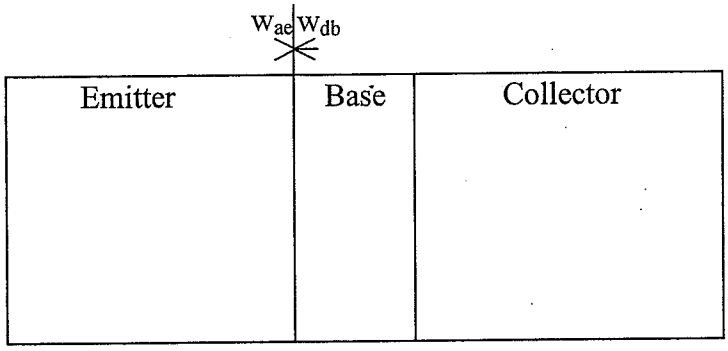
Device Problem

BJT device related questions:

(a) For a PNP BJT transistor to work with reasonable performance you need a certain doping concentrations in the emitter, base, and collector region. For example the emitter efficiency $y_E = I_{emitter,electrons} / (I_{emitter,electrons} + I_{holesfrombase}) = I_{emitter,electrons} / I_{emitter,total}$ should be large and you do not want to completely deplete the base. Fill in < or > signs in the boxed areas to describe the doping concentrations that are needed for the transistor to work well:

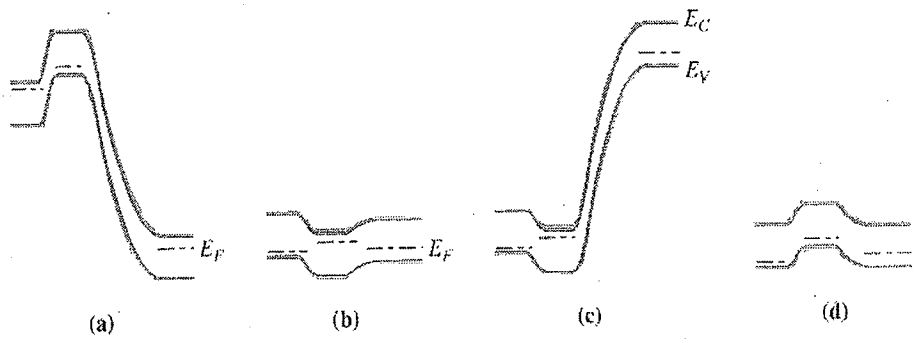
N_{ae} (emitter doping) ☐ N_{db} (base doping) ☐ N_{ac} (collector doping) **(1 point)**

(b) Write down a relationship for the partial widths $w_{ae\ (emitter\ side)}$, $w_{db\ (base\ side)}$ that form the depleted region at the emitter-base junction as a function of the respective doping concentration N_{ae} and N_{db}, and add shaded areas in the figure below that highlight the location and width at **both**, the **emitter-base** and **base-collector** junction.



(2 points)

(c) Assign each of the energy band diagrams to the proper BJT type and mode of operation.

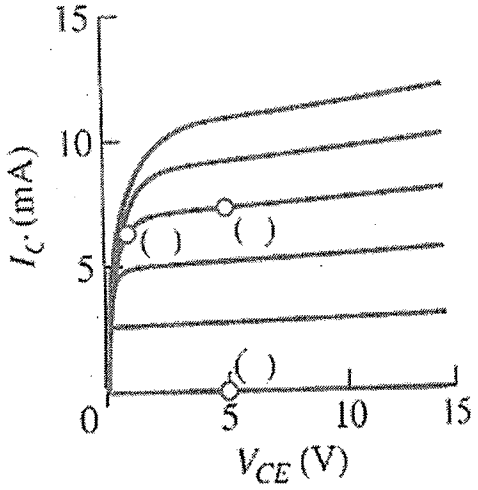


(1) NPN cutoff
(2) NPN active
(3) NPN saturation
(4) PNP cutoff
(5) PNP active
(6) PNP saturation
(7) Impossible

(4 points)

(d) Assign each of the operation points in the I-V curve corresponding energy band diagrams by filling in letters (a, b, c, d) in the appropriate locations.

(2 points)



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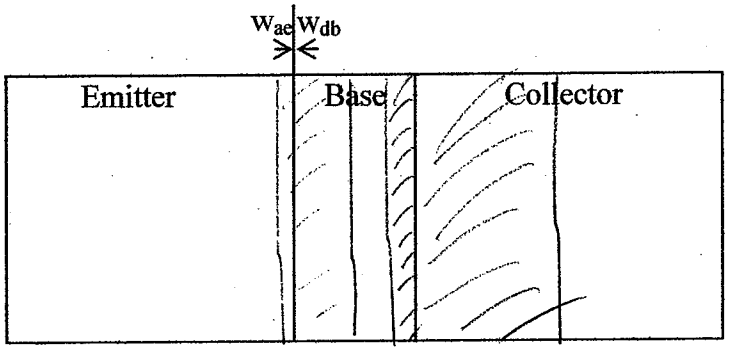
$W_{ae} \cdot N_{ae} = W_{db} \cdot N_{ob}$



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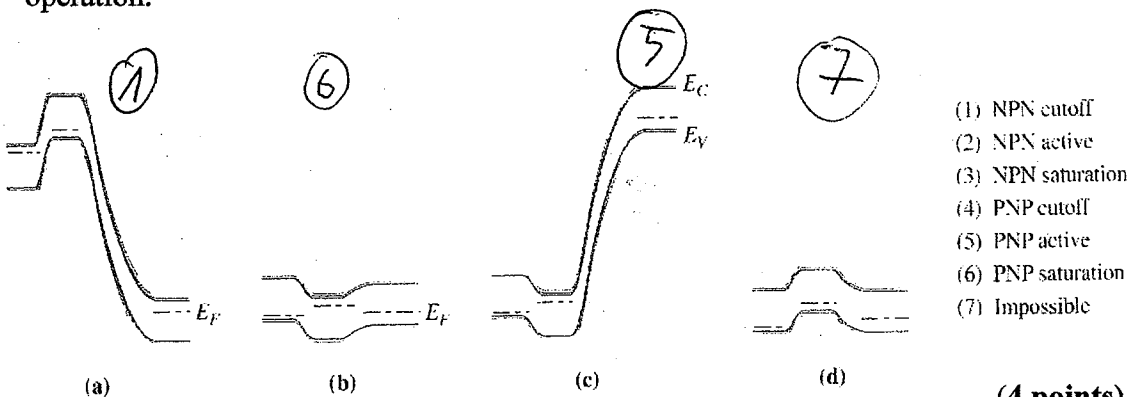

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