

Projektovanje elektronskih kola

Sadržaj:

1. Uvod - osnovni pojmovi
2. Stilovi projektovanja i izrade prototipova
3. Projektovanje digitalnih kola (vežbe)
4. Projektovanje analognih kola
5. Osnove fizičkog projektovanja (projektovanje štampanih ploča)

LEDA - Laboratory for Electronic Design Automation
<http://leda.elfak.ni.ac.rs/>
18.04.2018.



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Analiza kola

Analiza kola

Tipovi analize?

Zavisno od vrste pobude, ima smisla analizirati ponašanje kola u

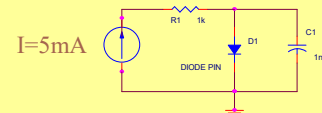
1. jednosmernom domenu (određivanje položaja jednosmerne radne tačke kola).
2. frekvencijskom domenu (frekvencijska karakteristika kola – amplitudska, fazna)
3. vremenskom domenu (talasni oblik napona/struja na izlazu kola pobuđenog impulsima poznatog talasnog oblika)

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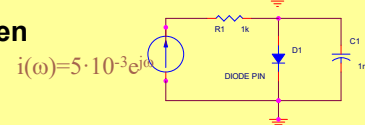
2

Tipovi analize kola

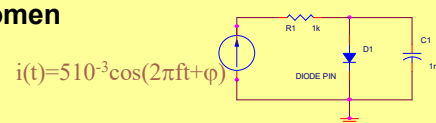
1. Jednosmerni domen (DC analiza)



2. Frekvencijski domen (AC analiza)



3. Vremenski domen (TR analiza)



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3

Analiza kola

Analiza kola

Tipovi analize?

Zavisno od vrste elemenata od kojih se kolo sastoji, različiti tip problema i metoda za analizu

1. Linearna otporna kola (R, linearni generatori, nezavisni i kontrolisani)
2. Linearna reaktivna kola (R, L, C, m, ...)
3. Nelinearna otporna (poluprovodničke komponente, R, ...)
4. Nelinearna reaktivna (poluprovodničke komponente, R, L, C, ...)

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Analiza kola

Tipovi elektronskih kola

1. Linearna otporna R
2. Linearna reaktivna L, C, m, ...
3. Nelinearna otporna dioda, tranzistor, R, ...
4. Nelinearna reaktivna dioda, tranzistor, R, L, C, ...

Tipovi analize kola


1. Jednosmerni domen (DC analiza)
2. Frekvencijski domen (AC analiza)
3. Vremenski domen (TR analiza)

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Analiza kola

Modeli


WDIODE
wdiode.asy




NMOS
nmos_035.asy




PMOS
pmos_035.asy



NMOS
nmos_035.asy



PMOS
pmos_035.asy



$V_m \approx 0.48 \text{ V}$
 $\mu_p C_{ox} \approx 90 \mu\text{A/V}^2$
 $\lambda_n \approx 0.035 \text{ 1/V (} L=1\mu\text{)}$
 $0.025 \text{ 1/V (} L=2\mu\text{)}$
 $<0.015 \text{ 1/V (} L>4\mu\text{)}$

$V_m \approx -0.62 \text{ V}$
 $\mu_p C_{ox} \approx 36 \mu\text{A/V}^2$
 $\lambda_p \approx 0.046 \text{ 1/V (} L=1\mu\text{)}$
 $0.019 \text{ 1/V (} L=2\mu\text{)}$
 $<0.01 \text{ 1/V (} L>4\mu\text{)}$

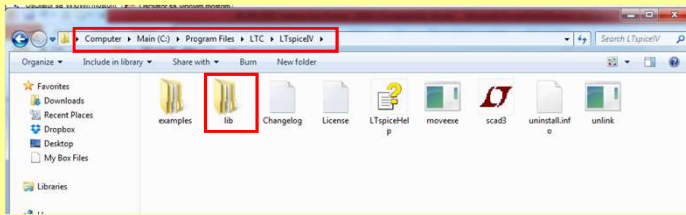
Gde su smešteni?

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Analiza kola

Modeli

Gde su smešteni?

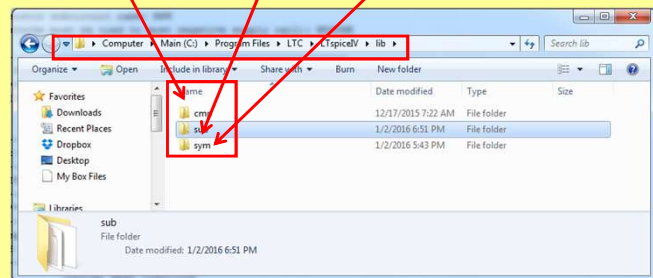


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Analiza kola

Modeli
Potkola (subcircuits)
Simboli

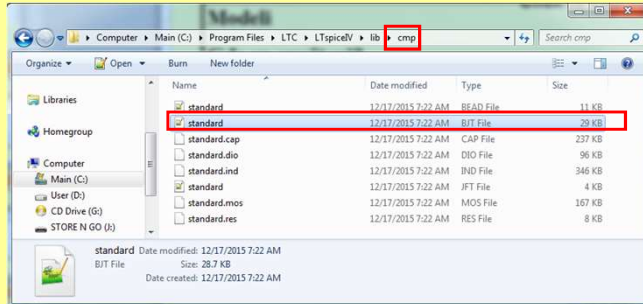
Gde su smešteni?



