Name:	**Dr JBO**
Student ID Number:	**Model answer**
Section:	01A / 01B
Lecturer:	Dr. Jamaludin Bin Omar

EEEB273 - Quiz 2 [Question Set 1]
SEMESTER 1, ACADEMIC YEAR 2011/2012
Date: 1 June 2011

Question:

For all BJT current sources mentioned in this question, all transistors are matched and have same parameters. The transistor parameters are: β = 50, V_{BE} **(on) = 0.6 V**, and V_A **= 150 V**. The circuit parameters are: V^+ **= 7.5 V**, V^- **= -7.5 V** and R_1 **= 10 kΩ**. Calculate output current (I_O) and output resistance (R_O) for every BJT current source given in **Table 1** and fill in the **Table 1**. **Show all calculations** and do not forget to put proper Units to I_O and R_O in the **Table 1**.

Answer:

Table 1

BJT current source	Output current, I_O	Output resistance, R_O
Three-transistor current source	1.379 mA	108.781 kΩ
Wilson current source	1.379 mA	2.719 MΩ
Cascode current source	1.278 mA	5.869 MΩ

[0.5 marks] x 6 blanks in the **Table 1** = [3 marks]

Which current source has the most stable I_O? Answer: Wilson/Cascode [1 mark]

Calculations for I_O and R_O for every BJT current source: [1 mark] x 6 = [6 marks]

Model answers:

Three-transistor current source	Wilson current source	Cascode current source
$I_{REF} = (V^+ - 2\,V_{BE} - V^-)/R_1$ = (7.5 – 2x0.6 – (-7.5))/(10k) = 1.380 mA		
$I_O = I_{REF}/(1 + 2/(\beta(1+\beta))$) = (1.380m)/(1+2/(150x151)) = 1.379 mA	$I_O = I_{REF}/(1 + 2/(\beta(2+\beta))$) = (1.380m)/(1+2/(150x152)) = 1.379 mA	$I_O = I_{REF}/(1 + 4/\beta$) = (1.380m)/(1+4/(150)) = 1.278 mA
$r_{O2} = V_A / I_O$ = 150/(1.379m) = 108.781 kΩ $R_O = r_{O2}$ = 108.781 kΩ	$r_{O3} = V_A / I_O$ = 150/(1.379m) = 108.779 kΩ $R_O = (\beta\, r_{O3})/2$ = (150x108.779k)/2 = 2.719 MΩ	$r_{O4} = V_A / I_O$ = 150/(1.278m) = 117.391 kΩ $R_O = \beta\, r_{O4}$ = 150x117.391k = 5.869 MΩ

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Section:	05A / 05B
Lecturer:	Dr. Jamaludin Bin Omar

EEEB273 - Quiz 2 [Question Set 1]
SEMESTER 1, ACADEMIC YEAR 2011/2012
Date: 2 June 2011

Question:

For all BJT current sources mentioned in this question, all transistors are matched and have same parameters. The transistor parameters are: β = 75, V_{BE} **(on) = 0.6 V**, and V_A **= 120 V**. The circuit parameters are: V^+ **= 10 V**, V^- **= -10 V** and R_1 **= 15 kΩ**. Calculate output current (I_O) and output resistance (R_O) for every BJT current source mentioned in **Table 1** and fill in the **Table 1**. **Show all calculations** and do not forget to put proper Units to I_O and R_O in the **Table 1**.

Answer:

Table 1

BJT current source	Output current, I_O	Output resistance, R_O
Three-transistor current source	1.253 mA	95.778 kΩ
Wilson current source	1.253 mA	3.591 MΩ
Cascode current source	1.190 mA	7.563 MΩ

[0.5 marks] x 6 blanks in the **Table 1** = [3 marks]

Which current source has the most stable I_O? Answer: Wilson/Cascode [1 mark]

Calculations for I_O and R_O for every BJT current source: [1 mark] x 6 = [6 marks]

Model answers:

