

Automatsko upravljanje 1



Visoka škola elektrotehnike i računarstva strukovnih studija

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UVOD

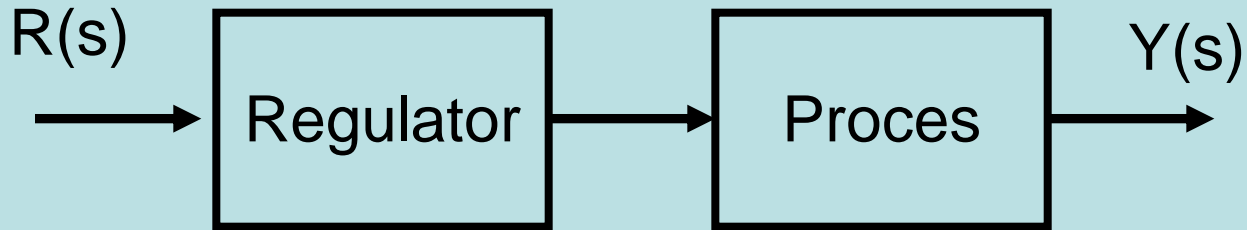
1.1. Struktura sistema upravljanja

1.2. Podela sistema automatskog upravljanja

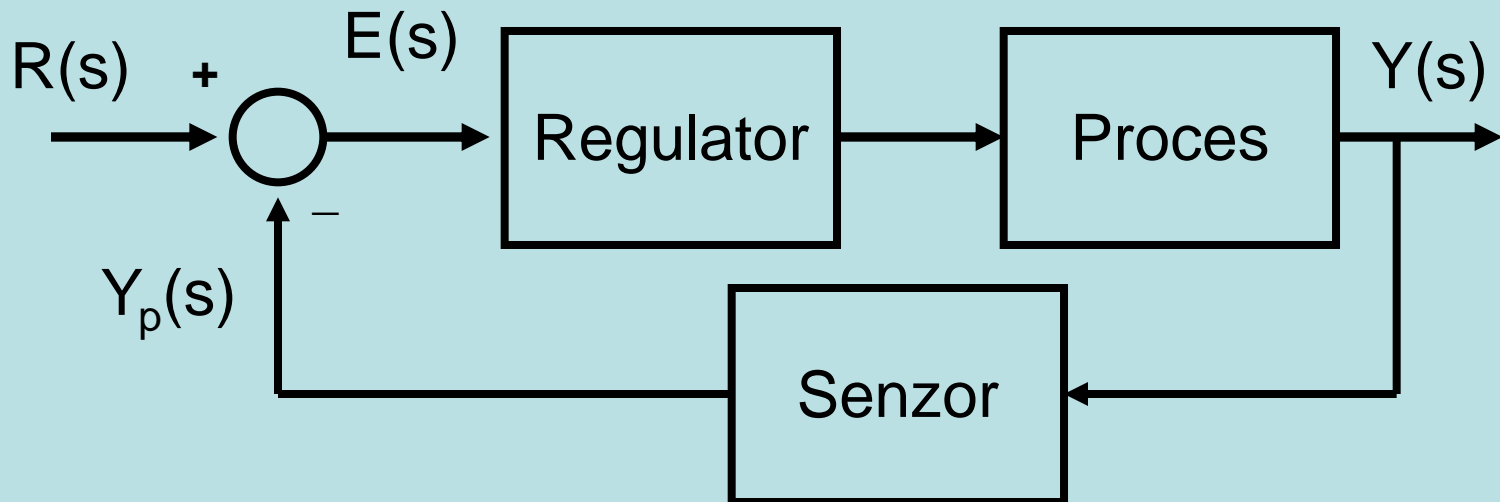




Osnovni tipovi SAU



Sa **otvorenom** petljom upravljanja



i **zatvorenom** petljom upravljanja

MATEMATIČKE OSNOVE MODELOVANJA PROCESA UPRAVLJANJA

2.1. Definisanje modela sistema

