PHY2250 - Electronics & Circuit Theory, Practice Test

Name:____Dr. Hawley__________

Turn off (OFF) all cell phones

Multiple Choice: In the following problems, choose the "best" answer.

1. (4 points) When a transistor is in saturation,

a) $V_{CE} = V_{CC}$ b) $I_C = 0A$
c) $V_{CE} = V_{CC} / 2$ d) $V_{CE} = 0V$

2. (4 points) For the common-collector amplifier, the input and output voltages are

a) in phase. b) 90° out of phase.
c) 180° out of phase. d) 270° out of phase.

3. (4 points) In a FET, what are the labels of the three connections?

a) emitter, collector, base b) drain, source, base
c) source, gate, drain d) gain, emitter, source

4. (4 points) How many leads on an op-amp are typically used?

a) 5 b) 6
c) 8 d) 9

5 . (4 points) How many pins are there on a 741 IC op amp package?

a) 5 b) 6
c) 7 d) 8

~~6. (4 points) Calculate the AC resistance~~ $\cancel{r'_E}$ ~~(or~~ $\cancel{R_{E1}}$~~) of the emitter diode in a transistor for an emitter current~~ $\cancel{I_E = 1mA}$~~.~~

~~a) 25 Ω b) 20 Ω~~
~~c) 10 Ω d) 5 Ω~~

7. (4 points) In a given transistor circuit, the DC currents are $I_E = 25mA$, $I_B = 1mA$. $I_C = ?$"

a) .4 mA b) 24 mA
c) 5 mA d) 2 mA

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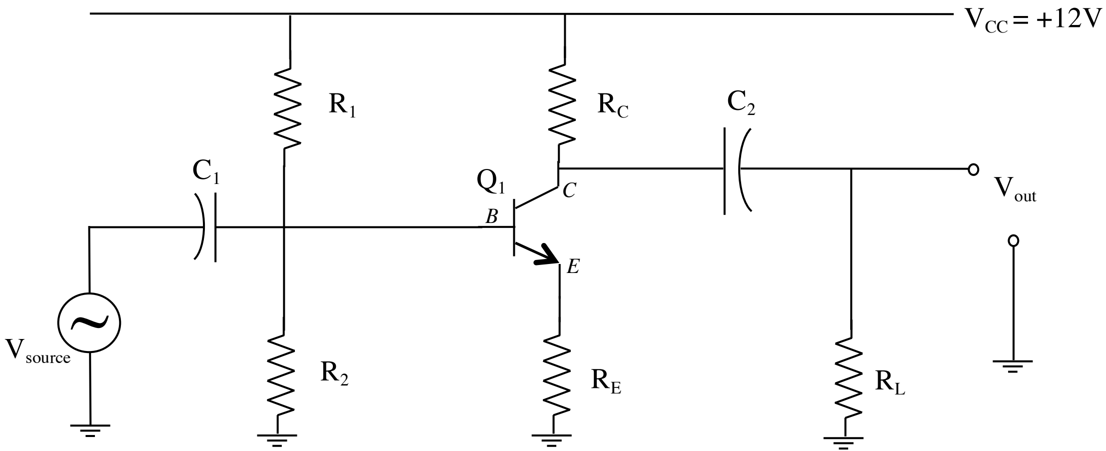
Questions 8 to 17 refer to the following circuit used (unknowingly) by the Jonas Brothers. Use the values $R_1 = 5.5k\Omega$, $R_2 = 4.5k\Omega$, $R_C = 1k\Omega$, $R_E = 750\Omega$, and R_L "=" infinity.



Questions 8 through 14 refer to DC, "quiescent points" of the transistor's operation:

8. (4 points) V_B =?
   a) 6.6 V　　c) 5.4 V
   b) 4.7 V　　d) 3.3 V

9. (4 points) V_E =?
   a) 6.6 V　　b) 5.4V
   c) 4.7 V　　d) 3.3V

10. (4 points) I_E =?
   a) 4.5 mA　　b) 0.2 mA
   c) 6.3 mA　　d) 1.2 mA

11. (4 points) If I_B = 0.1 mA, I_C =
   a) 0.32 mA　　b) 3.2 mA
   c) 6.2 mA　　d) 12 mA

12. (4 points) β_{DC} =
   a) 73　　b) 225
   c) 108　　d) 62

13. (4 points) V_C =?
   a) 4.3 V　　b) 6.2 V
   c) 4.7 V　　d) 5.8 V

14. (4 points) V_{CE}=?
   a) 1.2 V　　b) 3.8 V
   c) 1.5 V　　d) 12 V

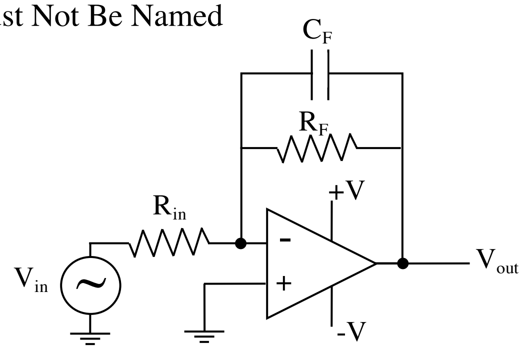
15. (4 points) If Q_1 were in saturation (e.g. when V_B swings high), what would V_C be?
   a) 0 V　　b) 4.7 V
   c) 5.14 V　　d) 12 V

