



INVESTICE DO ROZVOJE VZDĚLÁVÁNÍ

Název projektu: **Automatizace výrobních procesů ve strojírenství a řemeslech**
Registrační číslo: **CZ.1.07/1.1.30/01.0038**
Příjemce: **SPŠ strojnická a SOŠ profesora Švejcara Plzeň, Klatovská 109**
Tento projekt je spolufinancován Evropskou unií a státním rozpočtem České republiky

Produkt:

Zavádění cizojazyčné terminologie do výuky odborných předmětů a do laboratorních cvičení

Linear static characteristics

Návod v anglickém jazyce

Číslo tématu: **9b**

Monitorovací indikátor: **06.43.10**

INSTRUCTIONS FOR TOPIC: 9b

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Branch: 26-41-M/01 Electrical Engineering - Mechatronics

Subject: Control and regulation

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Linear static characteristics

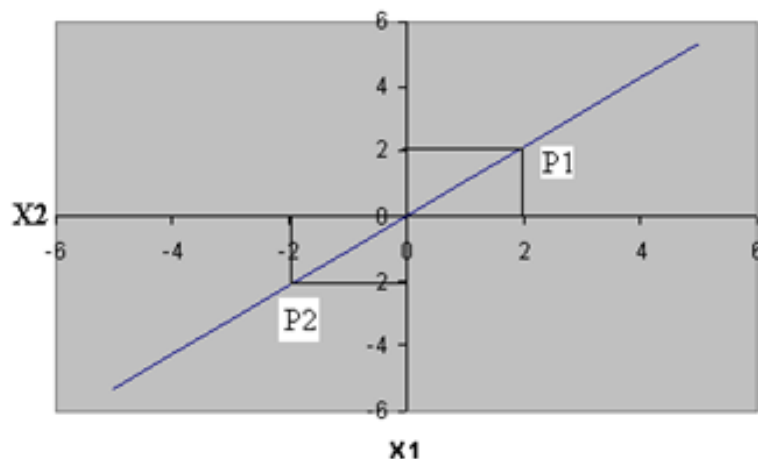
Indicates the the dependence of the output signal on the input $y = f(x)$ or $x_1 = x_2$



Types

- Net linear characteristic (passing through the centre)
- General linear characteristics (not passing through the centre)
- Quasi - linear characteristics
- Non - linear characteristics

Net linear characteristic (passing through the centre)

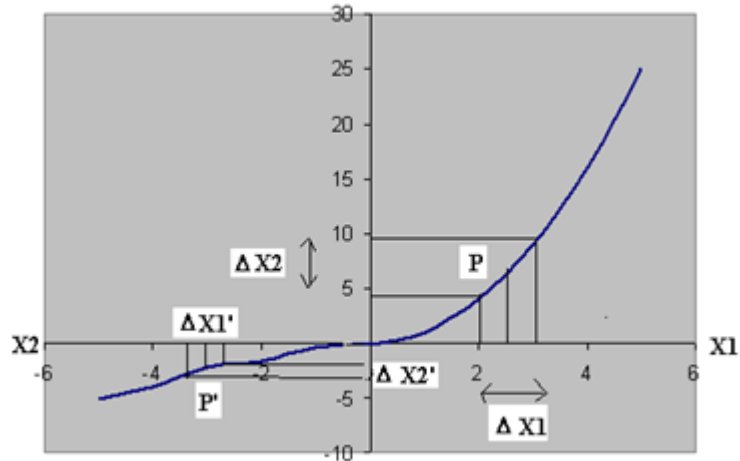


The static gain is defined for a particular operating point

$$P_1 : K_1 = \frac{X_2}{X_1} = \frac{2}{2} = 1$$

$$P_2 : K_2 = \frac{X_2}{X_1} = \frac{-2}{-2} = 1$$

Quasi - linear characteristics



Interval around operating point is chosen so that the area was almost linear

$$P : K_p = \frac{\Delta X_2}{\Delta X_1} = \frac{9,9 - 4,9}{3 - 2} = \frac{5}{1} = 5$$

$$P' : K_p = \frac{\Delta X_1}{\Delta X_2} = \frac{|-3| - |-2|}{|-3,2| - |-2,8|} = 1/0,4 = 2,5$$

Nonlinear characteristics

Characteristics that cannot be linearized

Components with no linearity : Diode, transistor, thyristor, thermistor and some others

