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2019W1_ELEC_201_101102
Assignment ASN7 due 11/20/2019 at 11:59pm PST

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1. (5 points)

Consider a NPN transistor which exhibits a v_{BE1}=0.727011 V at i_{C1}=1 mA and v_{BE2}=0.786537 V at i_{C2}=10 mA. Calculate the transistor's temperature and I_s.

Boltzmann's constant = 1.38064852e-23

Charge of electron = 1.6021766208e-19

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

(a) T **:** ___ K

(b) I_s **:** ___ $10^{-18}A$

Correct Answers:

- 300
- 612

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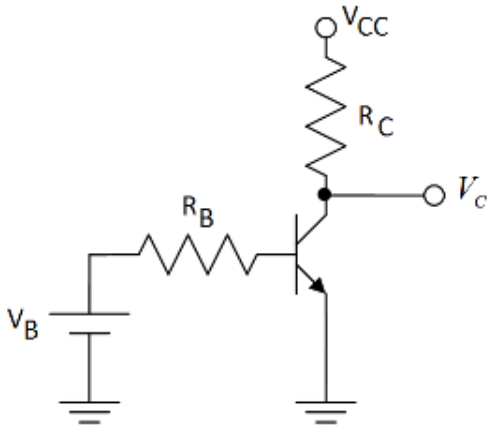
2. (5 points)

In the circuit below R_B=100$k\Omega$, R_C=1$k\Omega$, V_{CC}=10V, β=100, V_{BE}=0.7V, and $V_{CE(sat)}$=0.2V.

a. Calculate V_C if V_B=0.5V.
b. Calculate V_C if V_B=2.9V.
c. Calculate V_C if V_B=14.1V.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) V_C **:** ___ V

(b) V_C **:** ___ V

(c) V_C **:** ___ V

Correct Answers:

- 10
- 7.8
- 0.2

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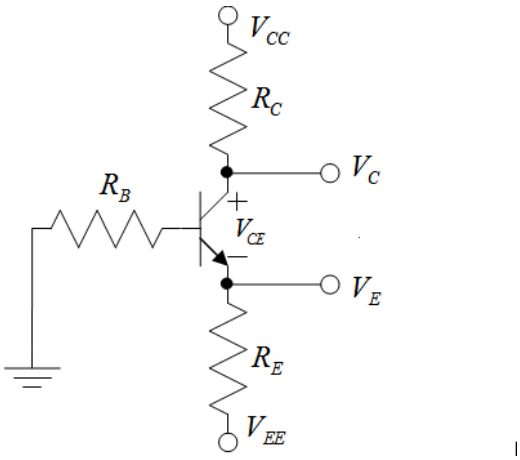
3. (10 points)

In the circuit below R_B=109$k\Omega$, R_C=0.12$k\Omega$, R_E=1.1$k\Omega$, V_{CC}=12V, V_{EE}=-12V, β=100, V_{BE}=0.7V, and $V_{CE(sat)}$=0.2V.

a. Calculate I_B in μA.
b. Calculate I_C in mA.
c. Calculate I_E in mA.
d. Calculate V_{CE} in V.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) I_B **:** ___ μA

(b) I_C **:** ___ mA

(c) I_E **:** ___ mA

(d) V_{CE} **:** ___ V

Correct Answers:

- 51.3403
- 5.13403
- 5.18537
- 17.68

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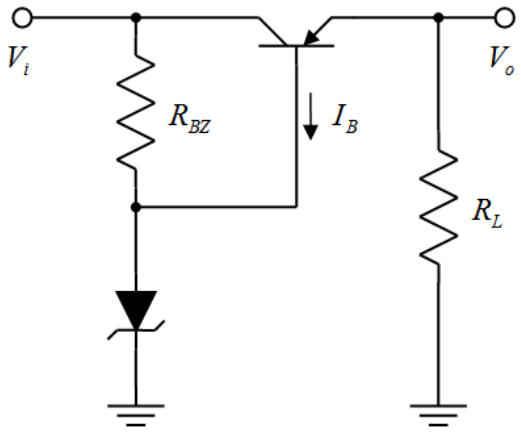
4. (10 points)

