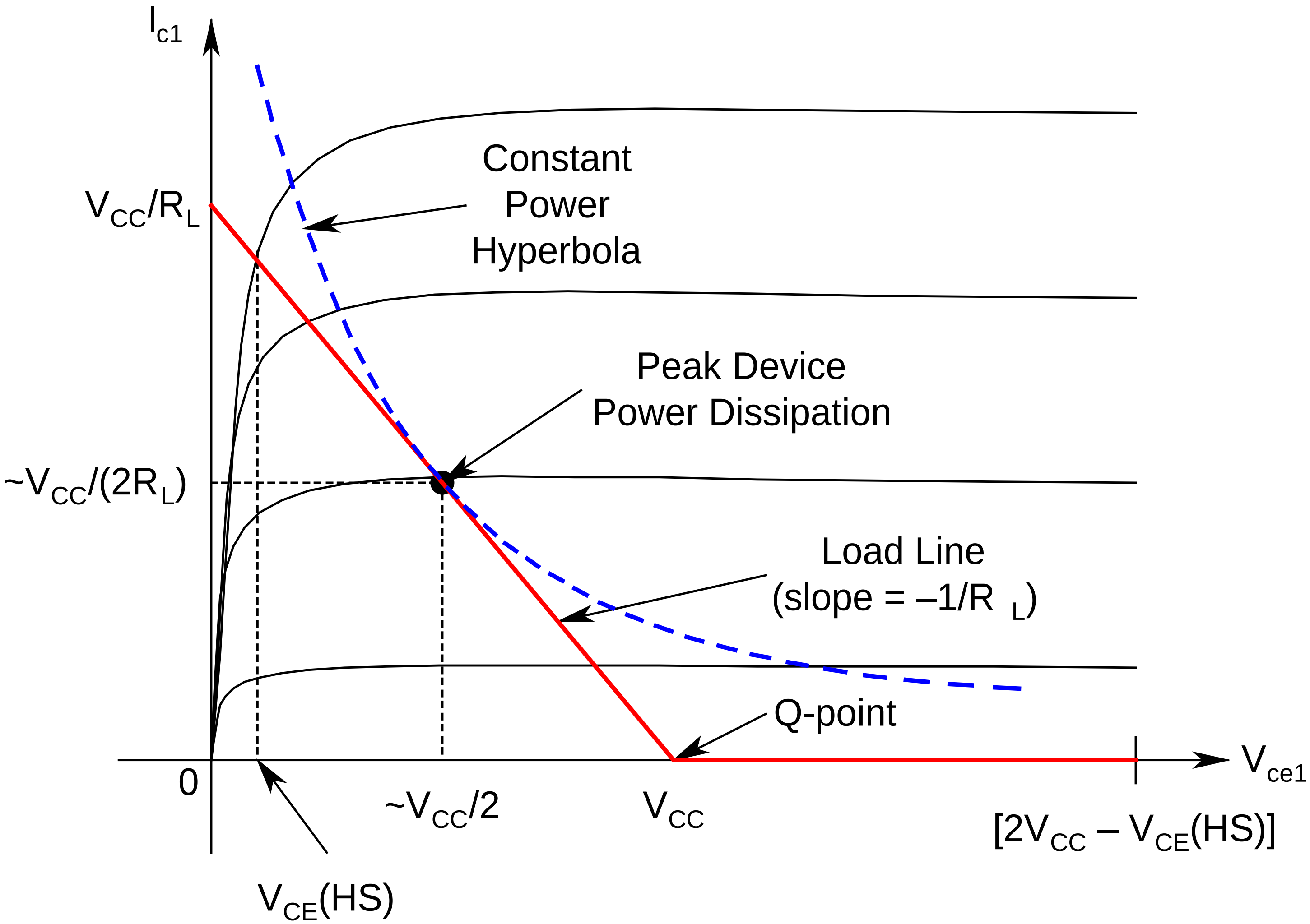
- ***Transistor Ratings***:
  - Specified by ***two parameters***:
    - ***Breakdown Voltage***
    - ***Maximum Power Rating***
  - ***Breakdown Voltage***:
    - ***Maximum positive/negative V_{CE} that can be applied to an npn/pnp BJT***
      - Known as the ***Collector-to-Emitter Breakdown Voltage with Base Open*** (BV_{CE0})
    - ***Focus on Q_1*** (***Q_2 will be similar***)
    - Refer to the diagram in the next slide (***Output characteristic of Q_1 along with the load line***)
    - In the analysis, the ***offset in the VTC***, the ***small standby current***, and ***$V_{CE1}(HS)$*** are ***neglected***



The Output Characteristic of Q_1 along with the Load Line

- ***At Q-point***: $V_o = 0 \Rightarrow V_{ce1} = V_{CC}$
- ***During positive half cycle***:

  $V_o(max) \approx V_{CC} \Rightarrow V_{ce1} \approx 0$

  $\Rightarrow$ ***V_{ce1} ranges between 0 and V_{CC} during the positive half cycle***
- The ***slope of the load line*** in this part of the characteristic = $-1/R_L$
- ***For negative half cycle***, ***Q_1 cuts off*** (***Q_2 conducts during this period***)

  $\Rightarrow$ ***$I_{c1} = 0$ for V_o ranging between 0 and $-V_{CC}$***

  $\Rightarrow V_{ce1}(max) = 2V_{CC}$

  $\Rightarrow BV_{CE0} = 4V_{CC}$ [using a ***Safety Factor*** (or ***Factor of Safety***) of 2]

- ***Maximum Power Rating***:
  - ***Same for both Q_1 and Q_2***
  - ***Average power P_L delivered by Q_1 to R_L during the positive half cycle*** = ***area covered under the load line***

$$\Rightarrow P_L = \frac{1}{2} \times V_{CC} \times \frac{V_{CC}}{R_L} = \frac{V_{CC}^2}{2R_L}$$

  - Refer to the ***constant power hyperbola*** ($V_{ce1} \times I_{c1}$) shown in the figure
  - ***Maximum power dissipation of Q_1 happens when this hyperbola becomes tangent to the load line***, ***which is right at the middle of the load line***
  - ***Proof***:

Constant power hyperbola (P_1):

$$P_1 = V_{ce1} \times I_{c1} = \left(V_{CC} - I_{c1}R_L\right) \times I_{c1} = V_{CC}I_{c1} - I_{c1}^2 R_L$$

Plug ***$dP_1/dI_{c1} = 0$*** to get ***$I_{c1} = V_{CC}/(2R_L)$***

This is the ***mid-point of the load line***, with ***coordinates [$V_{CC}/2$, $V_{CC}/(2R_L)$]***

$$\Rightarrow P_{max} = \frac{V_{CC}^2}{2R_L} \text{ (using a Safety Factor of 2)}$$

- ❖ There is also ***standby power***:

$$P_{Standby} = V_{CC} \times I_{Standby}$$

- ❖ In general, ***$P_{max} >> P_{Standby}$***
- ❖ Refer to the figure in the next slide
  - o ***V_{ce1} oscillates between 0 and $2V_{CC}$***
  - o ***I_{c1} appears only during the positive half cycle***, ***with peak value of V_{CC}/R_L*** (***when $V_{ce1} = 0$***)
  - o P_1 (= $V_{ce1} \times I_{c1}$) ***oscillates*** between 0 and $V_{CC}^2/(4R_L)$ at ***twice the frequency*** only during the ***positive half cycle***