EHB222E INTRODUCTION TO ELECTRONICS (10745, 10747, 10748, 11201)
MT1 Exam 16 November 2021 🕓 18:00-19:30
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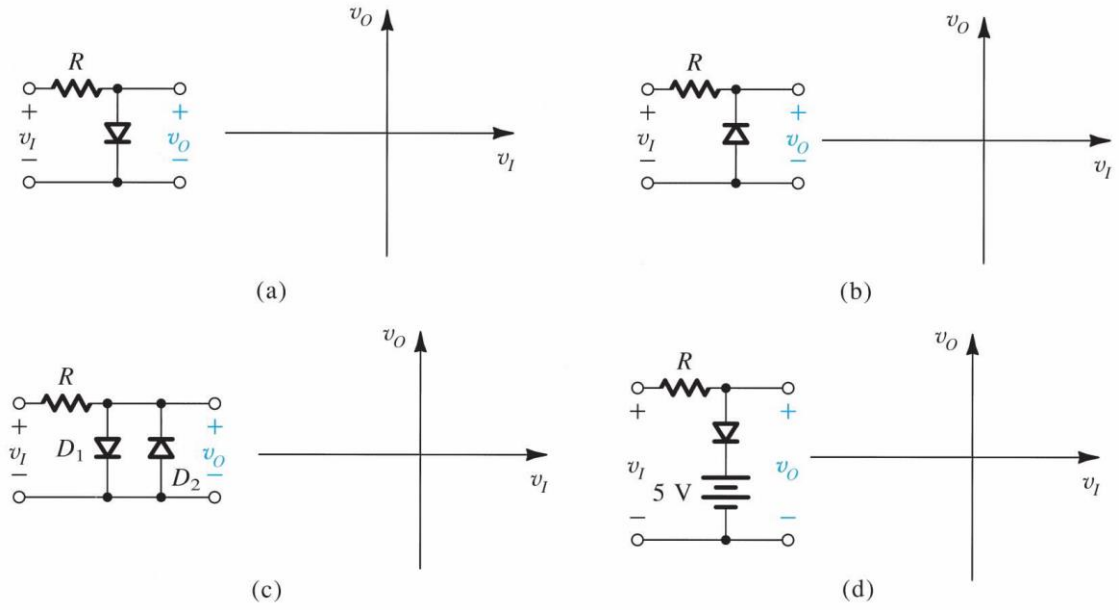
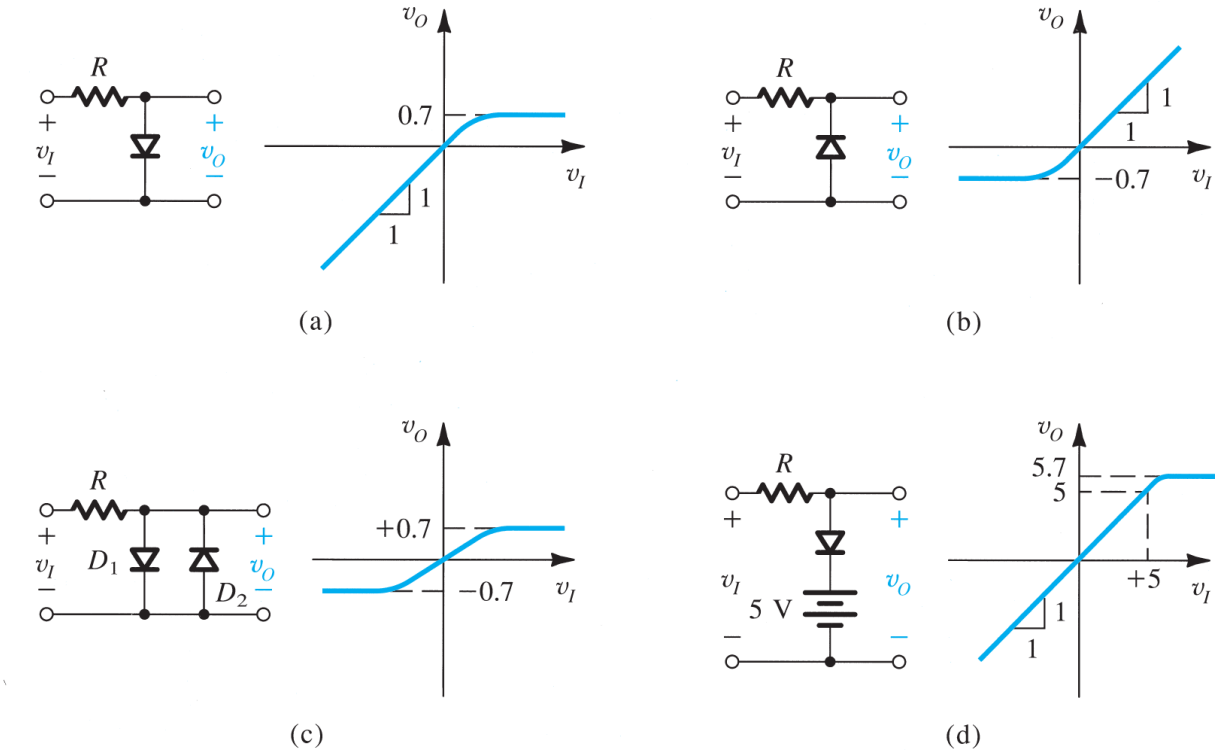
1. Assume you are to create p^+np transistor using n- and p-typed doped silicon with the following doping concentrations, **$2\cdot10^{18}$ /cm^3**, **10^{14} /cm^3**, and **$4\cdot10^{16}$ /cm^3**, for emitter, base and collector regions, respectively. You also know **L_n = 8 µm, L_p = 4 µm, μ_n = 1500 cm^2/Vs, μ_p = 500 cm^2/Vs, $n_i = 1{,}5\cdot10^{10}$/cm^3, q = $1{,}602\cdot10^{-19}$ C, ε_r = 12, $\varepsilon_o = 8{,}85\cdot10^{-12}$ F/m, V_T = 25 mV.** Calculate (26 points total)
   a. barrier potentials for EB and BC junctions. (2x 4 points) (V_{B1} = 688 mV, V_{B2} = 590 mV)
   b. saturation current for a junction area of 0,15 mm^2 assuming $h_{FE} = \beta$ is very large. (6 points) (16,9 pA)
   c. depletion zone widths of both junctions in unbiased state. (2x 4 points) state (w_{EB} = 3,02 µm, w_{BC} = 2,80 µm)
   d. What is the minimum V_{CE} for operation in active mode? (4 points) (V_{CEmin} = 688 mV)