The zener diode in the circuit below is a 1N4740A with V_Z=10V @ I_{ZT}=25mA, r_Z=7Ω. For the transistor β=60, V_{EB}=0.7V, and $V_{CE(sat)}$=0.2V. V_i=-15.2V, R_{BZ}=186Ω, and R_L=44Ω.

a. Calculate V_o in V using the constant voltage drop model to represent the zener.
b. Calculate the base current I_B in mA using the constant voltage drop model to represent the zener.
c. Calculate V_o in V using the incremental model $V_{Z0} + r_Z$ to represent the zener.
d. Calculate the base current I_B in mA using the incremental model $V_{Z0} + r_Z$ to represent the zener.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) V_o **:** ___ V

(b) I_B **:** ___ mA

(c) V_o **:** ___ V

(d) I_B **:** ___ mA

Correct Answers:

- -9.3
- 3.46498
- -9.29658
- 3.4637

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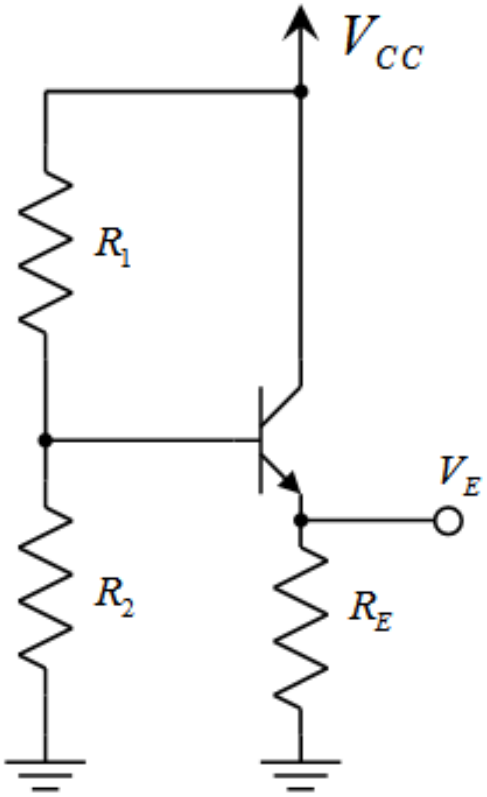
5. (10 points)

For the transistor in the circuit below β=100, V_{BE}=0.7V, and $V_{CE(sat)}$=0.2V. V_{CC}=14V, R_1=1028Ω, R_2=2036Ω, and R_E=42Ω.

a. Calculate the base current I_B in mA.
b. Calculate V_E in V.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) I_B **:** ____ mA

(b) V_E **:** ____ V

Correct Answers:

- 1.74674
- 7.40968

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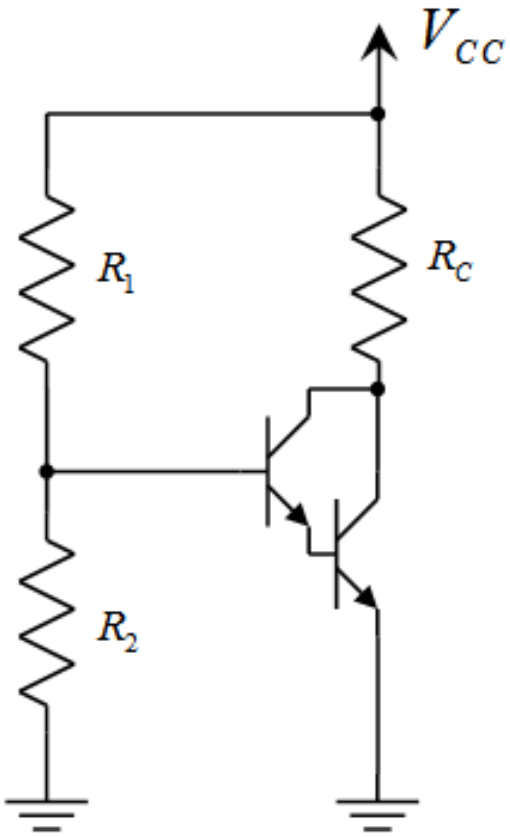
6. (10 points)