2.2. Matematičko modelovanje SAU

2.3. Laplasova transformacija

2.4. Funkcija prenosa



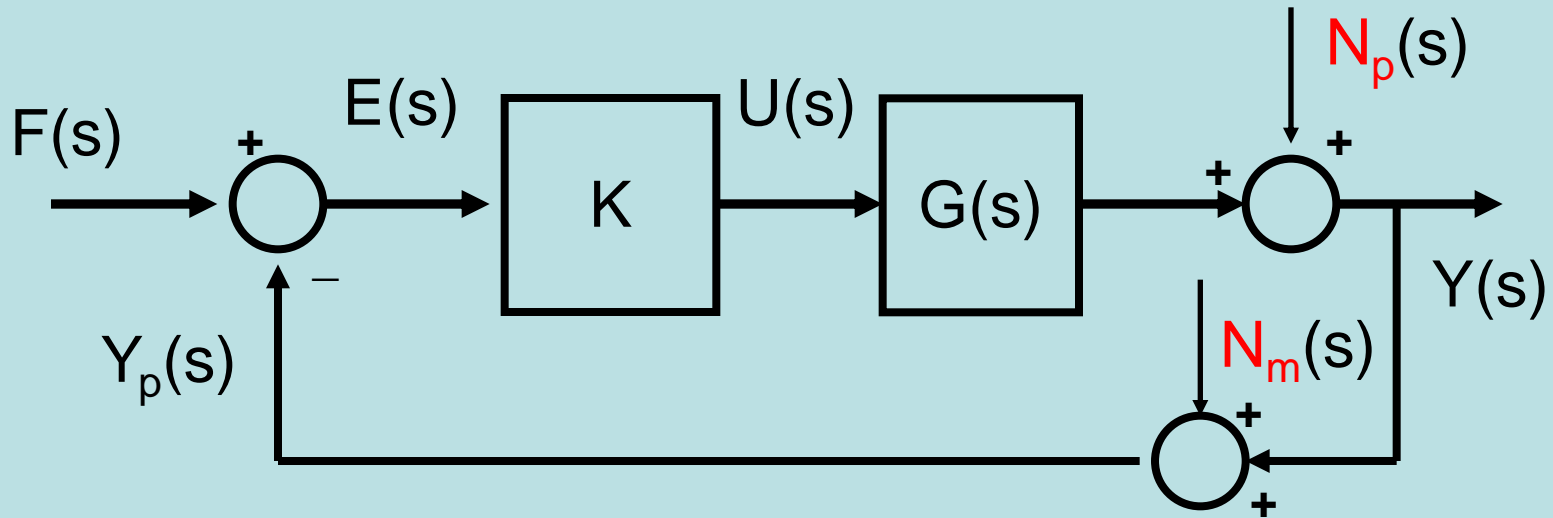
MODELOVANJE SISTEMA AUTOMATSKOG UPRAVLJANJA

- 3.1. Algebra funkcije prenosa
- 3.2. Karakteristične funkcije SAU
- 3.3. Klasifikacija sistema prema redu astatizma
- 3.4. Uloga funkcije prenosa pri određivanju odziva sistema
- 3.5. Model sistema u prostoru stanja





Uticaj povratne sprege na odziv sistema



$$Y(s) = \frac{KG(s)}{(1 + KG(s))} (F(s) - N_m(s)) + \frac{1}{(1 + KG(s))} N_p(s)$$

