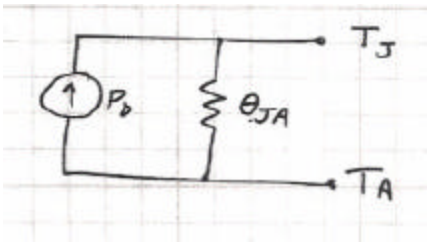
POWER TRANSISTORS

- 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_{JMAX}
- Consider transistor operating in open air at am ambient temperature T_A:

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

θ_{JA} => thermal resistance between junction and air {$^oC/W$}
P_D=> power dissipation of transistor

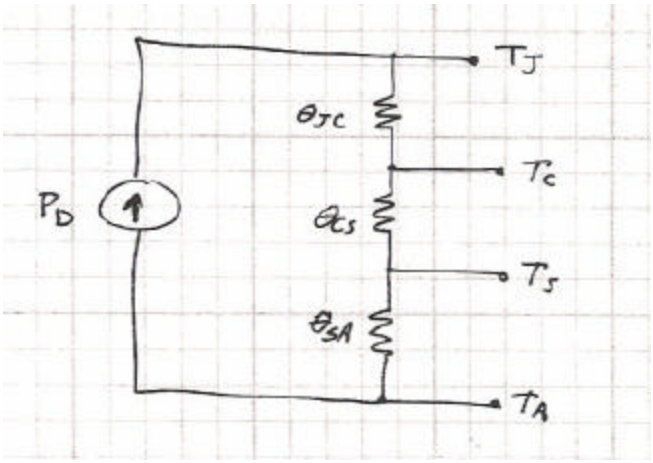
Temperature difference ⇔ voltage difference
Thermal resistance ⇔ electrical resistance
Power dissipation ⇔ current



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

Heat Sinks:

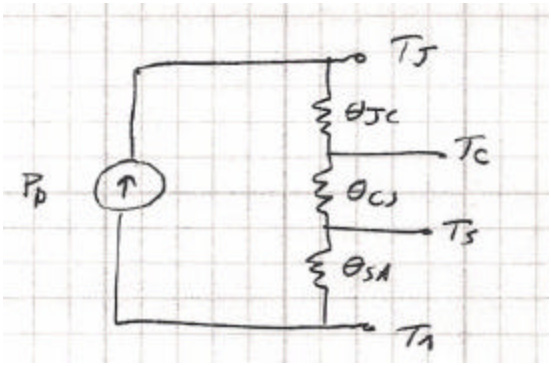
$$\theta_{JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$$



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_{DMAX} at T_A = 50°C, given the following heat sink?