For the transistors in the circuit below β=100, V_{BE}=0.7V, and $V_{CE(sat)}$=0.2V. V_{CC}=15V, R_1=0.96$M\Omega$, R_2=1.44$M\Omega$, and R_C=10Ω.

a. Calculate the base current I_B in μA.
b. Calculate the collector current I_C in mA.
c. Calculate the emitter current I_E in mA.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

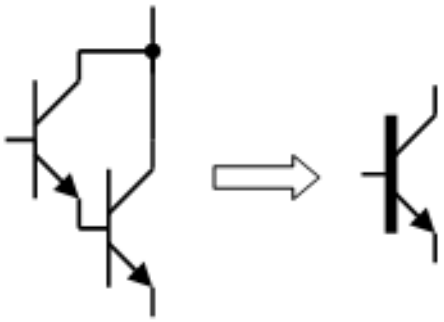


(a) I_B **:** ____ μA

(b) I_C **:** ____ mA

(c) I_E **:** ____ mA

When a couple of transistors are arranged in the manner shown in the figure above, the resulting combination is called a Darlington Pair, which is often represented with the symbol in the figure below. Calculate $\beta_{Darlington}$ of the equivalent transistor.



(d) $\beta_{Darlington}$ **:** ____

Correct Answers:

- 13.1944
- 134.583
- 134.597
- 10200

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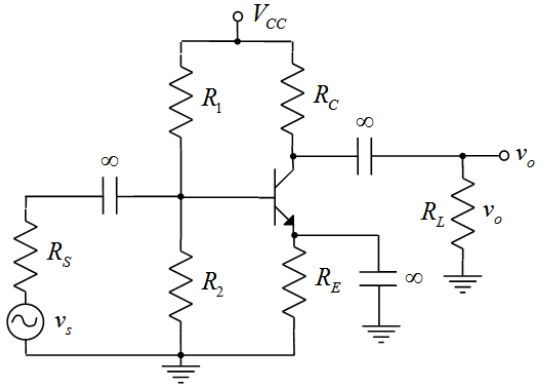
7. (10 points)

For the transistor in the amplifier below β=100, V_{BE}=0.7V, and $V_{CE(sat)}$=0.2V. Also R_S=50Ω, R_L=142Ω, V_{CC}=13.6V, R_1=6946Ω, R_2=3643Ω, R_C=906Ω, and R_E=501Ω. Assume V_T=0.025V.

a. Calculate g_m in $\frac{A}{V}$.
b. Calculate r_π in Ω.
c. Calculate the voltage gain A_V in $\frac{V}{V}$.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) g_m **:** ____ $\frac{A}{V}$

(b) r_π **:** ____ Ω

(c) A_V **:** ____ $\frac{V}{V}$

Correct Answers:

- 0.300347
- 332.949
- -31.4837

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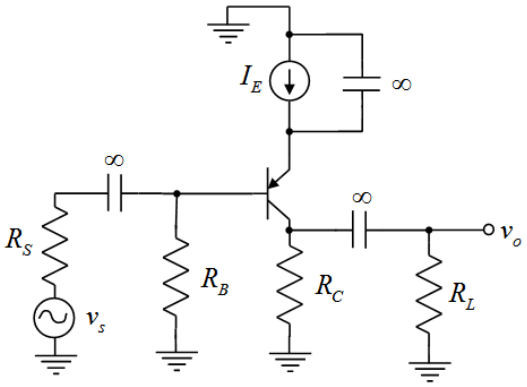
8. (10 points)

