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> **Rozvojové projekty v regionálnom školstve pre rok 2015** Projekt grafických systémov v odbornom vzdelávaní a príprave pre rok 2015

### **O**VERENIE VLASTNOSTÍ BIPOLÁRNEHO TRANZISTORA – VSTUPNÁ A PREVODOVÁ CHARAKTERISTIKA

**CIEĽ HODINY :** Overiť vlastnosti bipolárneho tranzistora - vstupné a prevodové charakteristiky.

**MERANÝ OBJEKT :** Bipolárny tranzistor NPN (PN2222)

#### DANÁ ÚLOHA:

- 1. Nakreslite schému zapojenia pre meranie vstupných a prevodových charakteristík bipolárneho tranzistora v programe MULTISIM.
- 2. Na bipolárnom tranzistore v zapojení SE odmerajte vstupnú a prevodovú charakteristiku pre hodnotu napätia  $U_{CE}$  =5 V.
- 3. Graficko-matematickou metódou určte **h parametre (h**<sub>11</sub> **a h**<sub>12</sub>). Parameter **h**<sub>12</sub> overte podľa katalógu.
- 4. Spracujte protokol podľa vzoru..

#### SCHÉMA ZAPOJENIA MERACIEHO OBVODU:



#### **POSTUP PRI MERANÍ :**

1. Nakreslite schému zapojenia v programe MULTISIM podľa predlohy (schéma zapojenia meracieho obvodu).

### Overenie vlastnosti bipolárneho tranzistora - vstupná charakteristika.

2. Výstupné charakteristiky overte pomocou analýzy "DC Sweep Analysis".



3. Nastavte parametre analýzy "DC Sweep Analysis" podľa obrázkov.

Analysis Parameters Output   Analysis Options   Summary   Source 1 Source   vv1   Change Filter Start value 0 v Stop value 50 v Increment 0.002 v Source 2 Source   vv2   Change Filter Start value 1 v Stop value 5 v Increment 5 v Increment 5 v DC Sweep Analysis Analysis Parameters Output   Analysis Options   Summary   Variables in circuit   Analysis Options   Summary   Variables   v   v   v   v   v   v   v   v   v		DC Sweep Analysis
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More Options		
Add device/model paramete	r	Show all device parameters at end of simulation in the audit trail
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		Beleet valiables to save

- 4. Stlačte tlačítko "Simulate"
- 5. V grafe upravte ("Graf properties"):
  - a. názov grafu,
  - b. názvy ôs X a Y,
  - c. rozsah ôs,
  - d. mriežku,
  - e. hrúbku jednotlivých charakteristík.
- 6. Pomocou kurzorov ("**Show/Hide cursors**") určite v rozkmite  $I_B=20$  30 mA parameter **h**<sub>11</sub>.
- 7. Exportujte údaje z grafu do programu Excel "**Tools Export to Excel**" a upravte tabuľku pre hodnoty  $I_B = 0 50 \ \mu\text{A}$  s krokom 1  $\mu\text{A}$  do 10  $\mu\text{A}$  a s krokom 10  $\mu\text{A}$  do 50  $\mu\text{A}$ . Upravte aj záhlavie tabuľky podľa vzoru.

P.č. 
$$U_{CE} = 5 V$$
$$I_{B} [\mu A] \qquad U_{BE} [V]$$

#### Overenie vlastnosti bipolárneho tranzistora - prevodové charakteristiky.

8. Postupujeme ako v bodoch 2 - 5 s rozdielom nastavenia parametru:

	DC Sweep Analysis		
Analysis Parameters Output Analysis Options Summary			
Source 1			
Source	vv1 Change Filter		
Start value	0V		
Stop value	50 V		
Increment	0.002 V		
6	☑ Use source 2		
Source 2	vv2 Change Filter		
Start value			
Stop value	5 4		
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	, , ,		
	Simulate OK Cancel Help		
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nalysis Parameters Output A Variables in circuit	nalysis Options Summary	Selected variables for analysis
Device/Model Parameters	-	All variables
	> Add >	
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Filter Unselected Variables	Edit Expression	Filter selected variables
- More Options		Show all device parameters at end
Add device/model paramet	er	of simulation in the audit trail Select variables to save