Three-transistor current source	Wilson current source	Cascode current source
$I_{REF} = (V^+ - 2\,V_{BE} - V^-)/R_1 = (10 - 2x0.6 - (-10))/(15k) = 1.253$ mA		
$I_O = I_{REF}/(1 + 2/(\beta(1+\beta)))$ = (1.253m)/(1+2/(120x121)) = 1.253 mA	$I_O = I_{REF}/(1 + 2/(\beta(2+\beta)))$ = (1.253m)/(1+2/(120x122)) = 1.253 mA	$I_O = I_{REF}/(1 + 4/\beta)$ = (1.253m)/(1+4/(120)) = 1.190 mA
$r_{O2} = V_A / I_O$ = 120/(1.253m) = 95.778 kΩ $R_O = r_{O2}$ = 95.778 kΩ	$r_{O3} = V_A / I_O$ = 120/(1.253m) = 95.778 kΩ $R_O = (\beta\, r_{O3})/2$ = (120x95.778k)/2 = 3.591 MΩ	$r_{O4} = V_A / I_O$ = 120/(1.190m) = 100.851 kΩ $R_O = \beta\, r_{O4}$ = 120x100.851k = 7.563 MΩ

Name:	**Dr JBO**
Student ID Number:	**Model answer**
Section:	05A / 05B
Lecturer:	Dr. Jamaludin Bin Omar

EEEB273 - Quiz 2 [Question Set 2]
SEMESTER 1, ACADEMIC YEAR 2011/2012
Date: 2 June 2011

Question:

For all BJT current sources mentioned in this question, all transistors are matched and have same parameters. The transistor parameters are: β = 75, V_{BE} **(on) = 0.6 V**, and V_A **= 100 V**. The circuit parameters are: V^+ **= 7.5 V**, V^{--} **= -7.5 V** and R_1 **= 12 kΩ**. Calculate output current (I_O) and output resistance (R_O) for every BJT current source mentioned in **Table 1** and fill in the **Table 1**. **Show all calculations** and do not forget to put proper Units to I_O and R_O in the **Table 1**.

Answer:

Table 1

BJT current source	Output current, I_O	Output resistance, R_O
Three-transistor current source	1.150 mA	86.987 kΩ
Wilson current source	1.150 mA	3.262 MΩ
Cascode current source	1.092 mA	6.869 MΩ

[0.5 marks] x 6 blanks in the **Table 1** = [3 marks]

Which current source has the most stable I_O? Answer: Wilson/Cascode [1 mark]

Calculations for I_O and R_O for every BJT current source: [1 mark] x 6 = [6 marks]

Model answers:

Three-transistor current source	Wilson current source	Cascode current source
$I_{REF} = (V^+ - 2\,V_{BE} - V^{--})/R_1 = (7.5 - 2x0.6 - (-7.5))/(12k) = 1.150$ mA		
$I_O = I_{REF}/(1 + 2/(\beta(1+\beta)))$ $= (1.150m)/(1+2/(75x76))$ $= 1.150$ mA	$I_O = I_{REF}/(1 + 2/(\beta(2+\beta)))$ $= (1.150m)/(1+2/(75x77))$ $= 1.150$ mA	$I_O = I_{REF}/(1 + 4/\beta)$ $= (1.150m)/(1+4/(75))$ $= 1.092$ mA
$r_{O2} = V_A / I_O$ $= 75/(1.150m)$ $= 86.987$ kΩ $R_O = r_{O2}$ $= 86.987$ kΩ	$r_{O3} = V_A / I_O$ $= 75/(1.150m)$ $= 86.987$ kΩ $R_O = (\beta\, r_{O3})/2$ $= (75x86.987k)/2$ $= 3.262$ MΩ	$r_{O4} = V_A / I_O$ $= 75/(1.092m)$ $= 91.594$ kΩ $R_O = \beta\, r_{O4}$ $= 75x91.594k$ $= 6.869$ MΩ

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EEEB273 - Quiz 2 [Question Set 3]
SEMESTER 1, ACADEMIC YEAR 2011/2012
Date: 2 June 2011

Question:

For all BJT current sources mentioned in this question, all transistors are matched and have same parameters. The transistor parameters are: β = 70, V_{BE} **(on) = 0.6 V**, and V_A **= 100 V**. The circuit parameters are: V^+ **= 10 V**, V^- **= -10 V** and R_1 **= 18 kΩ**. Calculate output current (I_O) and output resistance (R_O) for every BJT current source mentioned in **Table 1** and fill in the **Table 1**. **Show all calculations** and do not forget to put proper Units to I_O and R_O in the **Table 1**.