For the transistor in the amplifier below β=100, V_{EB}=0.7V, V_A=97V, and $V_{EC(sat)}$=0.2V. Also R_S=50Ω, R_L=2100Ω, I_E=8.585mA, R_B=94.117 kΩ, R_C=588Ω. Assume V_T=0.025V.

a. Calculate g_m in $\frac{A}{V}$.
b. Calculate r_π in Ω.
c. Calculate the voltage gain A_V in $\frac{V}{V}$.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) g_m **:** ____ $\frac{A}{V}$

(b) r_π **:** ____ Ω

(c) A_V **:** ____ $\frac{V}{V}$

Correct Answers:

- 0.34
- 294.118
- -128.27

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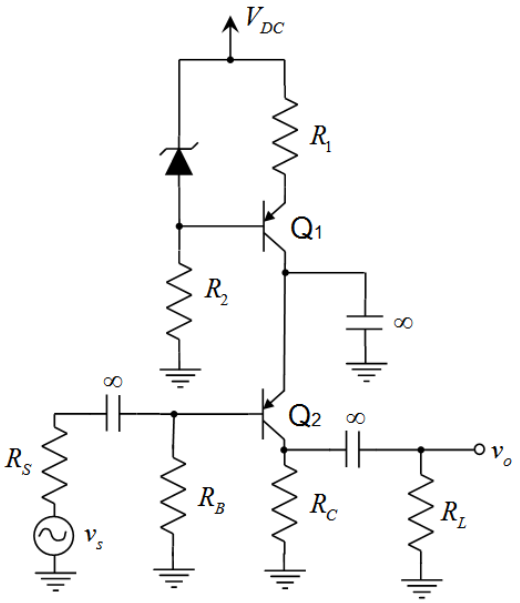
9. (10 points)

For both transistors in the amplifier below β=100, V_{EB}=0.7V, V_A=98V, and $V_{EC(sat)}$=0.2V. The zener diode can be modeled as a constant voltage source of V_Z=3.3V. Also R_S=50Ω, R_L=2710Ω, R_B=93.535 kΩ, R_C=584Ω, R_1=298Ω, and R_2=580Ω. Assume V_T=0.025V and V_{DC}=15V.

a. Calculate g_m in $\frac{A}{V}$.
b. Calculate r_π in Ω.
c. Calculate the voltage gain A_V in $\frac{V}{V}$.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



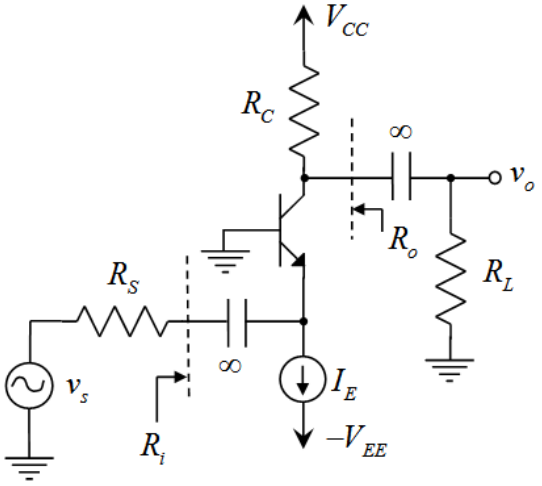
(a) g_m **:** ____ $\frac{A}{V}$

(b) r_π **:** ____ Ω

(c) A_V **:** ____ $\frac{V}{V}$

Correct Answers:

- 0.342117
- 292.298
- -134.653



(a) A_V **:** ____ $\frac{V}{V}$

(b) R_i **:** ____ Ω

(c) R_o **:** ____ Ω

Correct Answers:

- 7.81278
- 2.65957
- 620

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10. (10 points)