- 9. Pomocou kurzorov ("**Show/Hide cursors**") určte v rozkmite  $I_B=20$  30 mA parameter  $h_{21}$ .
- 10. Pomocou kurzorov ("**Show/Hide cursors**") určte parameter h<sub>21</sub>. (<u>http://html.alldatasheet.com/htmlpdf/92198/FAIRCHILD/PN2222/405/1/PN2222.html</u>)



Symbol	Parameter	Test Condition	Min.	Max.	Units
b v cbo	Collector-Base Breakdown Voltage	I С=10µА, IE=0	60		v
B V CEO	Collector Emitter Breakdown Voltage	I C=10mA, IB=0	30		v
B V EBO	Emitter-Base Breakdown Voltage	I E=10µA, IC=0	5		v
I CBO	Collector Cut-off Current	V CB=50V, IE=0		0.01	μΑ
I EBO	Emitter Cut-off Current	V EB=3V, IC=0		10	nA
h fE	DC Current Gain	VCE=10V, IC=0.1mA	35		
		V CE=10V, *IC=150mA	100	300	
V CE (sat)	* Collector-Emitter Saturation Voltage	I c=500mA, IB=50mA		1	v
V BE (sat)	* Base-Emitter Saturation Voltage	Ic=500mA, IB=50mA		2	V

11. Exportujte údaje z grafu do programu Excel "**Tools - Export to Excel**" a upravte tabuľku pre hodnoty  $I_B = 0$  - 50 µA s krokom 1 µA do 10 µA a s krokom 10 µA do 50 µA. Upravte aj záhlavie tabuľky podľa vzoru.

	U <sub>CE</sub> = 5 V	
P.č.	I <sub>Β</sub> [μΑ]	$I_C[mA]$

# 12. Spracujte protokol podľa vzoru.

- a. Do protokolu vložte schému zapojenia z MULTISIM-u, "PrtScr" grafov, tabuľky z Excelu, vypočítané parametre h<sub>11</sub> a h<sub>21</sub>.
- b. Overenie vyhodnoťte.

## **VZOR PROTOKOLU**

(vymazať v originálnej verzii)

Meno a priezvisko:

Trieda:

## **O**VERENIE VLASTNOSTÍ BIPOLÁRNEHO TRANZISTORA – VÝSTUPNÁ A SPÄTNÁ PREVODOVÁ CHARAKTERISTIKA

**MERANÝ OBJEKT :** Bipolárny tranzistor NPN (PN2222)

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- 2. Na bipolárnom tranzistore v zapojení SE odmerajte vstupnú a prevodovú charakteristiku pre hodnotu napätia  $U_{CE}$  =5 V.
- 3. Graficko-matematickou metódou určte **h parametre (h**11 **a h**12).
- 4. Overenie vyhodnoťte.

SCHÉMA ZAPOJENIA MERACIEHO OBVODU: sem vložte nakreslenú schému v MULTISIM-e

**TABUĽKY :** *sem vložte upravené tabuľky z Excel-u* 

Tabuľka nameraných hodnôt pre určenie vstupnej charakteristiky bipolárneho tranzistora

Tabuľka nameraných hodnôt pre určenie prevodovej charakteristiky bipolárneho tranzistora

VZOROVÝ VÝPOČET : sem vložte výpočet podľa zadania

$$h_{11} = \frac{\Delta U_{BE}}{\Delta I_B} \quad [\Omega; V, A] \implies h_{11} =$$

$$h_{21} = \frac{\Delta I_C}{\Delta I_B} \ [-; A, A] = h_{21} =$$

GRAFY: sem vložte PrtScr grafov z MULTISIM-u

VYHODNOTENIE: sem napíšte vyhodnotenie (porovnanie Vášho overenia s teoretickými vedomosťami)

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