2. v_1 is a sinusoidal wave source. Sketch the v_o -v_1 diagrams by using modified ideal diode model (V_D=0.7V: voltage drop on a diode) (4x 6 points

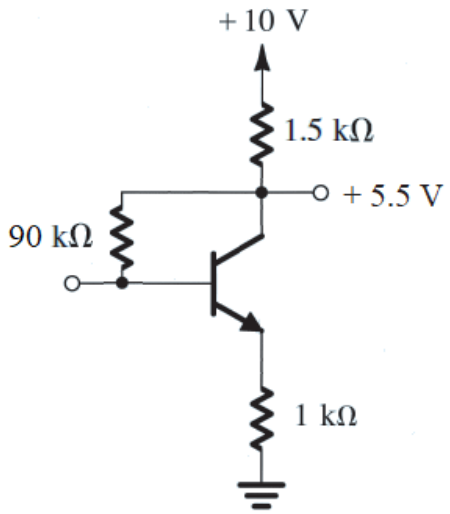


GOOD LUCK EVERYONE

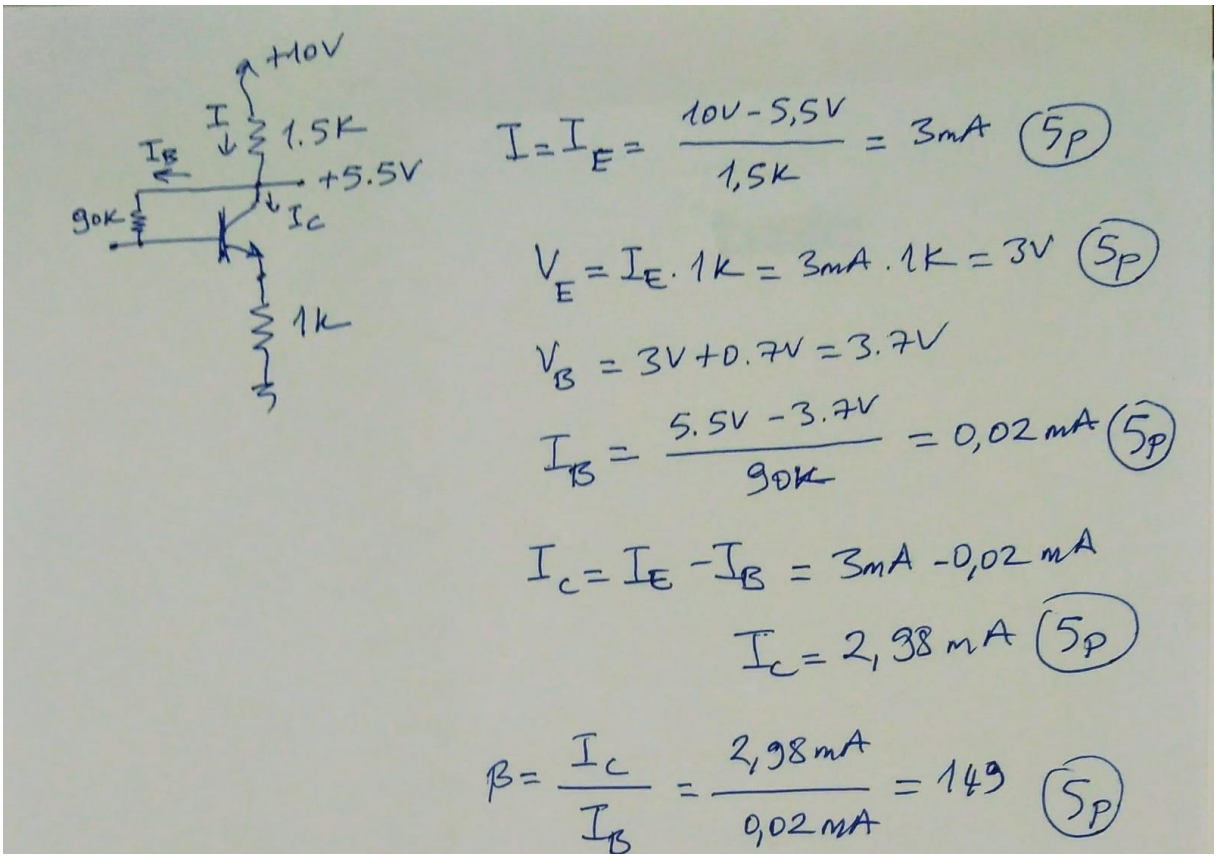
Solution:



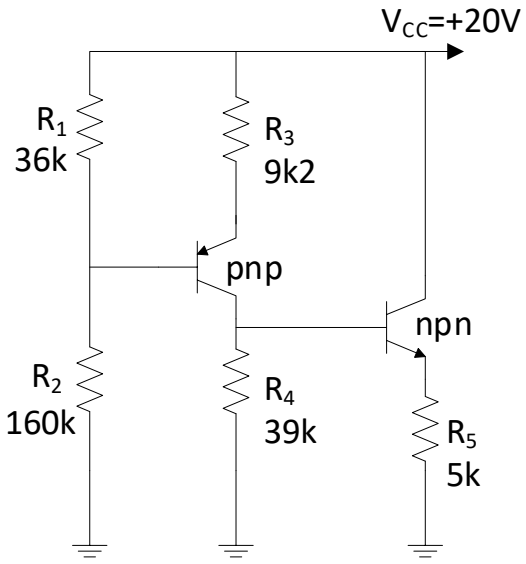
3. Measurement on the circuit of figure produce labelled voltage as indicated. Find the value of I_C, I_B, I_E, V_E and β for transistor. ($|V_{BE}|$=0.7 V) (5x 5 points)



