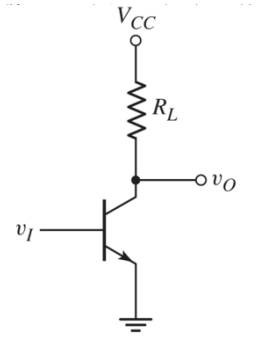
LO-4

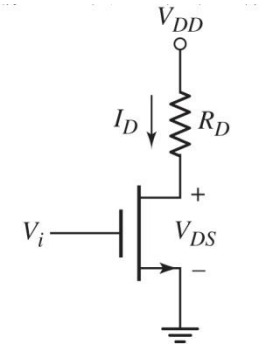
To Do the Analysis and Design of Power Amplifiers

1. Consider the common-emitter circuit given in the figure. The circuit parameters are:
   V_{CC} = 24 V, R_L = 8 Ω.

   (a) Determine the maximum current and voltage limits of the BJT transistor.
   (b) For which value of R_L, the power dissipation over transistor is maximum? What is the maximum power dissipation then?

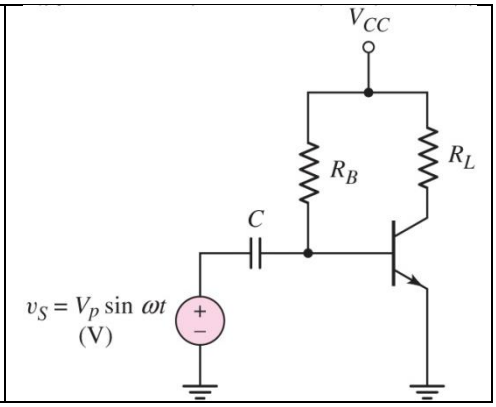


2. Consider the common-source circuit given. The circuit parameters are:
   V_{DD} = 10 V, R_D = 5 kΩ.
   and the transistor parameters are:
   V_{TN} = 1 V, K_n = 1 mA/V², and λ = 0.
   Assume the output voltage is limited to the range between the SAT-LIN transition point and v_{DS} = 0.9 V_{DD} to minimize the nonlinear distortion. Calculate the actual efficiency of this Class A output stage.



3. The maximum current, voltage and power ratings of the power BJT transistor used in the circuit of Q2 are 5 A, 80 V and 25 W respectively. Determine the value of R_D that produces a maximum power in the transistor for (i) V_{DD} = 80 V and (ii) V_{DD} = 50 V.

4. The common-emitter circuit in the figure is biased at V_{CC} = 24 V. The maximum transistor power is $P_{D,max}$ = 20 W and the current gain β = 80.
   (a) Determine R_L and R_B such that the maximum power is delivered to the load.
   (b) Find the value of V_P for the input signal that delivers the signal power. Sate any assumption.



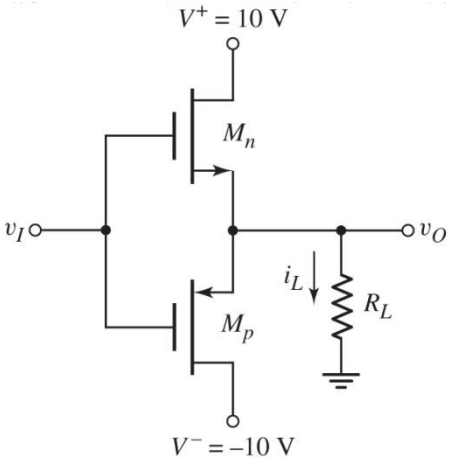
5. Consider the Class-B output stage with complementary MOSFETs shown in the figure. The transistor parameters are:

   $V_{TN} = V_{TP} = 0$. $K_n = K_p = 0.4$ mA/V^2.

   Let $R_L = 5$ kΩ.

   (a) Find the maximum output voltage such that M_n remains biased in the saturation region. What are the corresponding values of i_L and v_I for this condition.

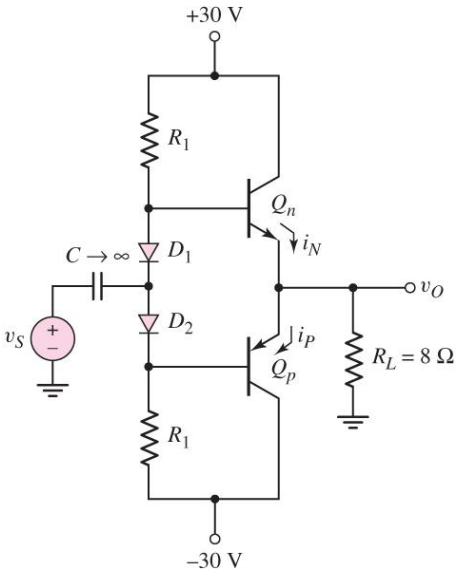
   (b) Determine the conversion efficiency for a symmetrical sine-wave output signal with peak value found in part (a).



6. Consider the class-AB stage in the figure. The diodes and the transistors are matched with parameters $I_S = 6 \times 10^{-12}$ A, and β = 40.

   (a) Determine R_1 such that the minimum current in the diodes is 25 mA when $v_O = 24$ V. Find i_N and i_P for this condition.