θ_{CS} = 1°C/W
θ_{SA} = 4°C/W



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

$T_S = T_A + P_D \theta_{SA} =$

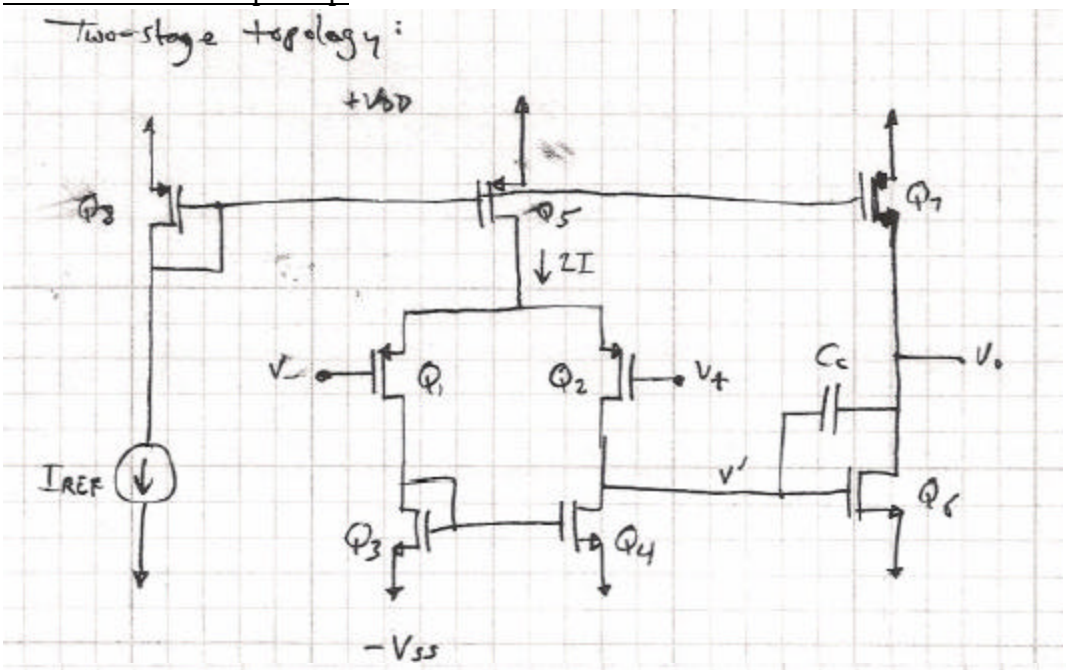
$T_C = T_S + P_D \theta_{CS} =$

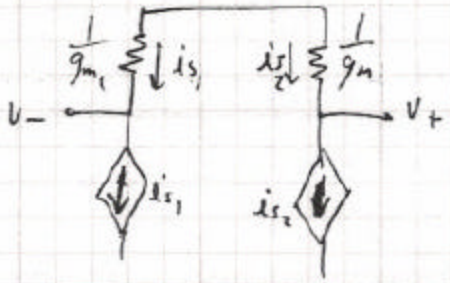
IC issues:

- Area = $$
  - BJTs 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

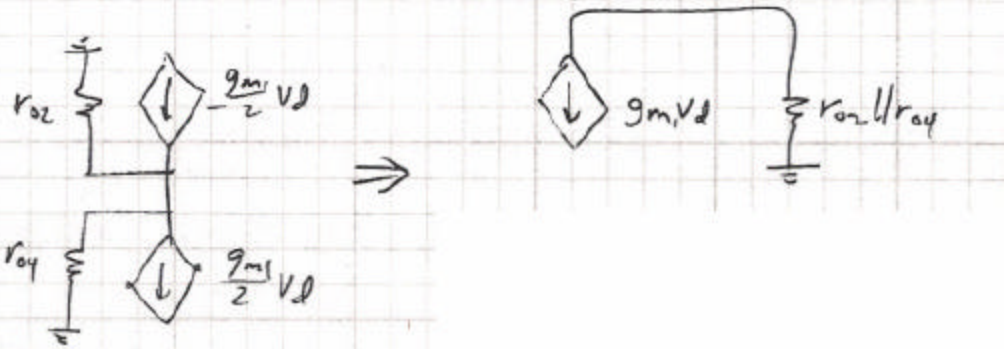
POWER TRANSISTORS

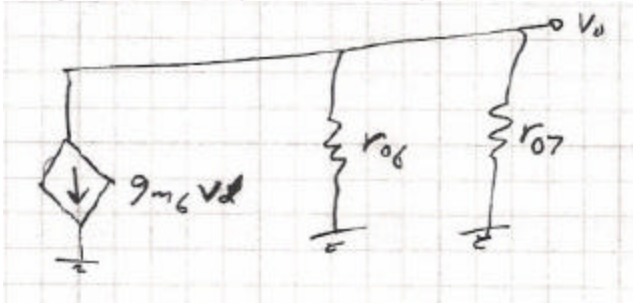
Common CMOS Op-Amp:





$$i_{d_1} = \frac{V_+ - V_-}{\frac{1}{g_m} + \frac{1}{g_m}} = \frac{g_m}{2} v_d$$





POWER TRANSISTORS

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

What is the purpose of C_C? _____