**POWER TRANSISTORS**

- Heat is a major concern
- $T_J = $ Collector-base junction temperature
  - Most power is dissipated here
  - $V_{CB}$ usually larger than $V_{BE}$
- Every transistor has a $T_{\text{MAX}}$
- Consider transistor operating in open air at an ambient temperature $T_A$:

  $$T_J - T_A = \theta_{JA} P_D$$

$\theta_{JA} \Rightarrow$ thermal resistance between junction and air [$^\circ$C/W]
$P_D \Rightarrow$ power dissipation of transistor

Temperature difference $\Leftrightarrow$ voltage difference
Thermal resistance $\Leftrightarrow$ electrical resistance
Power dissipation $\Leftrightarrow$ current

**Example:** From a data sheet, a particular transistor can safely dissipate a maximum of 40W at an ambient temperature of 25$^\circ$C. $T_{\text{MAX}} = 150^\circ$C, how much power can we dissipate in a case where $T_A = 50^\circ$C?

**Heat Sinks:**

$$\theta_{JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$$
**POWER TRANSISTORS**

**Example:** A particular transistor can dissipate a maximum of 40W at a case temperature ($T_C$) = 25°C. $T_{JMAX} = 150°C$. What is $P_{D\text{MAX}}$ at $T_A = 50°C$, given the following heat sink?

- $\theta_{CS} = 1°C/W$
- $\theta_{SA} = 4°C/W$

\[
P_D = \frac{T_J - T_A}{\theta_{JC} + \theta_{CS} + \theta_{SA}}
\]

\[
T_S = T_A + P_D \theta_{SA} =
\]

\[
T_C = T_S + P_D \theta_{CS} =
\]

**IC issues:**
- Area = $$
  - BJT are small
  - MOSFETs are VERY small
  - Resistors are LARGE (typically < 10kohm)
  - Caps are LARGE (typically < 20pF)
- Driving on-chip loads: usually MOSFET gates => small capacitive loads
POWER TRANSISTORS

Common CMOS Op-Amp:
What is A? Let $I_{Q5} = I_{Q7} = 25 \mu A$, $|V_A| = 25 V$, $k_n' = 20 \mu A/V^2$, $k_p' = 10 \mu A/V^2$, $|V_t| = 1 V$, W/L = 10 for all devices.

What is the purpose of $C_C$? _________________________________