The types of nonlinearities:

General nonlinearity

- Saturation nonlinearity
- Dead zone nonlinearity
- Nonlinearity influenced by gradients
- Nonlinearity of the hysteresis loop

General nonlinearity

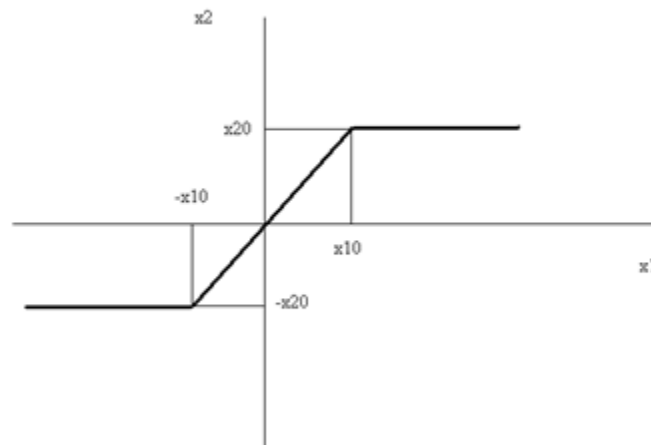
The effect of higher harmonic components

- Features operating in the general course of nonlinearity changing a through signal
- Generated higher harmonics which distort the output signal
- It is the noise (distortion audio amplifiers)
- Use of this effect: RF frequency multipliers

Effect of intermodulation distortion:

- If there are two input signals with different frequencies, signals of the frequency sums and differences entry will appear at the output .
- The result is e.g. dissonant sound for audio amplifiers
- Use of the effect: mixers, amplitude modulation

Saturation nonlinearity



An element acts as linear in the interval

$\langle -x_{10}; +x_{10} \rangle$.

After crossing this zone - proportionality - the output to increase the input signal does not respond, remains constant.

Incidence in regulators - actuators can not deliver an infinite amount of energy.

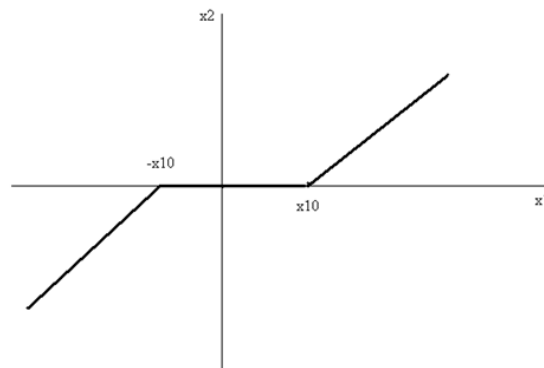
The influence on the stability of the circuit: After reaching the controller limits , the regulator may become unstable

Restrictions: the amplitude of output signal is given by the input linear interval – it limits the amplitude output.

Use of this effect:

- Formers of the signal -at great gain there is the sharp jump - a sharp edge
- Frequency modulation -reduction in amplitude, or cleaning up from parallel amplitude modulation

Dead zone nonlinearity



The element responds to an input signal only from a certain size in absolute value. Up to this value the output is zero.

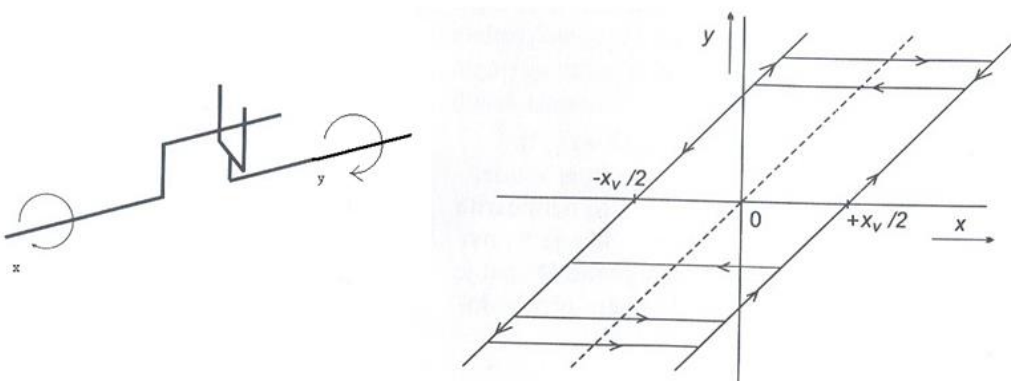
Where this affect appears:

- where there is friction (motion sensors, servo motors)
- audio amplifiers - for small amplitudes it is insensitive - so the weak input signals may be distorted

This effect stabilizes circuits.