$N_p(s)$, $N_m(s)$ – šumovi poremećaja i merenja

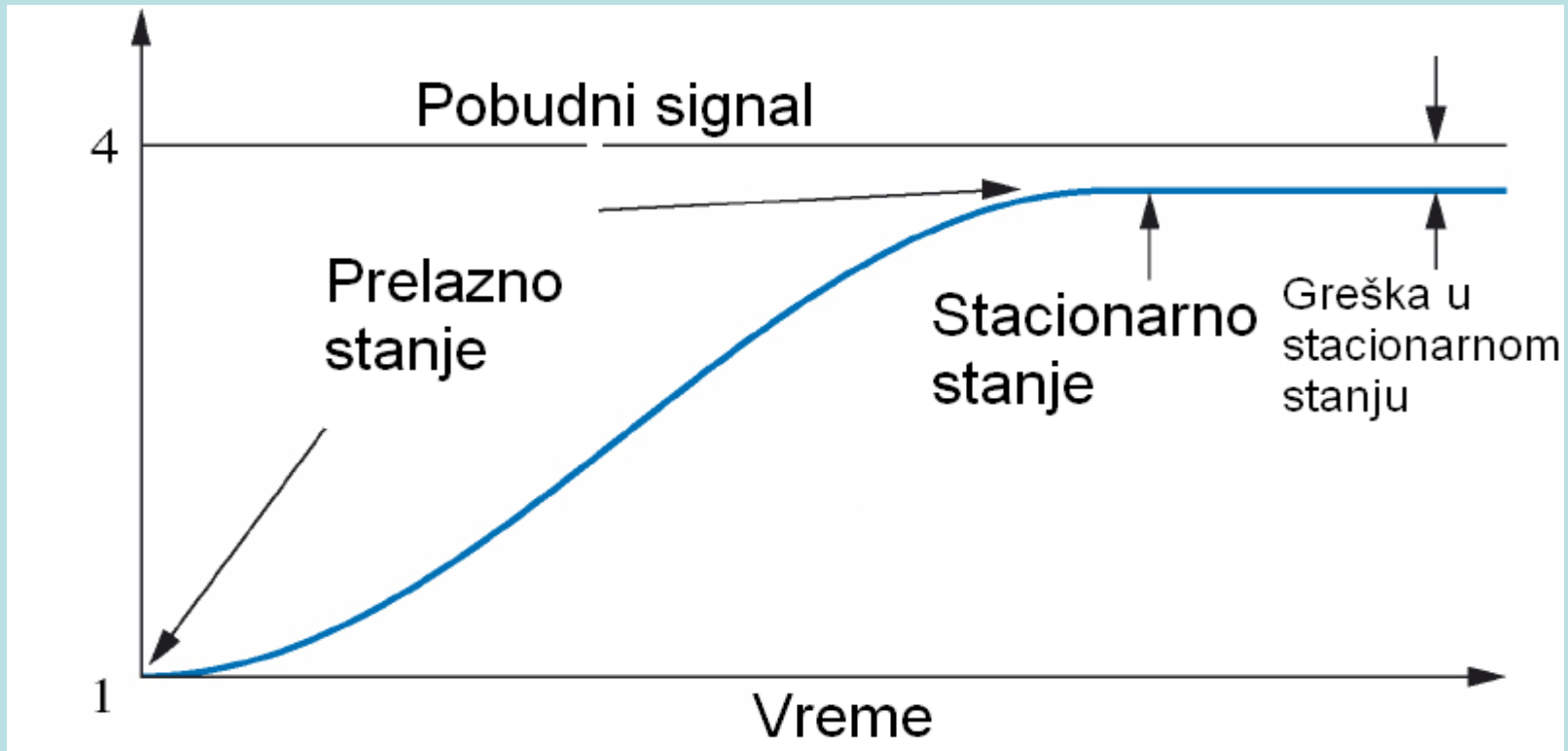
ANALIZA PONAŠANJA KONTINUALNIH SISTEMA AUTOMATSKOG UPRAVLJANJA

- 4.1. Zakoni uravljanja
- 4.2. Karakterizacija prelaznog režima
- 4.3. Karakterizacija stacionarnog stanja
- 4.4. Uticaj rasporeda polova i nula funkcije
prenosa na odziv sistema





Ciljevi analize i sinteze SAU



Zahtevana **stabilnost**, **minimalna greška** u stacionarnom stanju i **oblik prelaznog odziva** SAU

STABILNOST SISTEMA AUTOMATSKOG UPRAVLJANJA

5.1. Hurvicov kriterijum

5.2. Rausov kriterijum



KARAKTERISTIKE SISTEMA AUTOMATSKOG UPRAVLJANJA U FREKVENIJSKOM DOMENU

6.1. Amplitudne karakteristike SAU

6.2. Fazne karakteristike SAU





Matlab

- interaktivni program za numeričku obradu i vizuelizaciju podataka
- specijalizovana programska podrška za rešavanje širokog spektra naučno-tehničkih problema
- mogućnost primene u **Unix**, **Macintosh** i **Windows** okruženju



Bogat izbor Toolbox-ova

The screenshot displays the MATLAB environment with several windows open:

- Command Window:** Shows the command `>> demo` and `>>`.
- Help Navigator:** A tree view showing the 'Control System' toolbox, with 'Interactive Demos' expanded to show 'Notch Filter Discretization' selected.
- Help Page:** Displays the title 'Control System Demo: notchdemo' and the text 'Notch Filter Discretization' followed by 'notchdemo Discretization of a notch filter demo.' and a 'Run this demo' link.
- Notch Filter Discretization Demo:** A window containing two plots and control parameters:
 - Bode Diagram of Notch Filter:** Shows Magnitude (dB) vs. Frequency (Hz) and Phase (deg) vs. Frequency (Hz). It compares 'Continuous' (blue) and 'Discretized' (red) responses. The magnitude plot shows a sharp notch at 1 Hz, and the phase plot shows a corresponding phase shift.
 - Filtered Sine Wave at Notch Frequency:** Shows Amplitude vs. Time (sec). It displays a high-frequency sine wave (red) and its filtered version (blue) with a notch at 1 Hz.
 - Method:** Set to 'Zero-order hold'.
 - Sample Time:** A slider set to 0.1.



