Da test:
- Covers material through section 4-2
- Closed book and closed notes
- You may have one 8.5"x11" sheet with notes HAND WRITTEN on both sides (photocopies and computer printouts are not permitted)
- You may bring and use any scientific calculator (but it probably will not help you much)
- The test will be passed out before the start of class but you CAN NOT start until the bell and you MUST finish at the next bell or your exam will not be accepted and you will get a zero. EVERYONE should be allowed the same amount of time.
- Don’t cheat, this is just bad news for everyone involved.
- The test is designed to be difficult...

![Score Frequency Graph](image1)

![Score Frequency Graph](image2)
Active circuits
• have one or more devices that require an external power supply to operate correctly

Recall the proportionality property:
\[ y = Kx \]

Assuming \( y \) and \( x \) have the same units (A or V), what is the maximum that \( K \) could be for the circuits we have studied so far?

Signal amplification:
Linear dependent sources:

(a) CCVS

(b) VCVS

(c) CCCS

(d) VCCS

voltage gain
transresistance

current gain
transconductance
Warning,
Linear dependent sources are MODELS used to represent complicated circuits and or phenomena, they do not represent discrete devices.

The presence of active devices makes our analysis a bit more complicated...

E.g., superposition principle,
The response due to all independent sources acting simultaneously is equal to the sum of the responses due to each independent source acting one at a time.

The dependent sources are controlled by the independent sources.
There’s nothin’ up my sleve...

(a) Use note-voltage analysis to find the output, $v_o$, in terms of the input, $v_s$.
(b) Evaluate the i/o relationship as the gain, $\mu$, becomes very large.
... watch me pull a rabbit out of a hat.

(a) Formulate mesh-current equations for the given circuit
(b) Uses these equations to find $v_o$ and $R_{in}$ when $R_1=50\Omega$, $R_2=1k\Omega$, $R_3=100\Omega$, $R_4=5k\Omega$, and $g=100mS$
Meet the transistor... in particular, the large signal model of the BJT

\[ \begin{align*}
\text{Collector (C)} & \quad i_C, v_{CE} \\
\text{Base (B)} & \quad i_B, v_{BE} \\
\text{Emitter (E)} & \quad i_E
\end{align*} \]

An NPN BJT

**Cutoff (OFF)**

- \( i_B = 0 \)
- \( i_E = 0 \)

**Active (ON)**

- \( i_C = i_B \)
- \( v_{BE} = v \)

**Saturation (ON)**

- \( v_{CE} = 0 \)
- \( v_{BE} = v \)

KCL still applies to E B C

BJT large signal model:
Cutoff mode: $i_B = i_C = i_E = 0$
Active mode: $v_{BE} = V_\gamma$ and $i_C = \beta i_B$
Saturation mode: $v_{BE} = V_\gamma$ and $v_{CE} = 0$

How do you deal with these monsters? For now,
1) assume BJT is in active mode
2) do circuit analysis
3) verify assumption:
   if $i_B > 0$ the transistor can not be in cutoff and if $v_{CE} > 0$
   the transistor can not be in saturation

   then the assumption is correct
else if $i_B < 0$ the transistor is actually in cutoff

   then $i_B = i_C = i_E = 0$, repeat circuit analysis if necessary
else if $v_{CE} < 0$ the transistor is actually in saturation

   then $v_{BE} = V_\gamma$ and $v_{CE} = 0$, repeat circuit analysis if necessary
V_\_ = 0.7V, β = 100, R_B = 100kΩ, R_C = 1kΩ, V_{cc} = 5V
(a) Find i_C and v_{CE} when v_S = 3V, (b) Find the range of the input voltage, v_S, over which the transistor operates in active mode, (c) Plot the output voltage v_{CE} as a function of the input voltage over the range 0<v_S<10V
Cutoff mode: \( i_B = i_C = i_E = 0 \)
Active mode: \( v_{BE} = V_\text{N} \) and \( i_C = \beta i_B \)
Saturation mode: \( v_{BE} = V_\text{N} \) and \( v_{CE} = 0 \)