AMPLIFIERS TRIAL
MID-SEMESTER TEST

- This test is **closed** book, calculator permitted.
- Time permitted 1½ hours.
- Answer the questions in the spaces provided.
- **60 MARKS TOTAL (70% pass)**
- Clearly label all currents, resistors and voltage drops in the circuits and state any assumptions in order to obtain a full mark
- When calculating values, clearly show all steps, starting with the formula, then substituting with numbers and finally show the measuring units of the obtained result. Otherwise **NO MARKS** are given
- It is permitted to use lecturer's approved formula sheet.

Q1) Electrons orbiting the nucleus of an atom are grouped into energy bands called: **[1 mark]**

a. Tunnels
b. Slots
c. Tracks
d. Shells

Q2) Which of the following statements is true? **[1 mark]**

a. Valence electrons possess the highest energy levels of all electrons orbiting around the nucleus.
b. Valence electrons possess the lowest energy levels of all electrons orbiting around the nucleus.
c. Valence electrons energy levels are the same as all the others electrons orbiting around the nucleus.
d. All of the above could be true, depending on the circumstances.

Q3) Sketch the Bohr model of an atom. **[1 mark]**

Q4) Define *atom.* **[1 mark]**

Q5). Define *electron,* according to the Bohr model of an atom. **[1 mark]**

Q6). Define *proton,* according to the Bohr model of an atom. **[1 mark]**

Q7). What is the nucleus of an atom composed of? **[1 mark]**

Q8). Define *atomic number.* **[1 mark]**

Q9). Define *balanced (or neutral) atom.* **[1 mark]**

Q10). Define *valence electrons.* **[1 mark]**

Q11) What is a *free electron*? **[1 mark]**

Q12) What is the maximum number of electrons permitted in the first shell? **[1 mark]**

a. 2
b. 8
c. 18
d. 32

Q13) What is the maximum number of electrons permitted in the second shell? **[1 mark]**

a. 2
b. 8
c. 18
d. 32

Q14) What is the maximum number of electrons permitted in the third shell? **[1 mark]**

a. 2
b. 8
c. 18
d. 32

Q15) What is the maximum number of electrons permitted in the fourth shell? **[1 mark]**

a. 2
b. 8
c. 18
d. 32

Q16) Describe the process of *ionization*. **[1 mark]**

Q17) Describe the process of *recombination*. **[1 mark]**

Q18) What are the three main differences between the *Bohr model* of an atom and the more recent *Quantum model* of an atom? **[3 marks]**

a.

b.

c.

Q19) Define *orbitals*, according to the Quantum model of an atom. **[2 marks]**

Q20) Define *conductors*. Give a few examples. **[2 marks]**

Q21) Define *insulators*. Give a few examples. **[2 marks]**

Q22) Define *semiconductors*. Give a few examples. **[2 marks]**

Q23) What is meant by the term *intrinsic* crystal? **[1 mark]**

Q24) Sketch the energy diagrams for conductors, insulators and semiconductors. **[2 marks]**

Q25) Define *covalent bonds* in a silicon crystal. Sketch a diagram. **[1 mark]**

Q26) Which of the following statements is true? **[1 mark]**

a. At 0 Kelvin the intrinsic silicon crystal behaves as an ideal conductor.
b. At 0 Kelvin the intrinsic silicon crystal behaves as an ideal insulator.
c. The temperature does not affect the conductivity of the intrinsic silicon crystal.
d. None of the above.

Q27) Where are the free electrons located? **[1 mark]**

a. In the valance band.
b. In the conduction band.
c. In the band closest to the nucleus.
d. They are free. It is impossible to tell.

Q28) What is a *hole*? **[1 mark]**

Q29) What does the process of *doping* involve? **[1 mark]**

Q30) How is an *n-type* semiconductor formed? Sketch a diagram and explain. **[2 marks]**

Q31) How is an *p-type* semiconductor formed? Sketch a diagram and explain. **[2 marks]**

Q32) What is a *p-n junction*? **[1 mark]**

Q33) Describe the *depletion region*. **[1 mark]**

Q34) What is *barrier potential*? Sketch a diagram and explain. **[1 mark]**

Q35) What is *a diode*? **[1 mark]**

Q36) What two conditions have to be satisfied, in order to have a *forward-biased* diode? **[2 marks]**

a.

b.

