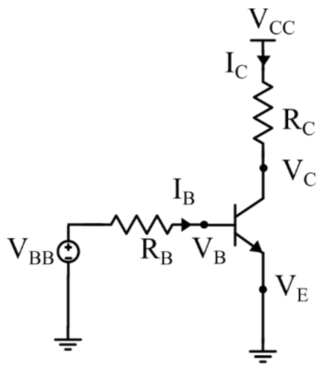
Week 02 : Assignment Solutions

1. **Capacitive/Inductive load when connected to BJT causes abnormal switching transients during____________.**
   a. **delay time(td)**
   b. **rise time (tr)**
   c. **storage time (ts)**
   d. **fall time (tf)**
   e. **both rise time (tr) and fall time (tf).**

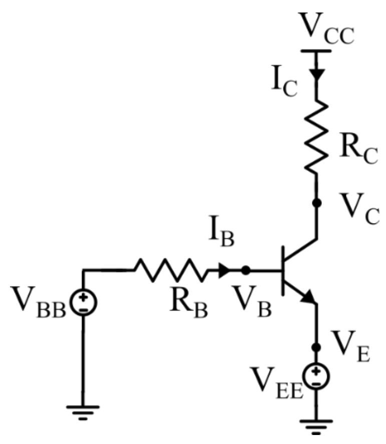
   Ans: (e)
   Solution:
   During rise time capacitive load can cause switching transient.
   During fall time inductive load can cause switching transient.

2. **A NPN BJT carries collector current (IC) of 200 mA, hFE (β) of the BJT is 100, base resistance (RB) is 500 Ω and VBE is 0.6V. What is the value of VBB?**



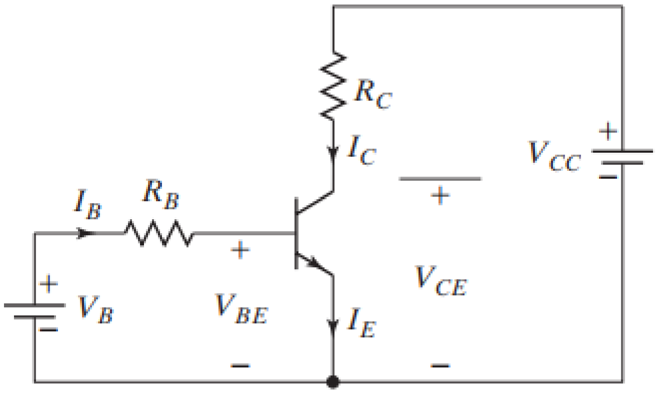
   Ans. 1.6 V [Range: 1.4 to 1.8]
   Solution:
   IB = IC/β =2mA
   VBB = VBE+(IB * RB)
   = 0.6+(2*(10^-3)*500) = 1.6 V

3. **A NPN BJT has hFE_sat (β) of 100, base resistance (RB) is 500 Ω, load resistance (RC) is 30Ω, VBE is 0.6V, VBB is 5V and VCC is 10V. If the BJT carries collector current (IC) of 200mA, what is the value of VCE?**



Ans: 0.6V [Range: 0.55 to 0.65]
Solution:
IB = IC/β = 2mA
VEE = VBB - (IB*RB) – VBE = 5 - (2*10^ - 3*500) - 0.6 = 3.4 V
VCE = VCC - (IC*RC) – VEE = 10 - (200*10^ - 3*30) - 3.4 = 0.6V

4. **In the following figure what should be the maximum value of R_B so that BJT operates in Saturation region? BJT Parameters:-β ranges from 10 to 50; $V_{CE(sat)}$ =0.5V; $V_{BE(sat)}$ =0.8V; VCC=100.5V; RC=25 ohm; VB=10V.**



Ans: 23 ohm [Range: 22.9 to 23.1].
Solution:
During the saturation region,
IC = (VCC - VCE(sat))/RC = 4A
Min base current required to drive the BJT in saturation region, $I_{B(sat)} \geq$ IC/βmin
≥0.4A
(VB-VBE(sat))/RB ≥ 0.4
RB ≤ 23 ohm

5. **For npn transistor which one is true:-**
   a) **The base driver source (V_B) should have sinking capability so that the negative base current can flow.**
   b) **In saturation region, $V_{CE} \geq V_{BE}$.**
   c) **The collector to emitter leakage current flows only when BJT is on.**
   d) **All of the above.**
   e) **A and C**
   f) **A and B**

Ans: (a)

6. **BJT is a**
   a) **Voltage controlled device**
   b) **Current controlled device**
   c) **Unipolar voltage device**
   d) **Bipolar charge carrier device**
   e) **Negative temperature coefficient device**

f) **Positive temperature coefficient device**
g) **All of the above**
h) **None of the above**

Ans: b, c, d, e

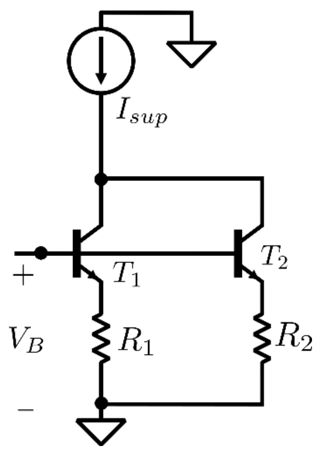
7. **The gain(beta) of a npn transistor is 45. A 10 ohm resistor connected in series with collector terminal dissipates a 2.5W of power. The base current required to drive the transistor is ___mA.**
   Ans: 11.1 (Range: 10.5 to 12)
   Solution:
   Power dissipated by collector resistor, Ploss = Ic^2*Rc
   Which gives, Ic = 0.5A
   Base Current, Ib = Ic/gain = 11.1mA

