

DINAMIK TIZIMLARNING VAQT BO'YICHA XARAKTERISTIKALARINI TAHLIL QILISH VA MATLAB MUHITIDA MODELLASHTIRISH

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Annotatsiya. Ushbu maqolada dinamik tizimlarning vaqt bo'yicha xarakteristikalarini, ularning asosiy kirish signallariga – pog'onali, impulsli va garmonik ta'sirlarga bo'lgan javoblari tahlil qilinadi. Xususan, tizimning pog'onali signaldagi javobi – **o'tish funksiyasi** ($h(t)$), impulsli signaldagi javobi esa – **og'irlik funksiyasi** ($\omega(t)$) sifatida qaraladi. Ushbu xarakteristikalar tizimning barqarorligi va tezkorligiga baho berishda muhim ahamiyat kasb etadi. MATLAB/Simulink muhitida o'tkinchi va impulsli xarakteristikalarini modellashtirish, ularni vizual ko'rinishda tahlil qilish yo'llari ko'rib chiqiladi. Bu yondashuv nazorat tizimlarini loyihalash va optimallashtirishda keng qo'llaniladi.

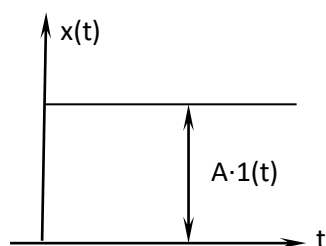
Kalit so'zlar. Dinamik tizimlar, vaqt xarakteristikasi, o'tish funksiyasi, og'irlik funksiyasi, MATLAB, Simulink, pog'onali signal, impulsli signal, LTI Viewer, nazorat tizimi.

Abstract. This article investigates the time characteristics of dynamic systems and their responses to typical input signals such as step, impulse, and harmonic signals. In particular, the system's response to a step input is referred to as the **transition function** ($h(t)$), while its response to an impulse input is described by the **weight function** ($\omega(t)$). These characteristics play a vital role in evaluating system stability and responsiveness. The study also demonstrates how to model and analyze these responses using MATLAB/Simulink tools. The presented approach is widely used in designing, analyzing, and optimizing control systems.

Keywords. Dynamic systems, time characteristics, transition function, weight function, MATLAB, Simulink, step input, impulse input, LTI Viewer, control system.

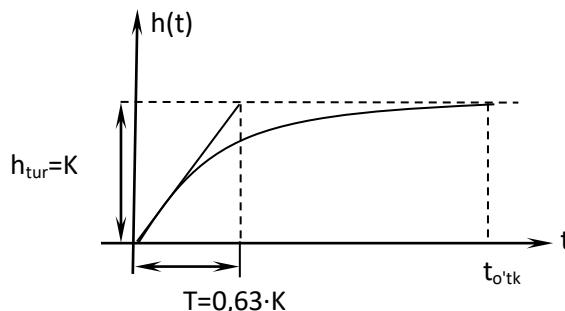
Dinamik sistemalarning vaqt bo'yicha qanday harakatlanishini o'rganish, ularning kirish signallariga qanday javob berishini tahlil qilish nazorat tizimlarining muhim qismidir. Bu jarayon asosan tipik kirish signallari asosida olib boriladi: pog'onali signal, impulsli signal va garmonik signal. Bu signallar yordamida tizimlarning turli vaqt xarakteristikalarini aniqlanadi, xususan, o'tkinchi va impulsli funksiyalar.

Sistema (zveno)larning birlik pog'onali ta'sirga bo'lgan reaksiyasiga o'tkinchi jarayon yoki o'tish funksiyasi deyiladi va $h(t)$ bilan belgilanadi.



$$x = A \cdot 1(t);$$

$$A = \text{sonst},$$



$$1(t) = \begin{cases} 1, & \text{булча } t \geq 0 \\ 0, & \text{булча } t < 0 \end{cases}$$