Q37) What two conditions have to be satisfied, in order to have a *reverse-biased* diode? **[2 marks]**

a.

b.

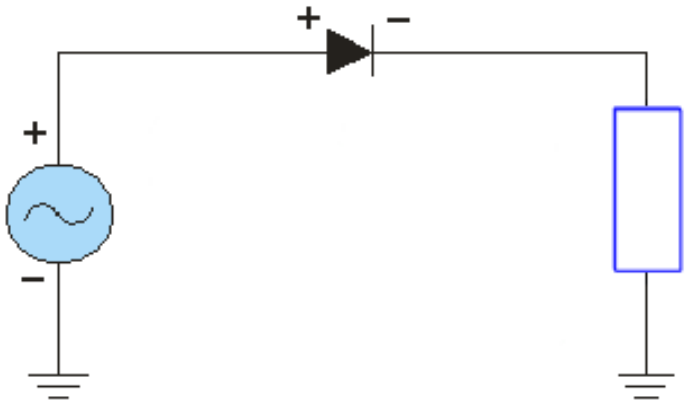
Q38) What is *reverse current*? **[1 mark]**

Q39) What is *reverse breakdown voltage*? **[1 mark]**

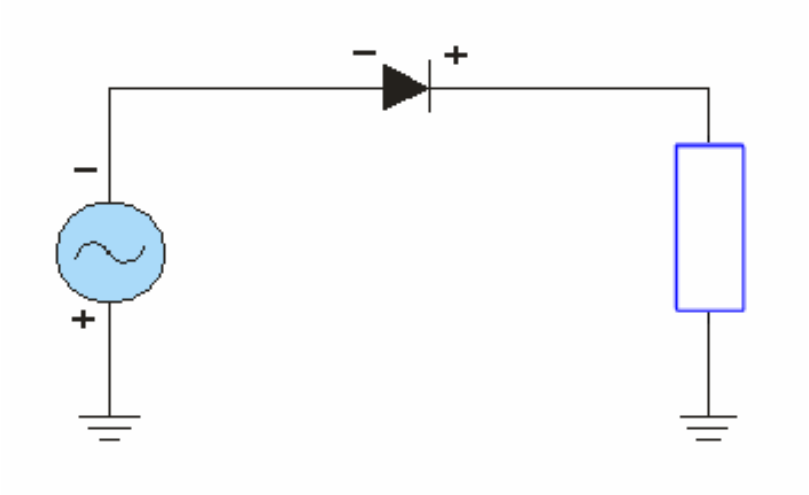
Q40) What is meant by *dynamic resistance* of a diode? What is the formula? **[1 mark]**

Q41) Draw the voltage-current characteristic of a diode. **[1 mark]**

Q42) Determine the forward current and the voltage drops across the diode and the load resistor in the figure given below, when the diode is conducting. Use the ideal, the practical and the complete diode model. Assume V_S = 10 V, R_L = 1 kΩ and r_d' = 10 Ω. **[3 marks]**

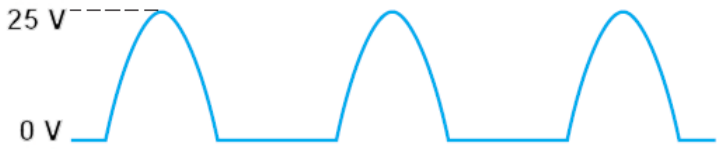


Q43) Determine the reverse current and the voltage drops across the diode and the load resistor in the figure given below, when the diode is NOT conducting. Use the ideal, the practical and the complete diode model. Assume V_S = 10 V, R_L = 1 kΩ and I_R = 1μA. **[3 marks]**