8. **Referring to question 7, the transistor emitter is grounded and collector resistance is connected to 15 V DC supply. The conduction loss in the transistor is ___W.**
   Ans: 5 (Range: 4.5 to 5.5)
   Solution:
   Drop across the Rc = Ic*Rc = 0.5*10 = 5V.
   Collector emitter voltage, Vce = Vdc – Ic*Rc = 15 – 5 = 10V
   Conduction loss, Pcond = Vce*Ic = 10*0.5 = 5W

9. **Two identical BJT with additional resistances R1 and R2 have been connected in parallel and is supplied through a constant current source as shown in Fig. 1. Calculate the total resistance R1+R2 required for the following conditions:**
   1. **V_be1(Transistor1 Base-to-emitter voltage) - Vbe2(Transistor2 Base-to-emitter voltage) = 0.02V**
   2. **(Current Source) Isup =1A**
   3. **V_B = 5V;**
   4. **For a transistor, relation between I_c and V_be is given by**

$$Ic = Iss * e^{V_{be}/nV_t}$$

where, Iss = Saturation current = 10^(-14), n=1, Vt = 25mV

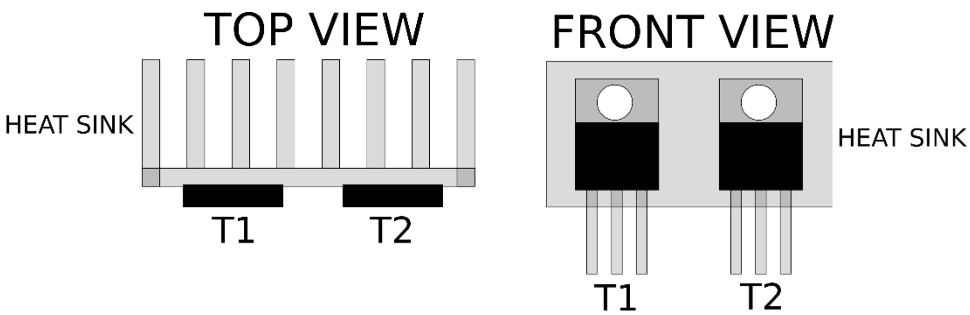


Ans: 19.71

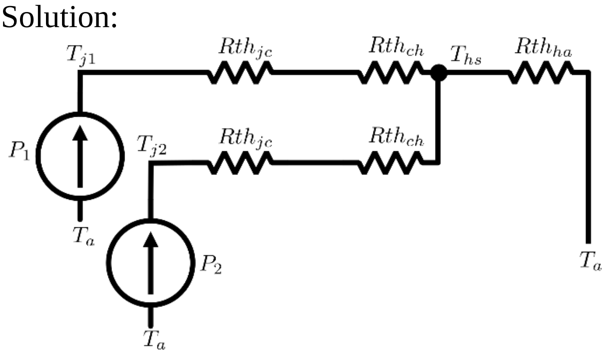
Solution:
Ic1 = Iss*exp(Vbe1/Vt),
Ic2 = Iss*exp(Vbe2/Vt)
Ic1/Ic2 = exp((Vbe1-Vbe2)/Vt) ---- (1)
Ic1 + Ic2 = Isup ----- (2)
Solving (1) and (2)
Ic2 = Isup/(1+exp((Vbe1-Vbe2)/Vt)) = 0.31A,
Ic1 = Isup-Ic2 = 0.69A
Vbe1 = ln(Ic1/Iss)*Vt = 0.7966V, Vbe2 = ln(Ic2/Iss)*Vt = 0.7766V -- (ln -> log base e)
R1 = (VB – Vbe1)/Ic1 = 6.0921 Ω, R2 = (VB-Vbe2)/Ic2 = 13.6227 Ω,
R1+R2 = 19.7147 Ω

10. **From the above figure, If both the trasnsitors are mounted on the same heat-sink as given below, find the thermal resistance Rth_ha (heat-sink to ambient) for the condition:**
    1. **Tj1 (T1 junction temperature)=60degC, Tambient = 25degC**
    2. **Rth_jc(junction to case) =40degC/W**
    3. **Rth_ch(case to heat-sink) = 0.5degC/W.**

    Note: Consider Heat sink temperature same throughout the heat sink body.(Vcesat1=0.6V, Vcesat2=0.58V)



Ans:30.7067. Range (30.65 to 30.75)
Solution:



P1 = Vcesat1 * Ic1 = 0.414W,
P2 = Vcesat2 * Ic2 = 0.1798W
Tj1 – Ta = P1*(Rth_jc + Rth_ch) + (P1+P2)*Rth_ha
Rth_ha = ((Tj1-Ta)-P1*(Rth_jc + Rth_ch))/(P1+P2)
= ((60-25)-0.414*(40.5))/(0.5938)
= 30.7067degC/W