Transistor Example: SPDT => single pole double throw

**Diagram:**
- A relay labeled "OMRON G2E 5V relay (56Ω coil)"
- A transistor labeled "2N3904 transistor"
- A diode labeled "DIODE IMPEDANCE"
- A temperature sensor labeled "TEMP SENSOR"
- Connections labeled "R, T, W"

**Equations and Calculations:**
- \[ h_{fe} \geq 50 \]
- \[ R_{coil} = 56 \Omega \]
- \[ i_{co} = 89.3 \text{mA} @ 5V \]
- \[ R_{coil} = \frac{5V}{0.089A} = 56 \Omega \]
- \[ i_{co} = \frac{120V}{0.25A} = 560 \Omega \]

**Notes:**
- Choose a transistor that can handle \( I_C > 89.3 \text{mA} \) and at least \( V_{CE} > 5V \)
- Due to the relay, the transistor's coil will dissipate the least amount of power when it is saturated.
- In cut-off, the transistor doesn't dissipate any power, but in cut-off, no power goes to the load.
- To find \( R_B \), we can ensure that when we write a '1' to the pin attached to \( R_B \), the transistor will be driven into saturation.
- When the transistor saturates, \( V_{CE} = 0.3V \) (see the data sheet for the 2N3904). In saturation, the collector current \( I_C \) will be:
  \[ I_C = \frac{5V}{0.3V} \]
  \[ I_C = 56 \Omega \]
  \[ I_C = 0.084A \]

**Current Calculation:**
- \( I_C = h_{fe} I_B \)
- \( I_B \) at saturation is \( 0.084A \)
- \( I_B \) at cut-off is \( 0.004 \text{mA} \)
- You want to give yourself some margin (say 2x-10x), so let \( I_B = 0.004 \text{mA} \).
- You can use the voltage for an '1' and add 'diode' drop.
- Choose \( R_B \) accordingly:
  \[ R_B = \frac{5V}{0.7V} \]
  \[ R_B = \frac{0.004A}{1.07 \Omega} \]
  \[ R_B = 1 \text{K} \] (gives you a little more margin and standard value)

**Diode Calculation:**
- \( V_{diode} \) drop is 0.7V
- MC current is 4.3 mA, OK