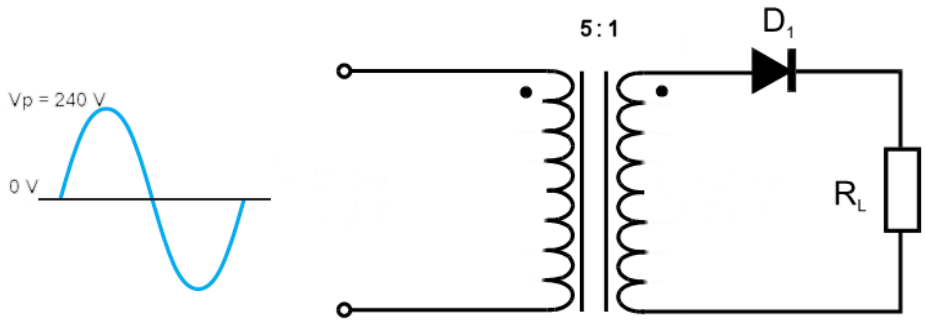


Q44) Draw a complete block diagram of a power supply, clearly indicating the functions of each block and the anticipated output after each one of them. **[2 marks]**

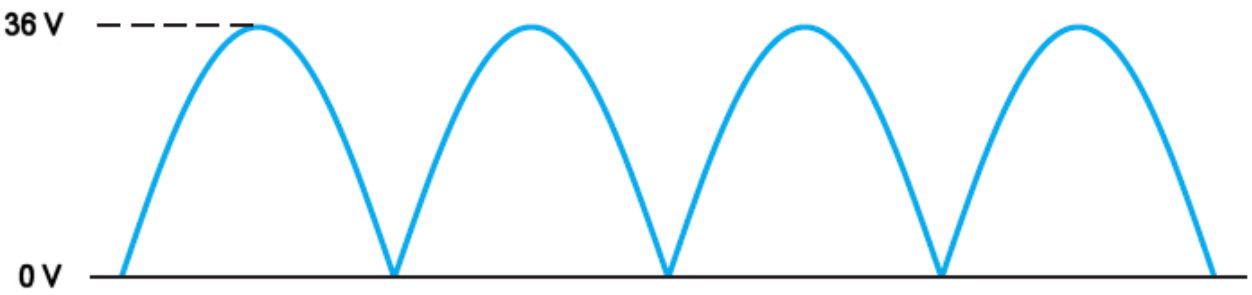
Q45) Determine the average value of the half-wave rectified voltage in the diagram below.
[2 marks]



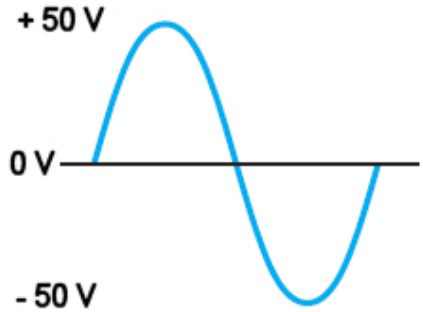
Q46) Determine the peak value of the output rectified voltage in the diagram below. **[2 marks]**

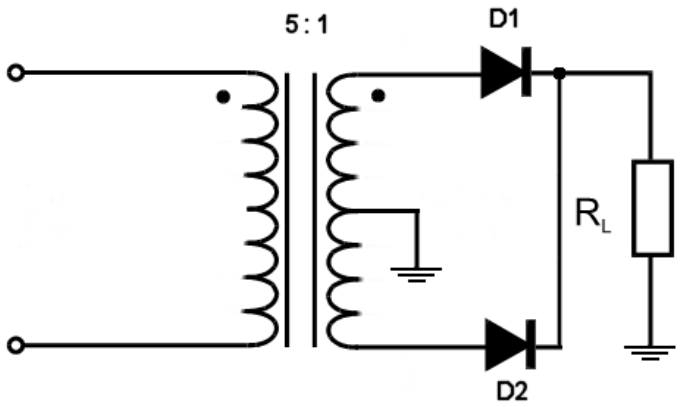


Q47) Determine the average value of the full-wave rectified voltage in the diagram below.
[2 marks]