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Analiza kola

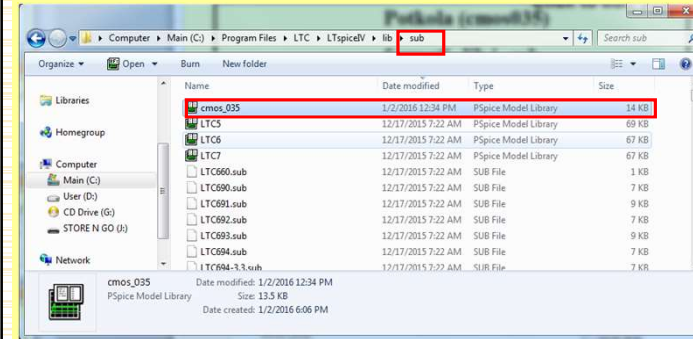
Modeli BJT TXT format sa ekstenzijom **.BJT**
.CAP .DIO .IND .RES .MOS



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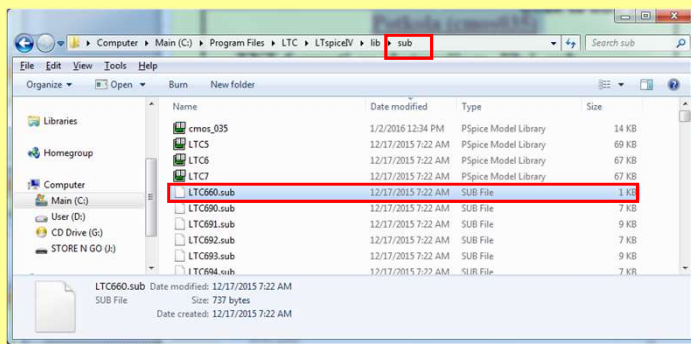
Analiza kola

Potkola (cmos035)
TXT format sa ekstenzijom **.lib**



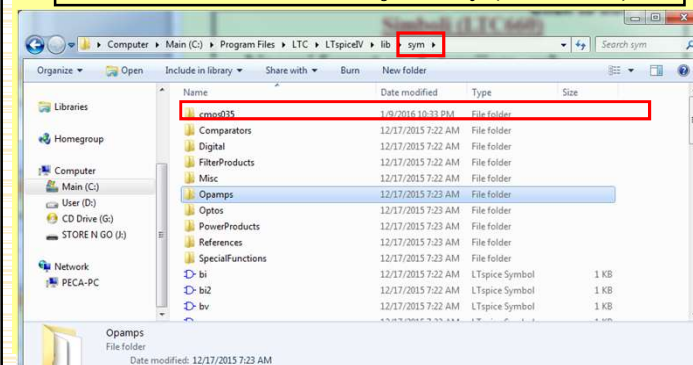
Analiza kola

Potkola (LTC660)
binarni format sa ekstenzijom **.sub**



Analiza kola


Simboli (cmos035 nmos)
TXT format sa ekstenzijom **.asy** (ista imena)




Analiza kola

Modeli


WDIODE
wdiode.asy




NMOS
nmos_035.asy




PMOS
pmos_035.asy



NMOS
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$V_{tp} \approx -0.62 \text{ V}$
 $\mu_p C_{ox} \approx 36 \text{ } \mu\text{A/V}^2$
 $\lambda_p \approx 0.046 \text{ 1/V (} L=1\mu)$
 $0.019 \text{ 1/V (} L=2\mu)$
 $<0.01 \text{ 1/V (} L>4\mu)$

Kako uneti novi model u LTSpice?

25.04.2018.

Analiza kola

Primeri analize

LTSpice CMOSINV

Oscillator

25.04.2018.


Analiza kola - Uvod

Šta treba da znamo?
Elementarno (za potpis)
Tipovi analize u programu Spice?

Osnovna (za 6)

- 1. Kako se dodaje novi korisnički model u programu Spice?**
- 2. Kako se dodaje nova komponenta postojećoj biblioteci u programu Spice?**

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Analiza kola - Uvod

Šta treba da znamo?
Ispitna pitanja

Koje parametre treba zadati i šta je rezultat

- a) **.OP analize?**
- b) **.DC analize?**
- c) **.TF analize?**
- d) **.AC analize?**
- e) **.noise analize?**
- f) **.tran analize?**

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