ID# ______________________________

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EE255 Exam 3 November 8th, 2000

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The exam consists of 16 multiple choice questions and 3 workout problems. Record the answers to the multiple choice on this page. Return the entire exam. There will be no partial credit for the multiple choice portion. There may be partial credit for the workout problems and hence show all your work.

DO NOT BEGIN UNTIL INSTRUCTED TO DO SO

1) a b c d e

2) a b c d e

3) a b c d e

4) a b c d e

5) a b c d e

6) a b c d e

7) a b c d e

8) a b c d e

9) a b c d e

10) a b c d e

11) a b c d e

12) a b c d e

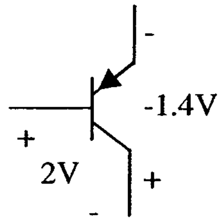
13) a b c d e

14) a b c d e

15) a b c d e

16) a b c d e

1. Given the transistor below, in which region will it operate ?



(a) Saturation (b) active (c) Cut-off (d) linear (e) inverse active

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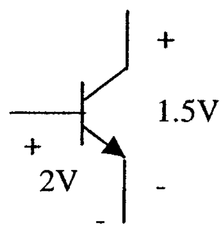
2. Given the transistor below, in which region will it operate ?



(a) Saturation (b) Active (c) Cut-off (d) Linear (e) Inverse active

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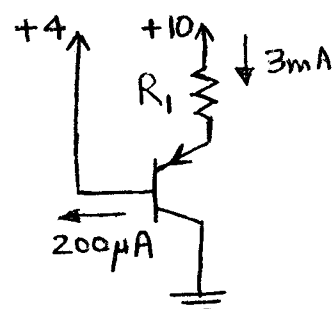
3. Given the circuit below as biased below and V_{BE_on} = -0.6, what is the value of R_1 ?



(a) 1.1kΩ (b) 1.8kΩ (c) 3.3kΩ (d) 4.6kΩ (e) 5.8kΩ

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4. What is the value of β for the transistor in problem 3 ?

(a) 11 (b) 12 (c) 13 (d) 14 (e) 15

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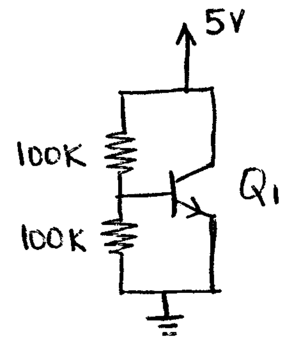
5. For the circuit shown below, find the value of I_C ? Use $V_{BE\_on} = 0.7$ $\beta = 100$



(a) 2mA (b) 3mA (c) 3.6mA (d) 4.5mA (e) 6mA

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6. Given an NPN transistor which has I_{C1}=1.1mA@V_{CE1}=4V and I_{C2}=1.2mA@ V_{CE2}=14V (both for the same I_B), then V_A is closest to which of the following answers ?

(a) 110 (b) 150 (c) 200 (d) 250 (e) 310

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7. If a transistor is biased at room temperature, I_C=2mA, and r_π=5kΩ, then β is closest to which of the following options ?

(a) 185 (b) 300 (c) 385 (d) 425 (e) 500

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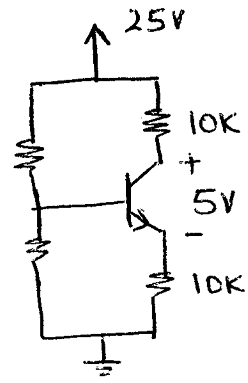
8. If a PNP device is operating at room temperature, V_A=50 and r_o=100kΩ, then g_m is closest to which of the following answers below ?

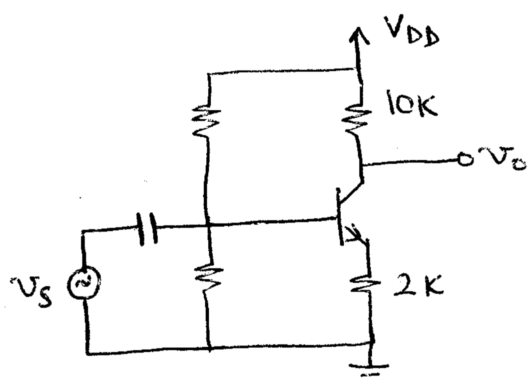
(a) 10 millimhos, (b) 20 millimhos, (c) 30 millimhos,
(d) 40 millimhos, (e) 10 millimhos,

9. If the transistor below is biased such that I_C=1mA. Now suppose that R_E is doubled, which one of the following will happen.