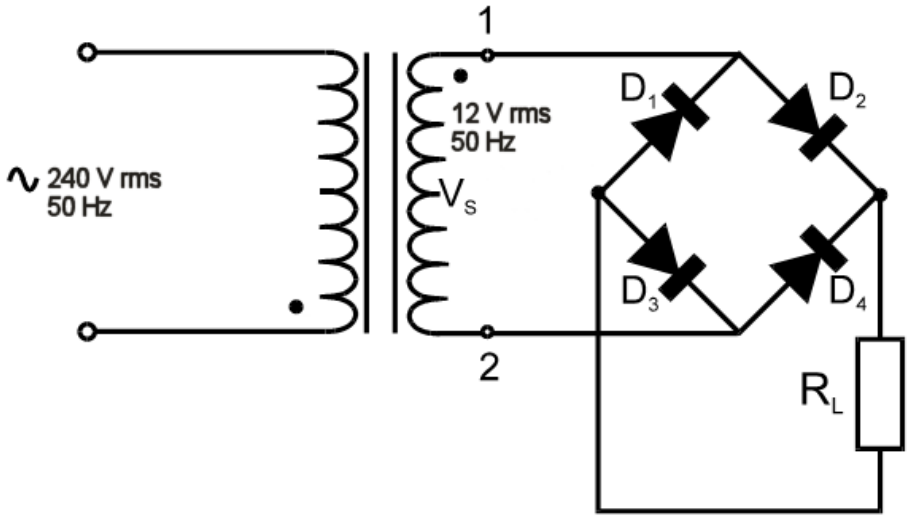


Q48) Show the voltage waveforms across each half of the secondary winding and across R_L when a 50 V peak sine wave is applied to the primary winding. Calculate PIV. **[2 marks]**





Q49) Determine the peak output voltage for the bridge rectifier given below. Assuming the practical model, what PIV rating is required for the diodes? The transformer is specified to have 12 V rms secondary voltage for the standard 240 V across the primary. **[3 marks]**


1
12 V rms
50 Hz
240 V rms
50 Hz
V_S
D_1
D_2
D_3
D_4
R_L
2

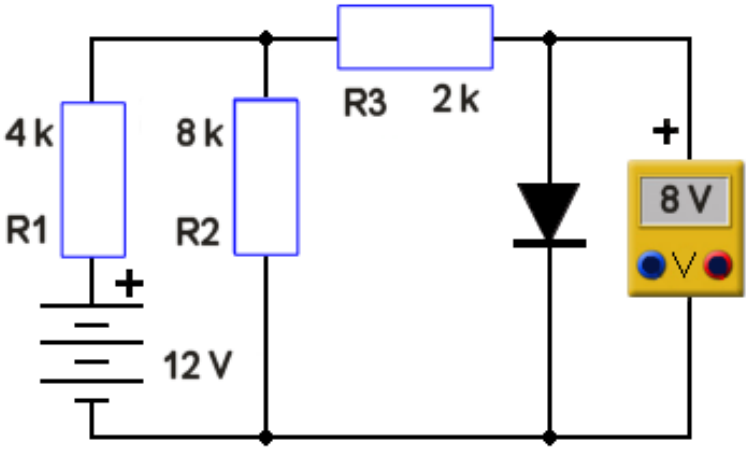
Q50) A properly functioning diode will produce a reading in what range when forward biased and reverse biased? **[2 marks]**

Q51) What reading the DMM will produce when a diode has failed open? **[1 mark]**

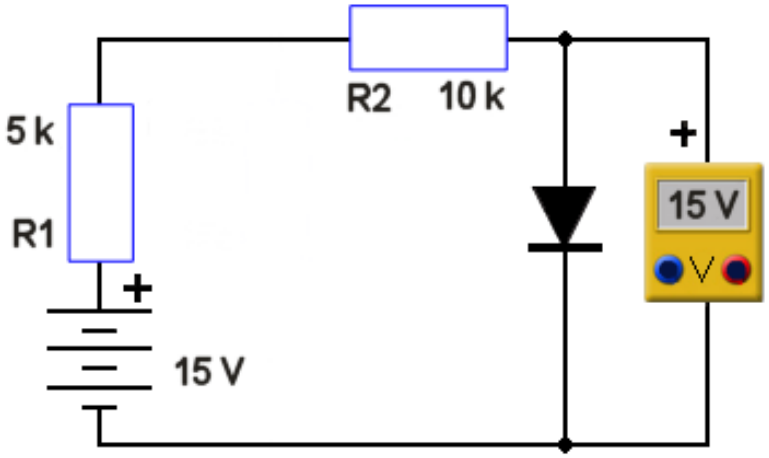
Q52) What reading will the DMM produce when a diode is shorted? **[1 mark]**