Answer:

Table 1

BJT current source	Output current, I_O	Output resistance, R_O
Three-transistor current source	1.044 mA	95.783 kΩ
Wilson current source	1.044 mA	3.352 MΩ
Cascode current source	0.988 mA	7.085 MΩ

[0.5 marks] x 6 blanks in the **Table 1** = [3 marks]

Which current source has the most stable I_O? Answer: Wilson/Cascode [1 mark]

Calculations for I_O and R_O for every BJT current source: [1 mark] x 6 = [6 marks]

Model answers:

Three-transistor current source	Wilson current source	Cascode current source
$I_{REF} = (V^+ - 2\,V_{BE} - V^-)/R_1 = (10 - 2x0.6 - (-10))/(18k) = 1.044$ mA		
$I_O = I_{REF}/(1 + 2/(\beta(1+\beta)))$ = (1.044m)/(1+2/(70x71)) = 1.044 mA	$I_O = I_{REF}/(1 + 2/(\beta(2+\beta)))$ = (1.044m)/(1+2/(70x72)) = 1.044 mA	$I_O = I_{REF}/(1 + 4/\beta)$ = (1.044m)/(1+4/(70)) = 0.988 mA
$r_{O2} = V_A / I_O$ = 100/(1.044m) = 95.783 kΩ $R_O = r_{O2}$ = 95.783 kΩ	$r_{O3} = V_A / I_O$ = 100/(1.044m) = 95.783 kΩ $R_O = (\beta\, r_{O3})/2$ = (70x95.783k)/2 = 3.352 MΩ	$r_{O4} = V_A / I_O$ = 100/(0.988m) = 101.216 kΩ $R_O = \beta\, r_{O4}$ = 70x101.216k = 7.085 MΩ

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Lecturer:	Dr. Jamaludin Bin Omar

EEEB273 - Quiz 2 [Question Set 4]
SEMESTER 1, ACADEMIC YEAR 2011/2012
Date: 2 June 2011

Question:

For all BJT current sources mentioned in this question, all transistors are matched and have same parameters. The transistor parameters are: β = 70, V_{BE} **(on) = 0.6 V**, and V_A **= 120 V**. The circuit parameters are: V^+ **= 7.5 V**, V^{--} **= -7.5 V** and R_1 **= 10 kΩ**. Calculate output current (I_O) and output resistance (R_O) for every BJT current source mentioned in **Table 1** and fill in the **Table 1**. **Show all calculations** and do not forget to put proper Units to I_O and R_O in the **Table 1**.

Answer:

Table 1

BJT current source	Output current, I_O	Output resistance, R_O
Three-transistor current source	1.379 mA	86.992 kΩ
Wilson current source	1.379 mA	3.044 MΩ
Cascode current source	1.305 mA	6.434 MΩ

[0.5 marks] x 6 blanks in the **Table 1** = [3 marks]

Which current source has the most stable I_O? Answer: Wilson/Cascode [1 mark]

Calculations for I_O and R_O for every BJT current source: [1 mark] x 6 = [6 marks]

Model answers:

Three-transistor current source	Wilson current source	Cascode current source
$I_{REF} = (V^+ - 2\,V_{BE} - V^{--})/R_1 = (7.5 - 2x0.6 - (-7.5))/(10k) = 1.380$ mA		
$I_O = I_{REF}/(1 + 2/(\beta(1+\beta)))$ = (1.380m)/(1+2/(70x71)) = 1.379 mA	$I_O = I_{REF}/(1 + 2/(\beta(2+\beta)))$ = (1.380m)/(1+2/(70x72)) = 1.379 mA	$I_O = I_{REF}/(1 + 4/\beta)$ = (1.150m)/(1+4/(70)) = 1.305 mA
$r_{O2} = V_A / I_O$ = 120/(1.379m) = 86.992 kΩ $R_O = r_{O2}$ = 86.992 kΩ	$r_{O3} = V_A / I_O$ = 120/(1.379m) = 86.992 kΩ $R_O = (\beta\, r_{O3})/2$ = (70x86.992k)/2 = 3.044 MΩ	$r_{O4} = V_A / I_O$ = 120/(1.305m) = 91.925 kΩ $R_O = \beta\, r_{O4}$ = 70x91.925k = 6.434 MΩ