For the transistor in the common base amplifier below β=100, V_{BE}=0.7V, and $V_{CE(sat)}$=0.2V. Also I_E=9.4mA, R_S=50Ω, R_L=1260Ω, R_C=620Ω, V_T=0.025V, V_{CC}=15V, and V_{EE}=-15V.

a. Calculate $A_v = \frac{v_o}{v_s}$ in $\frac{V}{V}$.
b. Calculate R_i in Ω.
c. Calculate R_o in Ω.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)

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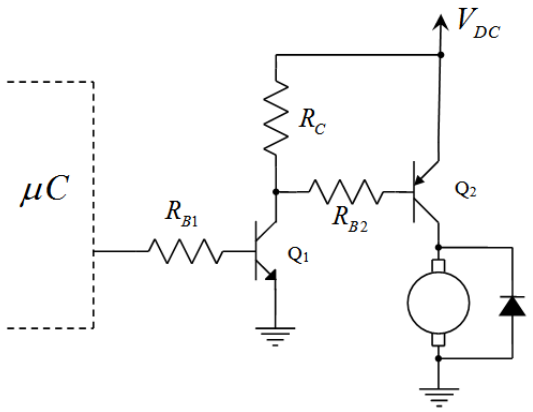
11. (5 points)

The circuit below is used to control a DC motor using a micro-controller for which logic one is 3V and logic zero is 0V. The motor consumes a maximum of 0.48A when turned on. For both Q_1 and Q_2: β=100, V_{BE}=V_{EB}=0.7V, and $V_{CE(sat)}$=$V_{EC(sat)}$=0.2V. Also R_C=11.2kΩ and V_{DC}=11.8V.

a. Calculate the maximum allowed value of R_{B1} in Ω.
b. Calculate the maximum allowed value of R_{B2} in Ω.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) R_{B1} **:** ____ Ω

(b) R_{B2} **:** ____ Ω

Correct Answers:

- 39412.5
- 2270.83

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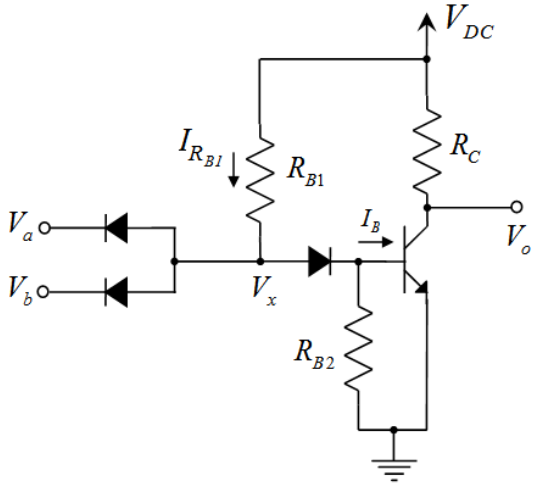
12. (5 points)

The circuit below is a Diode-Tansistor-Logic (DTL) NAND gate for which logic one is a voltage greater or equal than 1.4V and logic zero is a voltage less or equal than 0.2V. For the transistor β=100, V_{BE}=0.7V, and $V_{CE(sat)}$=0.2V. All the diodes can be represented as a constant voltage drop of V_D=0.7V; also R_C=1360Ω, R_{B1}=1350Ω, R_{B2}=6750Ω, and V_{DC}=5V. Both V_a and V_b can only be 0V (logic zero) or 5V (logic one).

a. Calculate the base current I_B in mA when the output V_o is logic zero.

b. Calculate the current trough R_{B1} ($I_{R_{B1}}$) in mA when the output V_o is logic one.

Note: In this problem, you may only submit numerical answers accurate to 0.02% or better. (i.e. If 4 is the correct answer, 3.9999 will be marked as correct, but 2+2 will be marked as incorrect.)



(a) I_B **:** ____ *mA*

(b) $I_{R_{B1}}$ **:** ____ *mA*

Correct Answers:

- 2.56296
- 3.18519