Q53) What reading will the DMM produce when a diode is leaky? **[1 mark]**

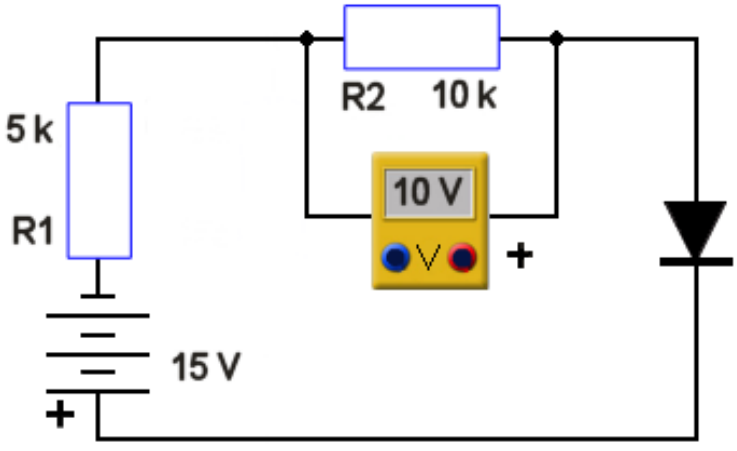
Q54) Consider the meter indications in the circuit and determine whether the diode is functioning properly. If not, state what is the most likely failure (shorted, open or leaky diode). Briefly describe the logical path you have followed, in order to arrive at your conclusion. Assume the ideal model.
[2 marks]



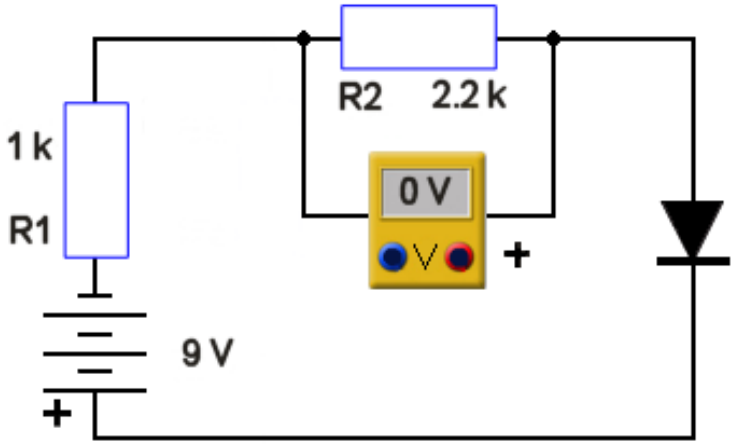
Q55) Consider the meter indications in the circuit and determine whether the diode is functioning properly. If not, state what is the most likely failure (shorted, open or leaky diode). Briefly describe the logical path you have followed, in order to arrive at your conclusion. Assume the ideal model.
[2 marks]



Q56) Consider the meter indications in the circuit and determine whether the diode is functioning properly. If not, state what is the most likely failure (shorted, open or leaky diode). Briefly describe the logical path you have followed, in order to arrive at your conclusion. Assume the ideal model.
[2 marks]



Q57) Consider the meter indications in the circuit and determine whether the diode is functioning properly. If not, state what is the most likely failure (shorted, open or leaky diode). Briefly describe the logical path you have followed, in order to arrive at your conclusion. Assume the ideal model. **[2 marks]**



Q58) Describe the construction and depict the symbol of an NPN type transistor. **[1 mark]**

Q59) Describe the construction and depict the symbol of an PNP type transistor. **[1 mark]**

Q60) Describe the two modes of operation of a transistor. **[2 marks]**

a.