... detaljan prikaz mogućnosti na konkretnim primerima

The image shows a MATLAB Help Navigator window on the left and a Disturbance Rejection Demo window on the right. The Help Navigator shows a tree view with 'DC Motor Control' selected under 'Case Studies'. The Demo window displays a circuit diagram of a DC motor with an armature circuit containing a resistor R and inductor L . The applied voltage is V_a and the back EMF is V_{emf} . The motor is connected to an Inertial Load J , which produces torque $\tau(t)$ and angular velocity $\omega(t)$. Viscous friction is represented by $K_f \omega(t)$. The demo window also includes a text area with the following text:

In armature-controlled DC motors, the applied voltage V_a controls the angular velocity ω of the shaft.

This demo shows two techniques for reducing the sensitivity of ω to load variations (changes in the torque opposed by the motor load).

Slide 1 of 14

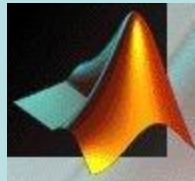
Start >>

Reset

More info

Close

Windows taskbar at the bottom shows the Start button, a browser address bar with `http://www.wsea...`, and several open applications including MATLAB and the Disturbance Rejection Demo.



MATLAB Demos

Help Navigator

Product filter: All Selected Select...

Contents Index Search Demos Favorites

- Getting Started with Demos
- MATLAB
- Toolboxes
 - Communications
 - Control System
 - Interactive Demos
 - RLC Circuit Response
 - Gain and Phase Margins
 - Notch Filter Discretization
 - Tutorials
 - Getting Started
 - Model Analysis
 - Do's and Don'ts
 - GUI Demos
 - Case Studies
 - DC Motor Control**
 - Feedback Amplifier Design
 - Digital Servo Control of Disk
 - Yaw Damper for a 747 Aircraft

M-File Help: dcdemo

[View code for dcdemo](#)

This demo compares three commands and reducing speed variations:
* feedforward command
* integral feedback control
* LQR regulation

See "Getting Started: Building a DC Motor Model" for the DC motor model.

Disturbance Rejection Demo

Slide 2 of 14

Next >>

Reset

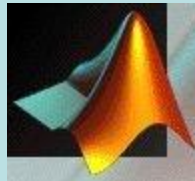
More info

Close

```
A simplified model of the DC motor is shown above. The torque T_d models load disturbances. You must minimize the speed variations induced by such disturbances.
```

```
For this example, the physical constants are:  
R = 2.0;           % Ohms  
L = 0.5;           % Henrys  
K_m = K_b = 0.1;  % torque and back emf constants  
K_f = 0.2;         % Nms  
J = 0.02;         % kg.m^2/s^2
```

Start | http://www.wsea... | vets | Microsoft Power... | MATLAB | Help | Disturbance Rej... | EN | 11:37



MATLAB Demos

The screenshot displays the MATLAB environment with the following components:

- Help Navigator:** A tree view on the left showing the 'Control System' folder expanded to 'Interactive Demos', with 'DC Motor Control' selected.
- M-File Help:** A window titled 'dcdemo' containing the text: "This demo compares three commands and reducing s... * feedforward command * integral feedback c... * LQR regulation". Below this, it says "See 'Getting Started:Bu... the DC motor model.'" and a link "View code for dcdemo".
- Bode Diagram:** A window titled 'Disturbance Rejection Demo' showing four Bode plots in a 2x2 grid. The top row is labeled 'From: w_{ref}' and the bottom row 'From: T_d'. The left column shows 'Magnitude (dB)' vs 'Frequency (rad/sec)' and the right column shows 'Phase (deg)' vs 'Frequency (rad/sec)'. The plots compare three designs: feedforward (red), integral feedback (green), and LQR (blue).
- Slide 13 of 14:** A control panel on the right with buttons for 'Next >>', 'Reset', 'More info', and 'Close'.
- Code Window:** A text area at the bottom of the Bode Diagram window containing the command:

```
>> bode(cl_ff,cl_rlqc,cl_lqr)
```

