ECE 320 - Quiz #8 - Name _____

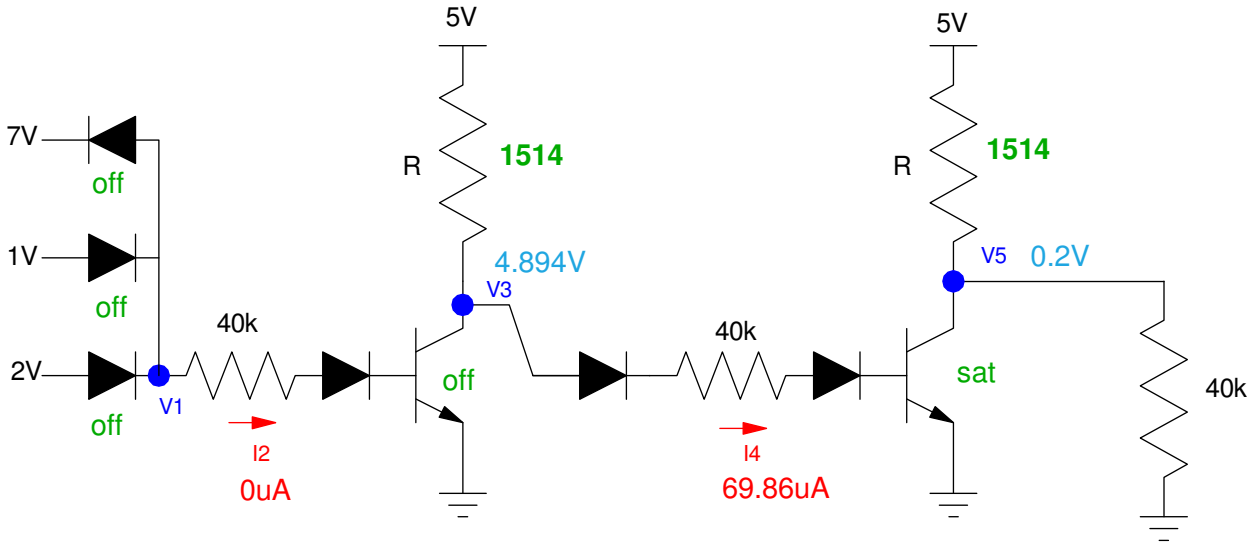
DTL, TTL Logic, MOSFETs.

DTL Logic Gate:

Determine the voltges and currents for the following DTL gate. Assume

- Ideal 3904 transistors (Vbe = 0.7V, Vce(sat) = 0.2V, gain = 100)
- Ideal silicon diodes (Vf = 0.7V)
- R = 1000 + 100(Birth Month) + (Birth Day). For example, May 14th gives R = 1514 Ohms.

R 1000 + 100*mo +day	V1	I2	V3	I4	V5
1514	**0**	**0**	**4.894V**	**69.86uA**	**0.2V**



The diodes on the left are all off

- The diode to 7V is reversed, so it's off
- The other two diodes need 2.1V to overcome the three diodes to ground

This results in

- V1 = 0
- I2 = 0

To find I4 and V3:

$$I_4 = \left(\frac{5V - 2.1V}{40k + 1514}\right) = 69.86\mu A$$

$$V_3 = 5V - 1514\Omega \cdot 69.86\mu A = 4.894V$$

V5 is saturated: I4 allows 6.986mA to flow through the second transistor. R limits the current to 3.3mA