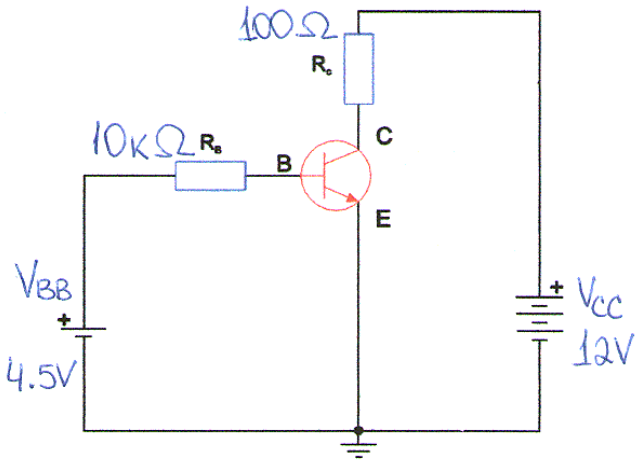
b.

Q61) Sketch a diagram, depicting a transistor as an amplifier. **[2 marks]**

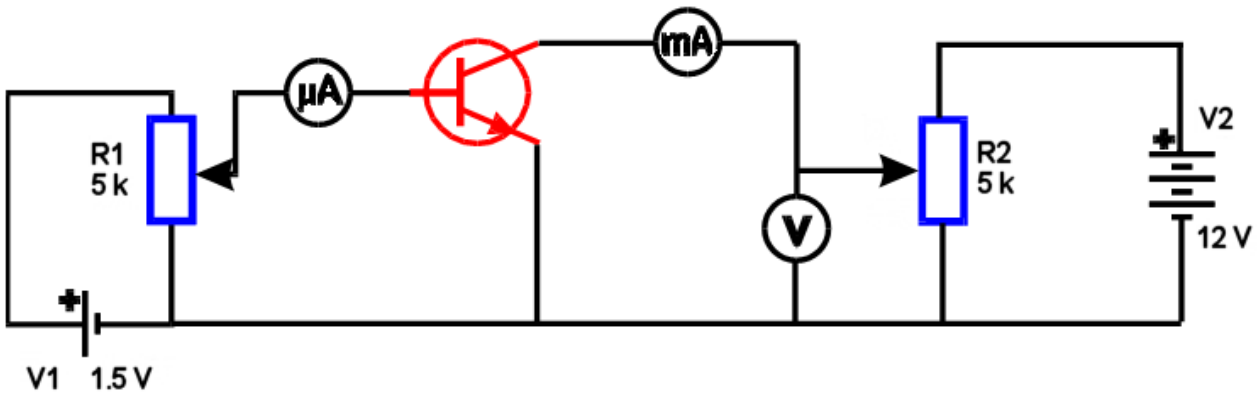
Q62) Determine the DC current gain β_{DC} and the emitter current I_E for a transistor, where I_B is 50 μA and I_C is 5 mA. **[2 marks]**

Q63) A certain transistor is to be operated with V_{CE} = 6V. If its maximum power rating is 300 mW, what is the most collector current that it can handle? **[2 marks]**

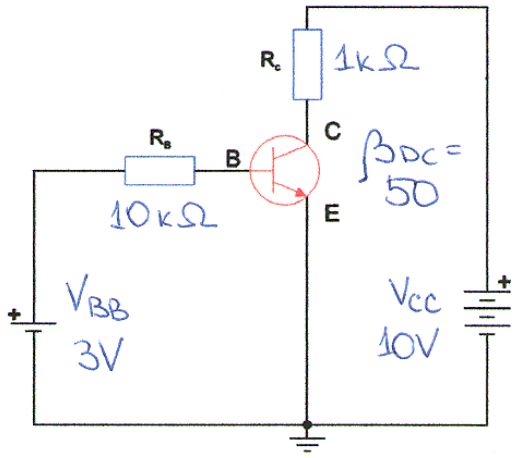
Q64) Determine I_B, I_C, I_E, V_{BE}, V_{CE} and V_{CB} in the circuit below. The transistor has a $\beta_{DC} = 150$ **[3 marks]**