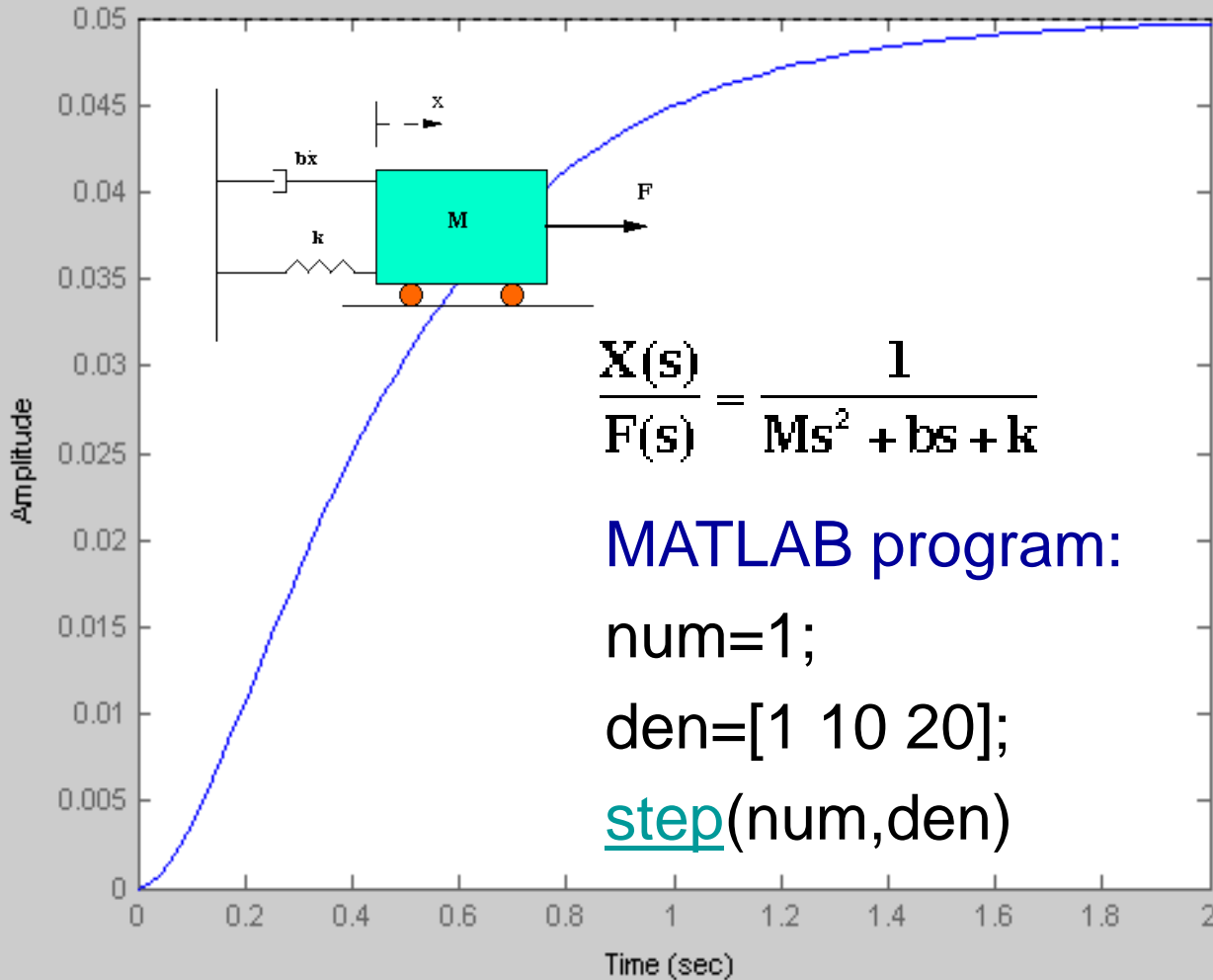
 and the instruction: "Click on the curves to identify the systems or inspect the data."

The Windows taskbar at the bottom shows the Start button, a browser window at 'http://www.wsea...', a folder named 'vets', and several application windows including 'Microsoft Power...', 'MATLAB', and 'Help'. The system clock shows 11:39.



Odziv sistema na step pobudu

Step Response



OCENA IZ PREDMETA

Dva kolokvijuma (30+50 bodova)

Vežbe (20 bodova)

U slučaju klasičnog ispita
(maksimalno 80 bodova na
pismenom)