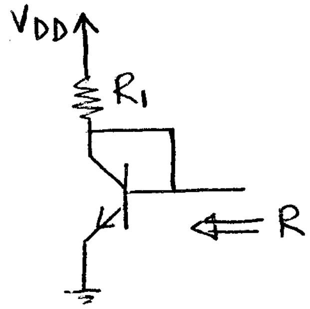
(a) Q forced into cut-off
(b) Q forced into saturation
(c) V_{CE} almost doubles
(d) V_{BE} almost doubles
(e) the temperature doubles

10. Given the transistor shown, the transistor is biased in forward active region. If β is quite large, and V_A = infinite, then the small signal voltage gain is about ;



(a) +2 (b) –2 (c) +5 (d) –5 (e) +10

11. Given the circuit as shown below, what is the impedance R as indicated;



(a) $R1 \| r_\pi \| r_o \| 1/g_m$ (b) $R1 \| r_\pi$ (c) $R1 \| r_o \| g_m$
(d) $r_\pi + r_o$ (e) r_π

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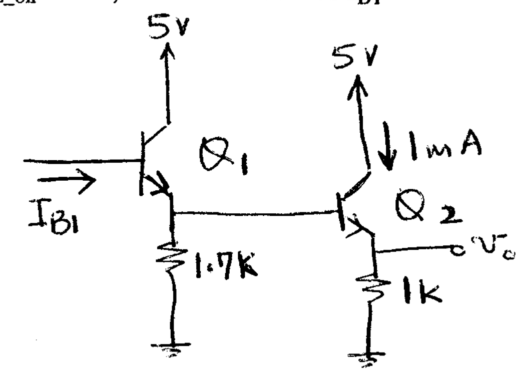
12. For the circuit shown below, if $\beta_1 = \beta_2 = 100$, and $V_{BE\_on} = 0.7$, find the value of I_{B1} ?



(a) 5μA (b) 10μA (c) 15μA (d) 20μA (e) 25μA

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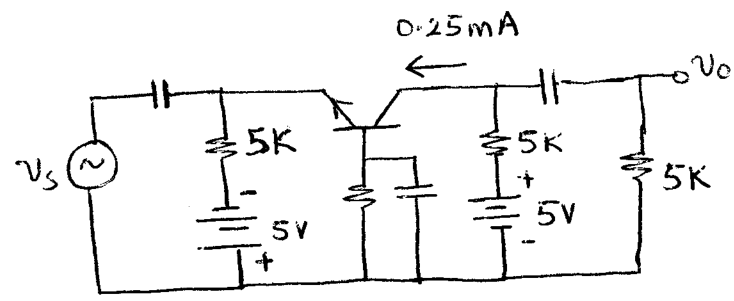
13. For the common base amplifier shown below at room temperature, V_A=infinite, the ac small signal gain is closest to;



(a) 15 (b) 25 (c) 35 (d) 45 (e) 55

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14. What type of amplifier has the lowest output impedance ?

(a) Common Source, (b) Common Base,
(c) Common Collector, (d) Common Emitter,
(d) Common Ground

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15. A power NPN transistor is biased such that I_C=100mA, and V_{CE}=20V. θ_{jc}=10°C/W and θ_{cs}=5°C/W. If the ambient temperature is 25°C and the device temperature was measured to be 75°C, find θ_{sa}= ?