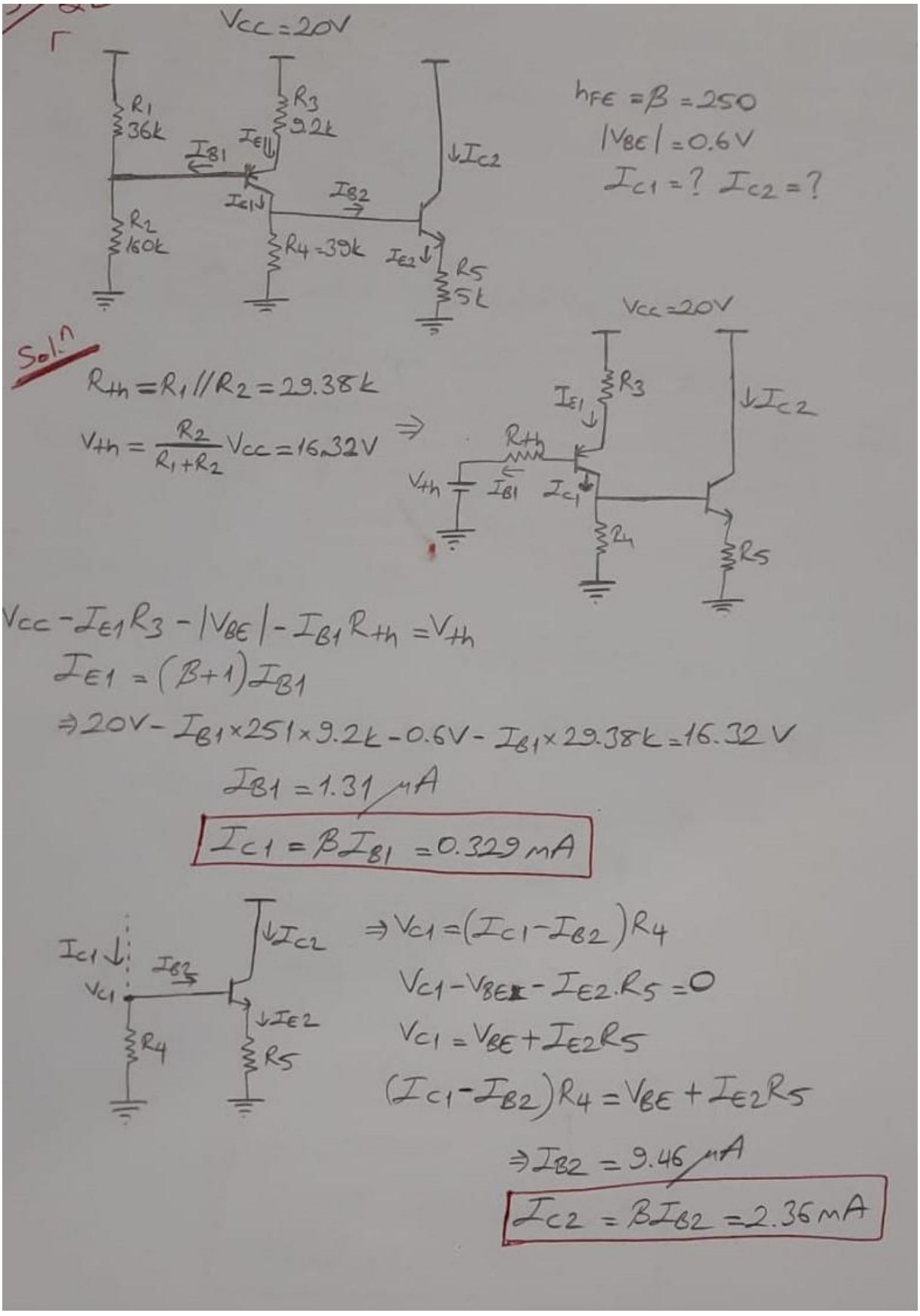
Solution:



4. In the figure below, the resistor values are given as the follows:
   R_1 = 36 kΩ, R_2 = 160 kΩ, R_3 = 9.2 kΩ, R_4 = 39 kΩ, R_5 = 5 kΩ. h_{FE}=β=250 and $|V_{BE}|$ = 0.6V for both BJT's. Please calculate collector currents, I_{C1} and I_{C2}? (25 points total)



Solution:


Vcc = 20V
R1 36k
R3 9.2k
R2 160k
R4 = 39k
R5 5k
IB1
IE1
IC1
IB2
IC2
IE2
hFE = β = 250
|VBE| = 0.6V
IC1 = ? IC2 = ?
Sol:n
Rth = R1 // R2 = 29.38k
Vth = R2/(R1+R2) Vcc = 16.32V
Vcc - IE1 R3 - |VBE| - IB1 Rth = Vth
IE1 = (β+1) IB1
⇒ 20V - IB1 × 251 × 9.2k - 0.6V - IB1 × 29.38k = 16.32 V
IB1 = 1.31 μA
IC1 = β IB1 = 0.329 mA
⇒ VC1 = (IC1 - IB2) R4
VC1 - VBE - IE2 . R5 = 0
VC1 = VBE + IE2 R5
(IC1 - IB2) R4 = VBE + IE2 R5
⇒ IB2 = 9.46 μA
IC2 = β IB2 = 2.36 mA