   (b) Using the results of part (a), determine the diode and the transistor currents when $v_O = 0$.



7. Consider the Class B output stage shown in the figure (V_{CC} = 12 V). Assume the transistors are ideal with

   $V_{BE1} = V_{EB2} = 0$ V

   $V_{CEsat1} = V_{ECsat2} = 0$ V.

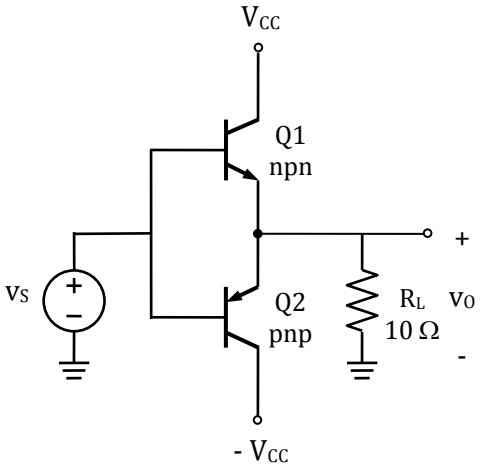
   The input is a sinusoidal waveform as well as the output as given below.

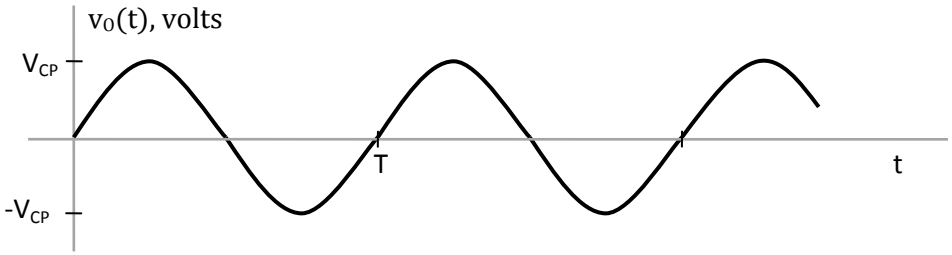
   i) Determine the average power dissipation over the load as a function of V_{CP}.

   ii) Determine the total average power drawn from the sources as a function of V_{CP}.

   iii) The average power dissipation over one transistor as a function of V_{CP}.

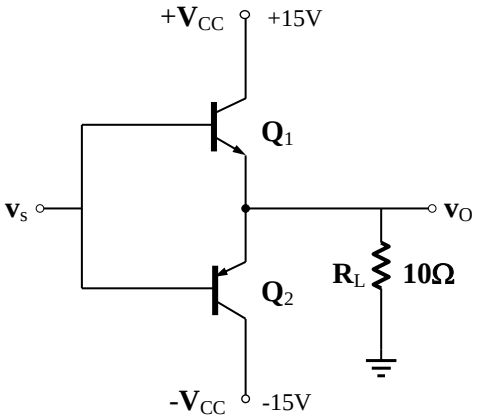
   iv) Determine the power conversion efficiency as a function of V_{CP}.





v) What is the power efficiency when V_{CP} = 6 V.
vi) For which value of V_{CP}, the power efficiency is maximum? What is the maximum power efficiency then?
vii) For which value of V_{CP}, the power dissipation over any transistor is maximum? What is the maximum power over any transistor then?

8. Consider the power amplifier shown in the figure.



i)
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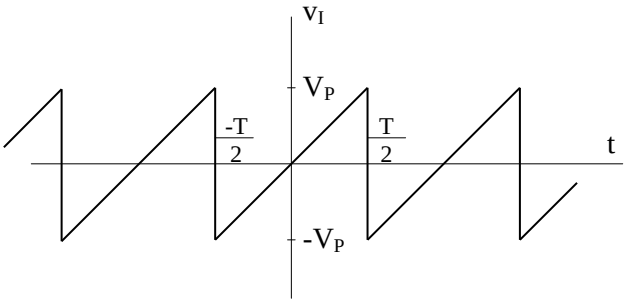
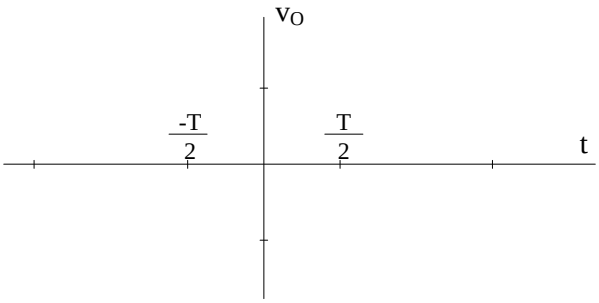


i) Assume the transistors are ideal with V_{BE1}=V_{EB2}=0 V and V_{CEsat1} = V_{ECsat2} = 0, for the input voltage v_I given above, plot the output waveform. (Assume $V_P < V_{CC}$)



ii) Determine the average power dissipation over the load as a function of V.
iii) The total average power drawn from the sources as a function of V.
iv) The average power dissipation over one transistor as a function of V.
v) Determine the power conversion efficiency as a function of V.
vi) For which value of V, the power efficiency is maximum? What is the maximum power efficiency then?
vii) For which value of V, the power dissipation over each transistor is maximum? What is the maximum power dissipation over any transistor then?