16. (4 points) If Q_1 were in cutoff (e.g. when V_B swings low), what would V_C be?
   a) 0 V　　b) 4.7 V
   c) 5.14 V　　d) 12 V

17. (4 points) The above transistor is connected in a common-____________ configuration.
   a) collector　　b) base
   c) emitter　　d) mode

18. (4 Points) The best name for the following op-amp circuit (below) is

a) Closed-loop non-inverting amplifier   b) Active Low-pass filter
c) Compressor   d) Comparator
e) The Circuit That Must Not Be Named

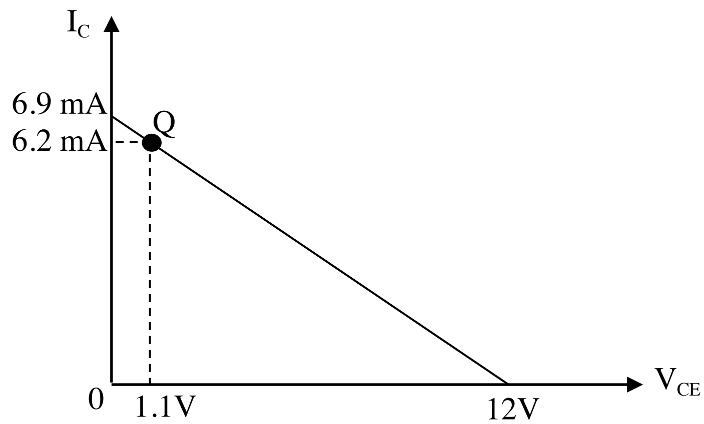


Short Answer: In the following problems, remember to *show your work* in completing any calculations.

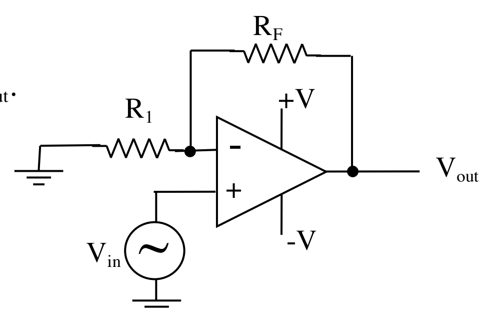
19. (6 points) Draw the DC Load Line for the circuit referred to in problems 8 to 17.

$\mathbf{V_{CE(OFF)} = 12V, \ V_{CEQ} = 1.1\ V}$

$\mathbf{I_{CQ} = 6.2\ mA, \quad I_{C(SAT)} = 12V / (750\Omega + 1000\Omega) = 6.9\ mA}$



20. (10 points) Regarding the following op-amp circuit…
a) Find V_-, the voltage at the - input, in terms of R_1, R_F and V_{out}.
b) If the feedback loop functions so as to force $V_- = V_+$,
use your answer to (b) to compute the gain of the amplifier
(in terms of R_1 and R_F). Show all work.



a) Regarding the upper "path" of the circuit as a voltage divider,

$$\mathbf{V_- = V_{out} R_1 / (R_1 + R_F)}$$

b) $\mathbf{V_+ = V_{in}}$**, so setting** $\mathbf{V_+ = V_-}$ **yields**

$$\mathbf{V_{in} = V_{out} R_1 / (R_1 + R_F)}$$

Thus $\mathbf{A_V = V_{out} / V_{in} = (R_1 + R_F) / R_1 = \boxed{1 + R_F / R_1.}}$

21. (12 points) Design a voltage-divider-biased amplifier, *i.e. find values for resistors R_1 , R_C and R_E* given the following specifications: V_{CC} = 12 V, V_C = 7 V, V_{CEQ} = 5.5 V, I_{CQ} = 20 mA, β_{DC} = 200, R_2=3kΩ. Show all work, and put boxes around your final resistor values.

Solve for R_C: $\mathbf{V_C = V_{CC} - I_C R_C}$. **Thus** $\mathbf{R_C = (V_{CC} - V_C) / I_{CQ} = (12 - 7)/.02 = 250\Omega}$

Solve for R_E: $\mathbf{V_E = V_C - V_{CEQ} = 7 - 5.5 = 1.5\ V}$

$\mathbf{I_E = I_C (\beta_{DC} +1)/ \beta_{DC} = 20mA\ (201)/200 = 20.1\ mA}$

$\mathbf{R_E = V_E / I_E = 1.5/0.0201 = \boxed{75\ \Omega}}$

Solve for R_1: $\mathbf{V_B = V_E + 0.7\ V = 2.2\ V}$

also $\mathbf{V_B = V_{CC}\ R_2 / (R_1 + R_2)}$

$\mathbf{V_B(R_1 + R_2) = V_{CC}\ R_2}$

$\mathbf{V_B\ R_1 + V_B\ R_2 = V_{CC}\ R_2}$

$\mathbf{V_B\ R_1 = V_{CC}\ R_2 - V_B\ R_2 = R_2\ (V_{CC} - V_B)}$

$\mathbf{R_1 = R_2\ (V_{CC} - V_B) / V_B}$

$\mathbf{= 3k\ (12 - 2.2) / 2.2}$

$\mathbf{= \boxed{13364\ \Omega}}$

Extra Credit:

22. (3 points) Which is the more popular transistor biasing method *and why* : base bias or voltage divider bias?

Voltage divider biasing is more common because it is more stable with respect to temperature fluctuations and with respect to variations in β_{DC} of the transistor (e.g. if the transistor is replaced).

23. (2 points) How many valence electrons does Aluminum have?

Answer: 3.