Examples of the use of the effect: - Digital technology – the set insensitivity
resistance determines the resistance to noise

Nonlinearity influenced by gradients



It appears at the gearing.

Input signal: the angle of rotation of the driving wheel

Output signal: the angle of rotation of the driven wheel

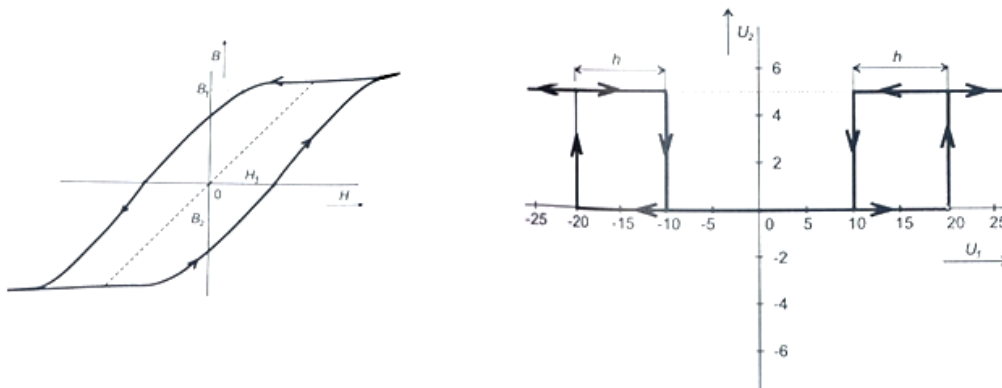
The ideal situation without the play is drawn by dashed line. This is a numbness, which appears when input signals change.

The effect on stability:

- Permanent oscillations with amplitude, which is determined by the size of the will (for actuators)
- Slowing down of the response to changes in the input (steering wheel in vehicles)

How to eliminate : When the load is lower, 2 gears with prestressed springs are standardly used.

Nonlinearity of the hysteresis loop



Is caused by the hysteresis loop

For the value H there exist 2 values B :

B₁ at decreasing H

B₂ at rising H

Moreover, the saturation will be before the amplitude reaches its maximum value, So the circuit can respond significantly lower than the nominal value

Switching electromagnetic relays for the rated voltage 24 V (input - U₁), which switches the 5V voltage (output - U₂)

+ U: Turns on: 20 V, closes at 10 V

à hysteresis: $h_1 = U_{H1} - U_{D1} = 20 - 10 = 10V$

-U: Turns at -20 V, -10 V turns off when

à hysteresis: $h_2 = U_{H1} - U_{D1} = -20 - (-10) = -10V$

Lineární statická charakteristika - Linear static characteristics - slovníček odborných termínů

Vocabulary

actuate
actuator
amplifier
amplitude
automation
circuit
component, element
dashed line
decrease
dependence
determine
distort
distortion
effect
friction
gain
gear
general
gradient
increase
influence
input
loop
net
output
particular
pass
resistance to noise
respond
saturating

Slovníček

zapnout
tvarovač
zesilovač
rozkmit
automatizace
obvod
součást, prvek
čárkovaná čára
snížit, klesnout
závislost
určit, stanovit
zkreslit, zkazit, poškodit
zkreslení, nevěrohodnost
účinek
tření
zisk, navýšení
ozubený převod
obecný, všeobecný
sklon
zvýšit
ovlivnit, vliv
vstup
smyčka
síťový, síť
výstup
určitá, daná
procházet čím
odolnost vůči šumu
reagovat, odpovídat, odezva
nasycenost

sensitive, insensitive	citlivý, necitlivý
sharp edge	náběžná hrana ostrá
size of the will	velikost vůle
spring	pružina
stable , unstable	stálý, stabilní, nestálý nestabilní
steering wheel	volant
surroundings	okolí
value	hodnota

Zdroj:

ŠULC, B., a kol. *Automatizace a automatizační technika II*. Praha: Computer Press, 2000.
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