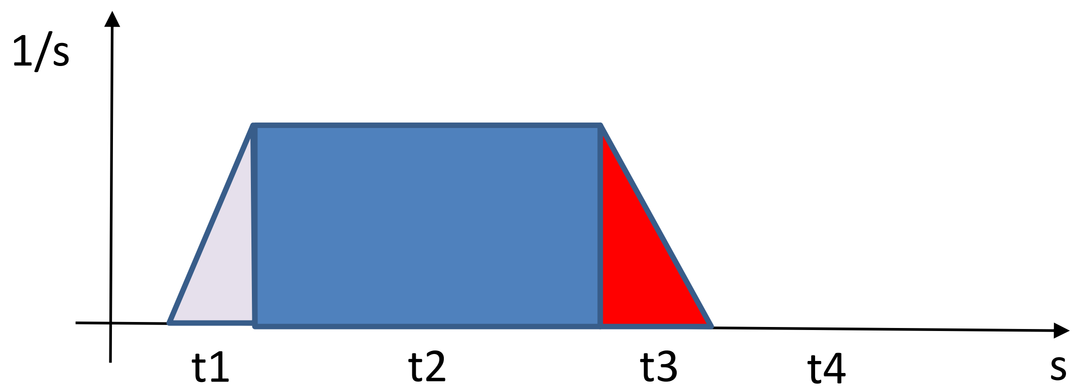
Design of servo drive

Initial conditions for servomotor selection

- The load torque should be lower than the rated motor torque
- The load speed should be lower than the rated output speed.
- The moment of inertia of the load should be less than 3 * times the moment of inertia of the drive (rotor).
- For dynamically demanding applications a moment of inertia of a load should be lower than the moment of inertia of the drive (rotor).

Návrh servo-pohonu





Design of servo drive

Average moment load

$$M_{ekv} = \sqrt{\frac{M_1^2.t_1 + M_2^2.(t_2 + t_4) + M_3^2.t_3}{t_1 + t_2 + t_3 + t_4}}$$

- M1 system acceleration
- M2 steady running
- M3 system deceleration

Mekv < Mjm

Design of servo drive

M1 acceleration

- sum of moments of constant load, acceleration of rotating / sliding masses and passive resistances

M2 steady state

- sum of constant load moments and passive resistances

M3 deceleration

- difference of moment for accelerating / sliding masses of constant and sum of moments from constant load and passive resistances

Design of servo drive

Constant load moment and passive resistances

$$Mv = F.\frac{R}{i\ .\eta}$$

F load
R the distance of its location from the center of rotation
i transmission between motor and location, total transmission
H transmission efficiency

Design of servo drive

Dynamic torque

$$M_{ZR} = J_{RED}.\varepsilon_O = J_{RED}.\frac{\omega_0}{t_k}$$

Jred reduced moment of inertia
ϵ angular acceleration
ω angular speed
t start-up time

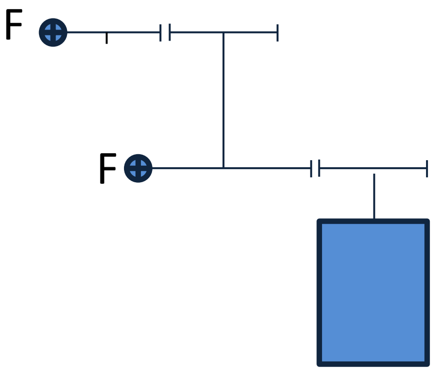
Moment of inertia to its own axis of rotation

$$Jz = \int_{(m)} r^2\, dm = \int_{(V)} r^2 \rho\, dV$$

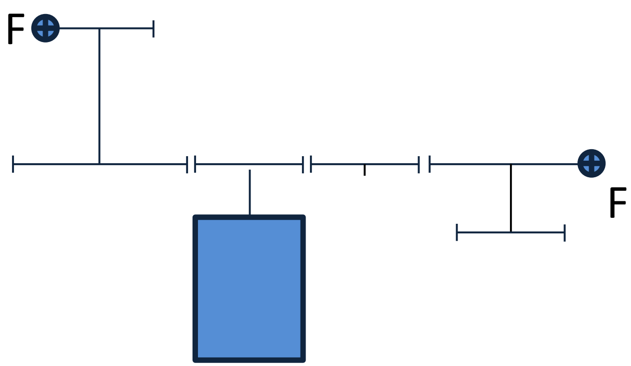
r perpendicular distance of the mass element dm from the axis of rotation
dm mass element
dV volume element
ρ material density

Design of servo drive- tasks

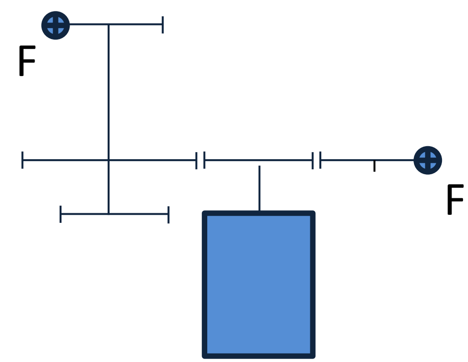
Task A



Task B



Task C



Review

- List the most common uses of brushless motors.
- List some types of brushless motor control.
- List the differences between DC and brushless motors.
- Design the actuator according to the previous assignment.

Thanks for your attention ☺