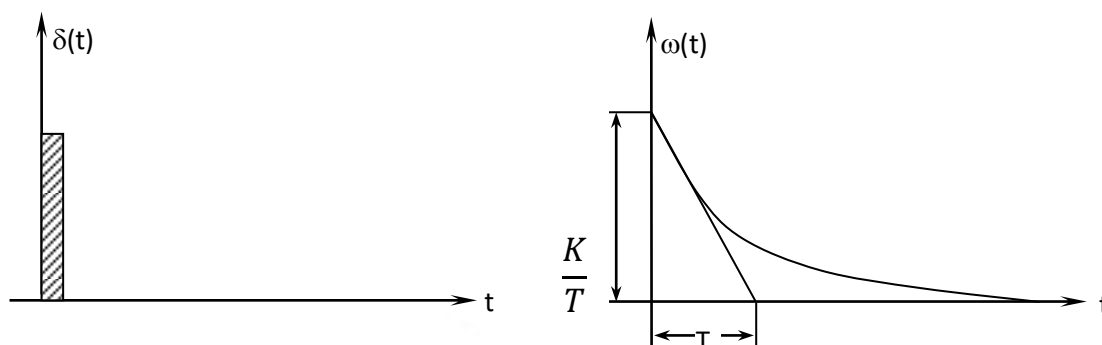
$$L\{A \cdot 1(t)\} = A \frac{1}{p}$$

t_{otk} - o'tkinchi jarayon davomiyligi - chiqish signali turg'unlashgunga bo'lgan vaqt.

$T = \tau$ - vaqt doimiysi.

$$\text{Bunda, } T = t \cdot h(t) = k(1 - 0,37) \cdot 1(t) = 0,63k.$$

Sistema (zveno)larning birlik impulsli ta'sirga bo'lgan reaksiyasi impulsli o'tkinchi jarayon yoki vazn funksiyasi deyiladi va $\omega(t)$ bilan belgilandi.



$$x(t) = A \cdot \delta(t); \quad A = \text{const};$$

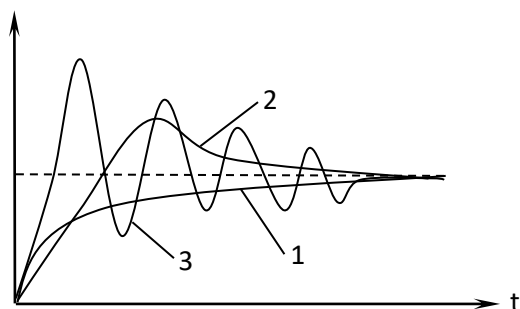
$$\delta(t) = \begin{cases} 0, & \text{булча } t > 0 \\ \infty, & \text{булча } t = 0 \end{cases} \quad \int_0^{\infty} \delta(t) dt = 1. \quad A \rightarrow \infty; \Delta t \rightarrow 0$$

O'tkinchi va impulsli o'tkinchi funksiyalar jarayonning vaqt xarakteristikalarini hosil qiladi - bu signal kattaligi o'zgarishning vaqtga bog'liqligidir.

Sistema (zveno) larning garmonik ta'sirga bo'lgan reaksiyasi chastotaviy xarakteristika deyiladi.

O'tkinchi jarayon quyidagicha bo'lishi mumkin:

1. Monoton;
2. Aperiodik;
3. Tebranuvchan.



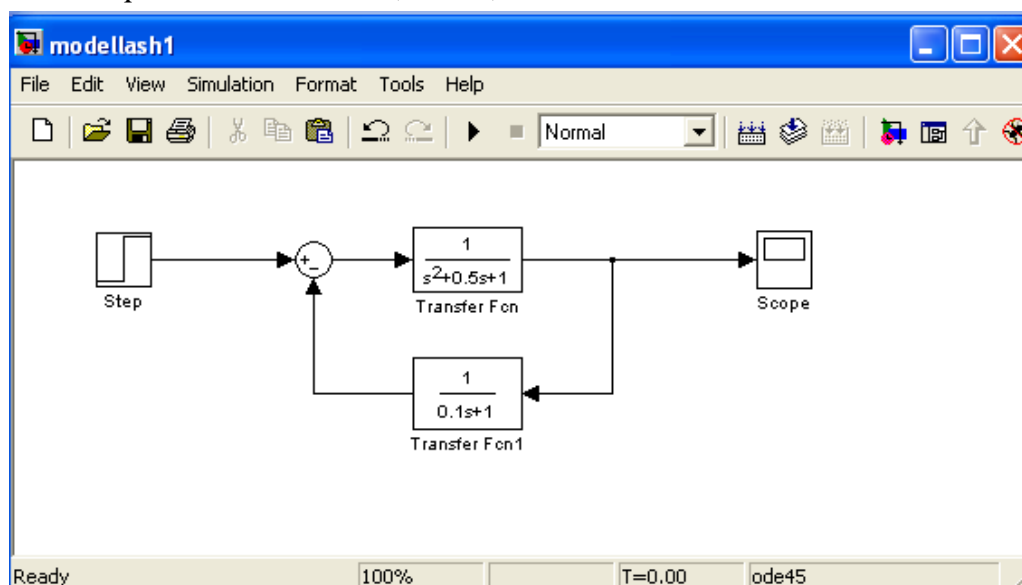
MATLAB dasturi asosiy sahifasi ochilgandan keyin **Simulink** qism dasturini ishga tushirish kerak.

