1. V_{CC}=15 V, β_{Fn}=200, β_{Fp}=50, $|V_{BEon}|$=0.7 V, $|V_{CEsat}|$=0.2 V is given for the circuit in Figure below. Assume I_{C3}=0.22 mA and sinusoidal signals.

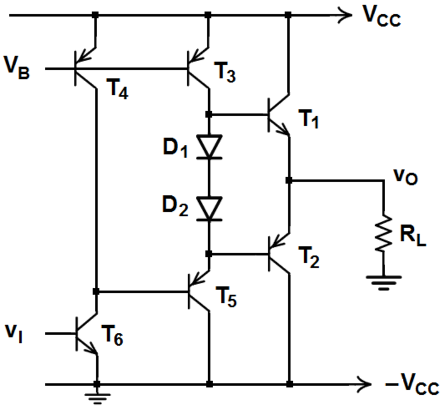
a) Calculate the positive and negative limits of the output voltage for 1 kΩ and 200 Ω load resistance values when positive and negative voltages are applied at the input.

b) How should the current I_{C3} be chosen so that the output voltage swings equally on both sides for R_L=200 Ω?

c) Calculate the maximum power which can be delivered to the load before clipping occurs for R_L=1 kΩ.

d) Calculate the efficiency for the output devices only, for conditions given in c).

e) Design a V_{BE} multiplier circuit which can replace the diodes D_1 and D_2.



Solutions:

1 a) For $R_L = 1k\Omega$

$$V_o^- = -V_{CC} + V_{CEsat6} + V_{EB5} + V_{EB2}$$
$$= -15 + 0{,}2 + 0{,}7 + 0{,}7 = -13{,}4\,V$$

$$V_o^+ = V_{CC} - V_{ECsat3} - V_{BE1} = 14{,}1V$$

For $R_L = 200\Omega$

V_o^- is same.

V_o^+ is limited by the current of T_3.

$$I_{omax} = \beta_{Fn} . I_{C3} = 200 . 0{,}22\,mA = 44\,mA$$

$$V_o^+ = I_{omax} . R_L = 44\,mA . 200 = 8{,}8\,V$$

b) $V_o^- = V_o^+$ should be satisfied.

$$13{,}4 = I_{omax} . 200 \Rightarrow I_{omax} = 67\,mA$$

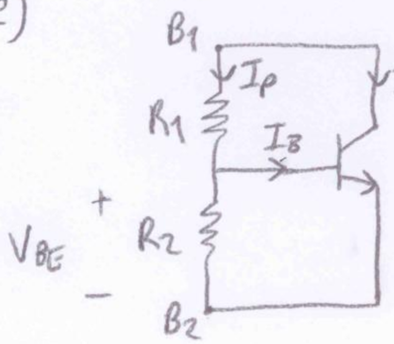
$$I_{C3} = \frac{I_{omax}}{\beta_{Fn}} = 0{,}335\,mA$$

c) $$P_{Lmax} = \frac{(V_o^-)^2}{2.R_L} = \frac{(13{,}4)^2}{2.10^3} = 89{,}8\,mW$$

d) $$P_{DC} = 2.V_{DC} I_{DC} = 2 . V_{DC} . \frac{V_o^-}{\pi . R_L} = \frac{2.15.13{,}4}{\pi . 10^3} = 128\,mW$$

$$\eta = \frac{P_{Lmax}}{P_{DC}} = \frac{89{,}8\,mW}{128\,mW} = \%70$$

e)



$$V_{B1,B2} = \frac{R_1 + R_2}{R_2} . V_{BE}$$

$$I_p \gg I_B$$
$$I_C \gg I_p$$