$$\beta I_b > I_c \qquad \textit{saturated}$$

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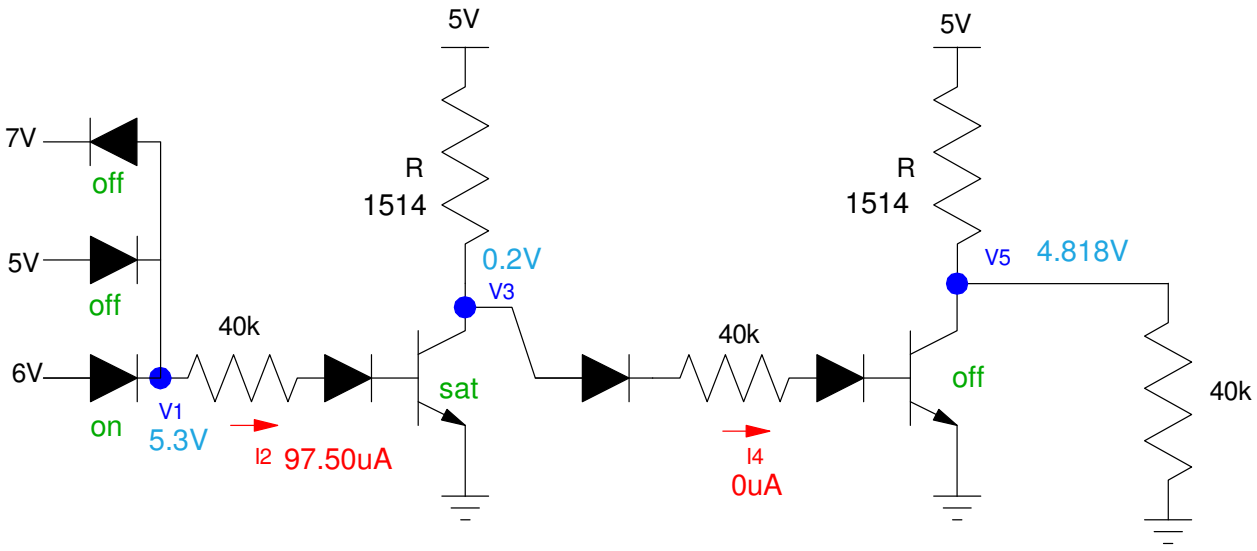
R 1000 + 100*mo +day	V1	I2	V3	I4	V5
1514	**5.30V**	**97.50uA**	**0.2V**	**0uA**	**4.818V**