Modelning o'tkinchi xarakteristikasini olish.

1. Sistemaning birlik pog'onali ta'sirga bo'lgan reaksiyasi $h(t)$ - o'tish funksiyasini olish. Modelning kirishiga birlik pog'onali ta'sir hosil qilib beruvchi blok (**Step**) qo'yiladi va chiqishda shu funksiyaning grafiini ko'rsatuvchi (**Sscope**) bloki qo'yiladi.

2. Sistemani ishga tushirish uchun **Simulink** sahifasi uskunalar panelidagi (**Start**) tugmasi bosiladi. O'tkinchi jarayon grafigini ko'rish uchun esa **Sscope** bloki ustiga kursor keltirilib, sichqonchaning chap tugmachasi ikki marta tez bosiladi.

Yopiq sistema o'tish funksiyasini olish uchun modelda teskari bog'lanish zanjiri amalga oshiriladi va ikkinchi punkt takrorlanadi (1-rasm).

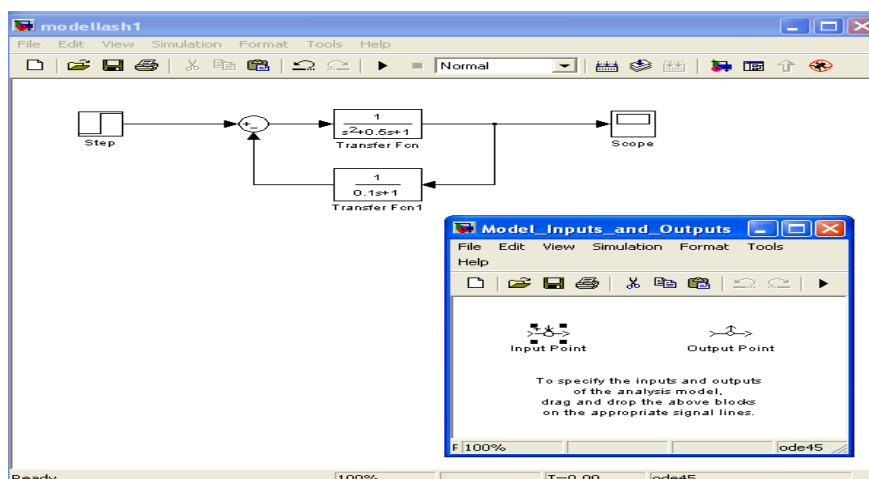


1-rasm.

Sistemaning vazn funksiyasini olish.

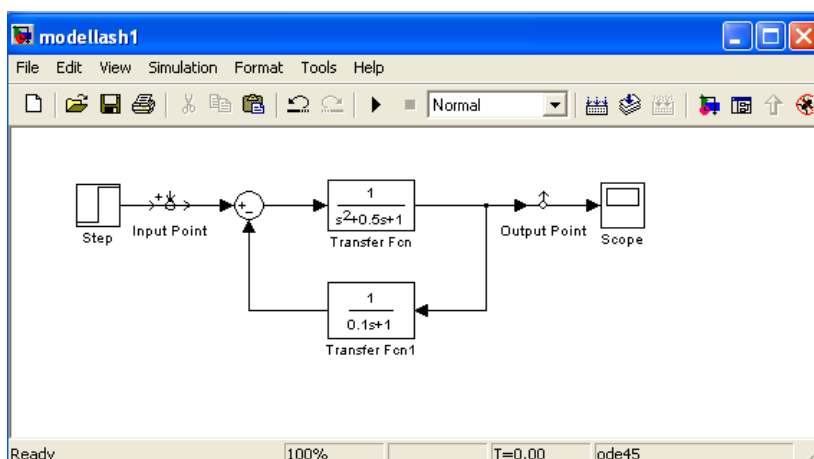
Buning uchun **Simulink LTI-Viewer** qism dasturini ishga tushirish lozim. Bu quyidagicha amalga oshiriladi:

1. **Simulink**-modeli sahifasida **Tools\Linear Analysis...** komandasini bajarilganda **Model_Inputs_and_Outputs** sahifasi hamda **Simulink LTI-Viewer** bo'sh sahifasi ochiladi (2-rasm).



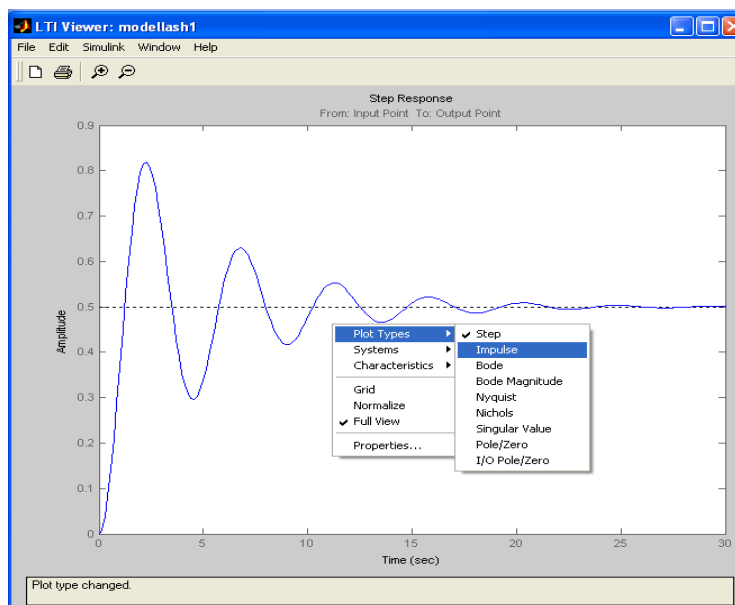
2-rasm. **Model_Inputs_and_Outputs** sahifasi.

2. Sistema kirishiga **Input Point** bloki va chiqishiga **Output Point** blokini o'rnatiladi (3-rasm).



3-rasm. **Input Point** bloki va **Output Point** bloki o'rnatilgan model.

3. **LTI Viewer** sahifasida **Simulink\Get Linearized Model** komandasi bajariladi.



4-rasm.. **LTI Viewer** sahifasi.

Bunda ekranda sistemaning birlik pogonali signalga bo'lgan reaksiyasi $h(t)$ -xarakteristika hosil bo'ladi. Sitemaning vazn funksiyasini chiqarish uchun **LTI Viewer** sahifasida sichqonchanning chap klavishasini bosiladi unda xarakteristikani o'zgartirish darchasi paydo bo'ladi. U yerdan **Impulse** punkti tanlaniladi (4-rasm).

Tizimlarning vaqt xarakteristikalarini ularning barqarorligi va javob tezligini aniqlashda muhim o'rin tutadi. MATLAB/Simulink vositalari yordamida:

- ✓ Tizim javobining grafisini tez va aniq ko'rish,
- ✓ Kirish signaliga mos holda o'tish va impulsli funksiyalarni olish,
- ✓ Tizim modelini modifikatsiya qilish orqali natijalarni solishtirish imkoniyati yaratiladi.

Bu yondashuv nazorat tizimlarini loyihalashda muhim nazariy va amaliy asos bo'lib xizmat qiladi.

Dinamik tizimlarning vaqt xarakteristikalarini, xususan, o'tish va impulsli funksiyalarini tahlil qilish tizimning ishlash printipini chuqur tushunish imkonini beradi. MATLAB/Simulink muhiti bu tahlillarni samarali amalga oshirishda qulay vosita hisoblanadi. Bunday tadqiqotlar nazorat va boshqaruv tizimlarini yaratishda, ularni tahlil qilish va optimallashtirishda keng qo'llaniladi.

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