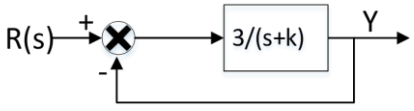
System identification

- Estimate some parameters in the system.
- **Example**: estimate k by measuring y and r
- MATLAB System Identification Toolbox



https://www.mathworks.com/videos/introduction-to-system-identification-toolbox-68901.html

✓Ident …

Command line:

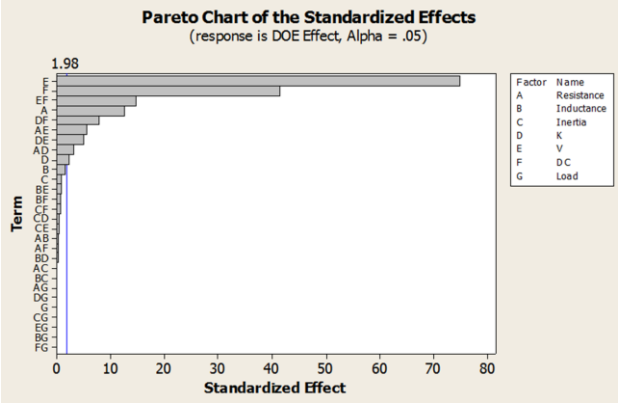
✓Import data (load, iddata, tfest, idtf, idss, ssest)

✓e.g.: [sys,ic]=tfest(data, np, nz))

✓Sys=idtf(num,den)

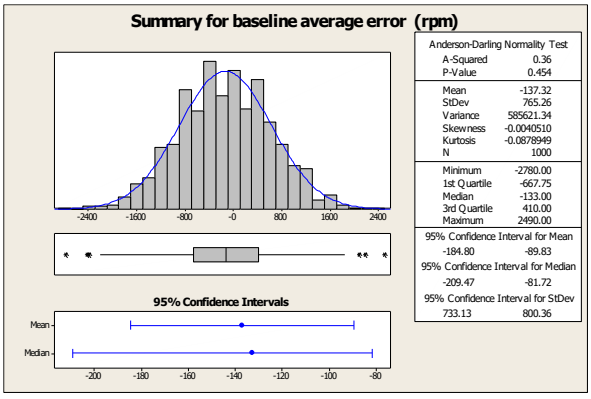
Industrial Application Case Study 1: Motor Dynamics

Design of Experiments



Monte Carlo analysis

- Resistance: lognormal, mu=0.1, sigma=0.05*mu;
- Inductance: lognormal, mu=1.0e-4, sigma=0.05*mu;
- Inertia: lognormal, mu=9.0e-5, sigma=0.05*mu;
- Torque (Back emf) gain: lognormal, mu=0.02, sigma=0.05*mu;
- Load: from 0.05 Nm to 0.2 Nm, uniform distribution;
- Battery voltage: from 10 v to 16 v; uniform distribution;
- Duty cycle: 20%;



Project (Team of 2 students)

- Motor requirements:
  - No-load speed above 260 rpm
  - Stalled torque greater than 248 oz-in
  - No-load current less than 0.3 A
  - Stalled current less than 7 A
  - Max efficiency greater than 44%
  - Rated torque 70-74 oz-in
  - Nominal voltage 12V
  - Motor inertia between 5-7 oz-in-s^2

Task 1 (Designing a motor): Does the motor we used in simulation meet the requirements?

- If not, what can be changed to meet the requirements?

Task 2 (Check a given motor): System identification

- Use a motor model to create input/output data (add random noise to output)
- Identify the transfer function use this data
- Plot I vs T_L and speed vs T_L for different voltages
- Does it meet the requirements
- Suggestions for change of parameters

Task 3: Plot the speed vs load torque curve and current vs load torque curve for PWM control for 50% duty cycle. (V=12). Compare these with the steady state curves (without PWM).

Task 4: Starting at σ_i =10% of the nominal value for each motor parameter, calculate the standard deviation of the max efficiency.

- Specify the standard deviations with lowest cost such that the standard deviation for max efficiency is reduced by 50%. (Assume cost is $C = \sum \frac{1}{\sigma_i}$)

Task 5: DOE analysis. Which parameter has more impact on the result?

The min/max value for each parameter can be set as

nominal value +/-20% of nominal value

The following factors must be considered:

- Resistance
- Inductance
- Inertia
- Torque (Back emf) gain
- Load: 0.255 Nm, 0.345 Nm;
- Battery voltage: 7.5 v, 16.5 v;
- Duty cycle: 15%, 25%;