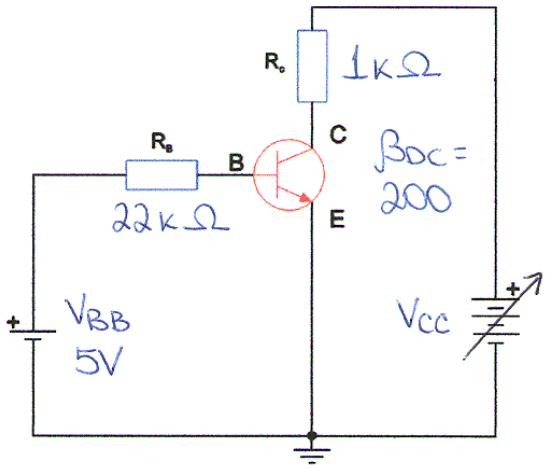
Q65) Sketch an ideal family of collector curves for the circuit given below for I_B = 5 µA to 30 µA in 5 µA increments. Assume $\beta_{DC} = 100$ and that V_{CE} does not exceed breakdown. **[3 marks]**



Q66) Determine whether or not the transistor given in the figure below is in saturation. Assume $V_{CE(sat)} = 0.2$ V. **[3 marks]**



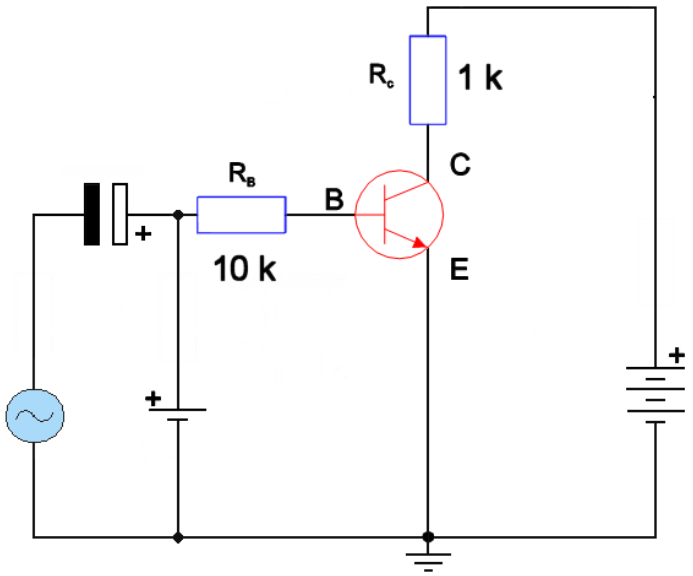
Q67) The transistor, given in the figure has the following maximum ratings: $P_{D(max)}$ = 700 mW, $V_{CE(max)}$ = 15 V, and $I_{C(max)}$ = 100 mA. Determine the maximum value to which V_{CC} can be adjusted without exceeding the rating. Which rating would be exceeded first? **[3 marks]**



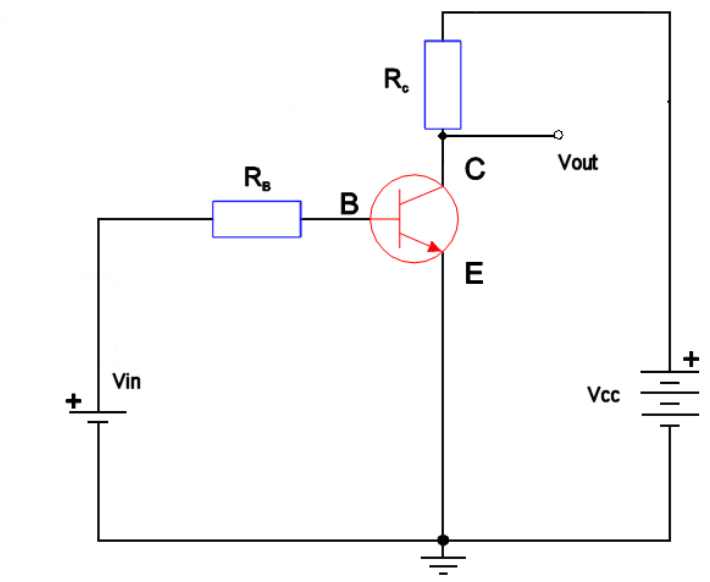
Q68) In the circuit, given in the previous question 67, assume that the transistor 2N3904 is used. Your task is to obtain the datasheet for this transistor and to determine the maximum value to which V_{CC} can be adjusted without exceeding the rating. Which rating would be exceeded first?