(a) 10°C/W (b) 15°C/W (c) 20°C/W (d) 25°C/W (e) 30°C/W

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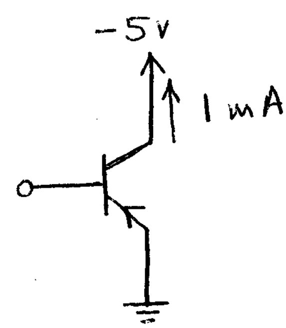
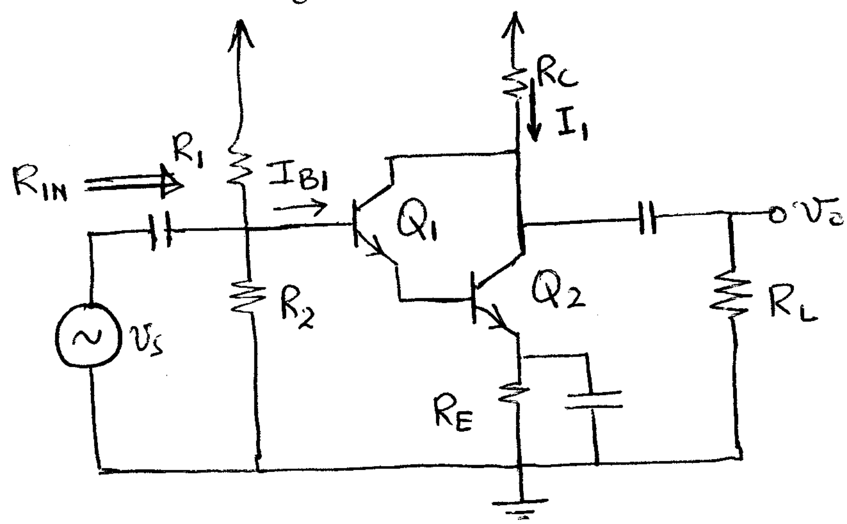
16. Given the PNP transistor below at room temperature, if $I_S=10^{-13}$ A, and V_A=10V, find the value of V_{EB} ?



(a) 0.455 (b) 0.586 (c) 0.689 (d) 0.799 (e) 100

17-19 pertain to the circuit diagram below.



$\beta 1 = \beta 2$, V_A = infinite

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17. Draw and label the ac equivalent circuit for the amplifier above. (6 points)

18. Find the expression for the input impedance R_{in} ? (R_{in} is indicated in the figure) (7 points)

19. Derive the expression for I_1/I_{B1}? (7 points) (I_1 and I_{B1} are shown in the circuit)

EE-255 Formula Sheet: Exam 3

Data:

$At\ 25\ ^{\circ}C\,(R.T.)\quad V_T = kT/q = 0.026$ volts

$k = 1.3806\times10^{-23}\ \mathrm{J/K} = 8.618\times10^{-5}\ \mathrm{eV/K}\qquad q = 1.6022\times10^{-19}\ C\qquad 0^{\circ}C = 273.16\,K$

Formulas: $e^x = 1 + x + x^2/2 + \cdots$

Bipolar Transistors:

$$I_C = \beta I_B \cong I_S\, e^{\frac{V_{BE}}{V_T}}\left(1+\frac{V_{CE}}{V_A}\right)\ (active)\qquad \beta=\frac{\alpha}{1-\alpha}\quad \alpha=\frac{\beta}{1+\beta}$$

$$I_C = \frac{\beta[V_{Th} - V_{BE}(on)]}{R_{Th} + (\beta+1)R_E}$$

Thermal Effects:

$$T_{dev} - T_{amb} = \theta P_D \qquad P_D = I_B V_{BE} + I_C V_{CE} \qquad P_D = I_D V_{DS}$$

Bipolar Amplifiers:

$$g_m = \frac{I_C}{V_T}\qquad g_m r_\pi = \beta \qquad r_o = \frac{V_A}{I_C}$$

CE: $A_{vi} = -g_m(R_C \parallel r_o \parallel R_L)\qquad R_{is} = r_\pi \parallel (R_1 \parallel R_2)\qquad R_o = R_C \parallel r_o$

CE with emitter degeneragion:

$$A_{vi} = \frac{-\beta(R_C \parallel R_L)}{r_\pi + (1+\beta)R_E}\qquad R_{is} = (R_1 \parallel R_2)\parallel[(r_\pi + (\beta+1)R_E)]\qquad R_o = R_C$$

CB: $A_{vi} = +g_m(R_C \parallel R_L)\qquad R_{is} = R_E \parallel \frac{r_\pi}{\beta+1}\qquad R_o = R_C$

CC: $$A_{vi} = \frac{(1+\beta)(r_o \parallel R_E \parallel R_L)}{r_\pi + (1+\beta)(r_o \parallel R_E \parallel R_L)}$$

$$R_{is} = (R_1 \parallel R_2)\parallel[r_\pi + (\beta+1)r_o \parallel R_E \parallel R_L]\qquad R_o = r_o \parallel R_E \parallel\left[\frac{r_\pi + (R_1 \parallel R_2)\parallel R_S}{\beta+1}\right]$$