[3 marks]

Q69) Determine the voltage gain and the AC output voltage in the figure below if r_e' = 75Ω and V_b = 0.1 V **[2 marks]**

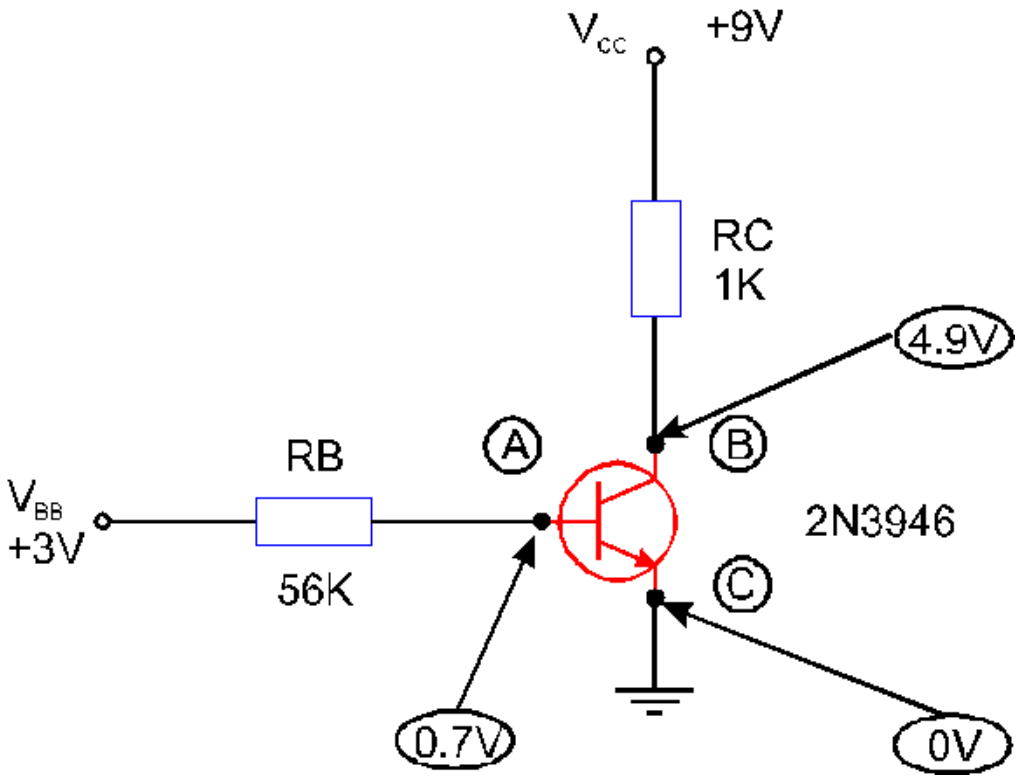


Q70) For the transistor, given in the figure, what is V_{CE} when V_{IN} = 0 V? What minimum value of I_B is required to saturate this transistor if β_{DC} is 150. Assume V_{CC} is 10 V. Neglect $V_{CE(sat)}$. Calculate the maximum value of R_B when V_{IN} = 5 V. **[3 marks]**



Q71) In the circuit given below the normal operating voltages of the transistor 2N3946 are indicated at points A, B and C in respect to ground. Sketch three diagrams for the three typical transistor faulty conditions: open base, open collector and open emitter and clearly indicate what voltages you anticipate to measure at points A, B and C for each faulty condition.

[3 marks]



Q72) How can a transistor be tested with the DMM's diode test function? Draw the equivalent diagram for PNP and NPN transistors. **[3 marks]**

NOTE: Only about 20 - 25 of the questions in this trial test will be given to you on the actual test. The values of the components, power supplies etc. will be changed, but in essence the questions will remain almost identical.

END OF TEST
(Check your work!)