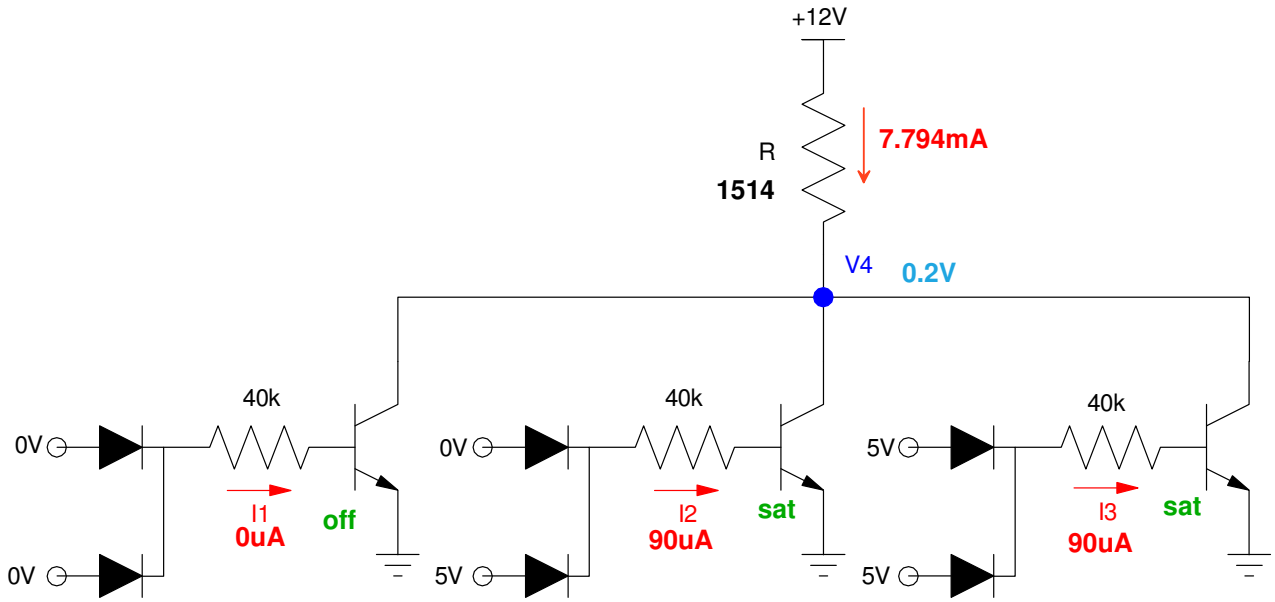


Open Collector Logic

Determine the voltages and currents for the following circuit. Assume

- Ideal silicon diodes (Vf = 0.7V)
- Vbe = 0.7V
- β = 100
- R = 1000 + 100(Birth Month) + (Birth Day). For example, May 14th gives R = 1514 Ohms.

R 1000 + 100*mo +day	I1	I2	I3	V4
1514	**0**	**90uA** allows 9mA	**90uA** allows 9mA	**0.2V** 9mA > 7.794mA

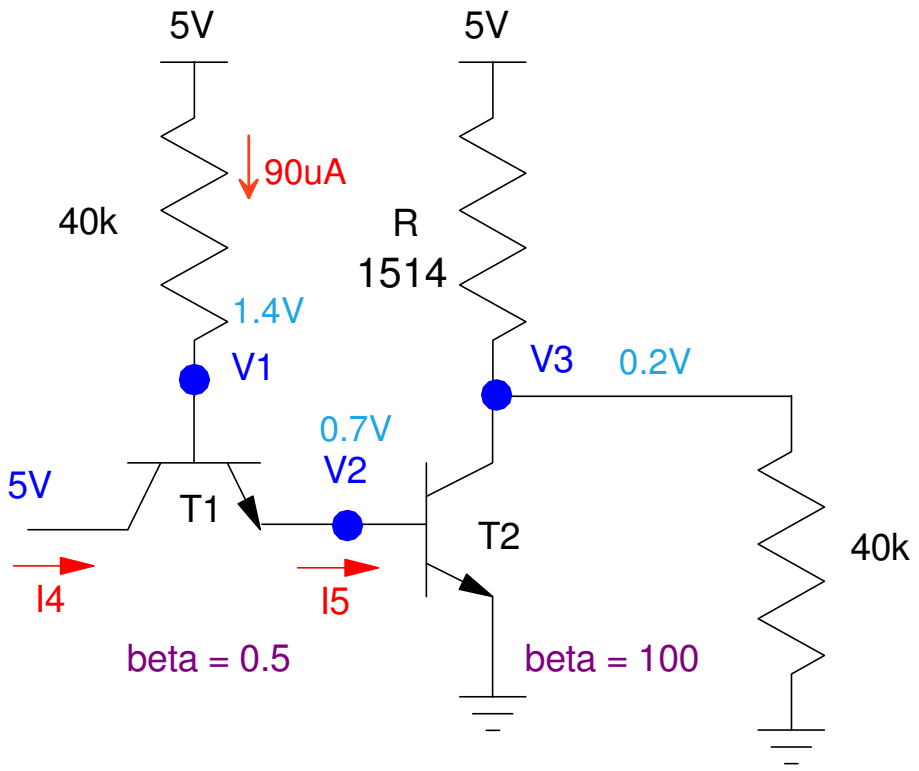


TTL Logic

Determine the voltges and currents for the following DTL gate. Assume

- Ideal 3904 transistors (Vbe = 0.7V, Vce(sat) = 0.2V, β = 2 (left) or 100 (right) transistor
- R = 1000 + 100(Birth Month) + (Birth Day). For example, May 14th gives R = 1514 Ohms.

R 1000 + 100*mo +day	V1	V2	V3	I4	I5
1514	**1.4V**	**0.7V**	**0.2V**	**45uA** Ic = 0.5 * Ib	**135uA** Ib + Ic

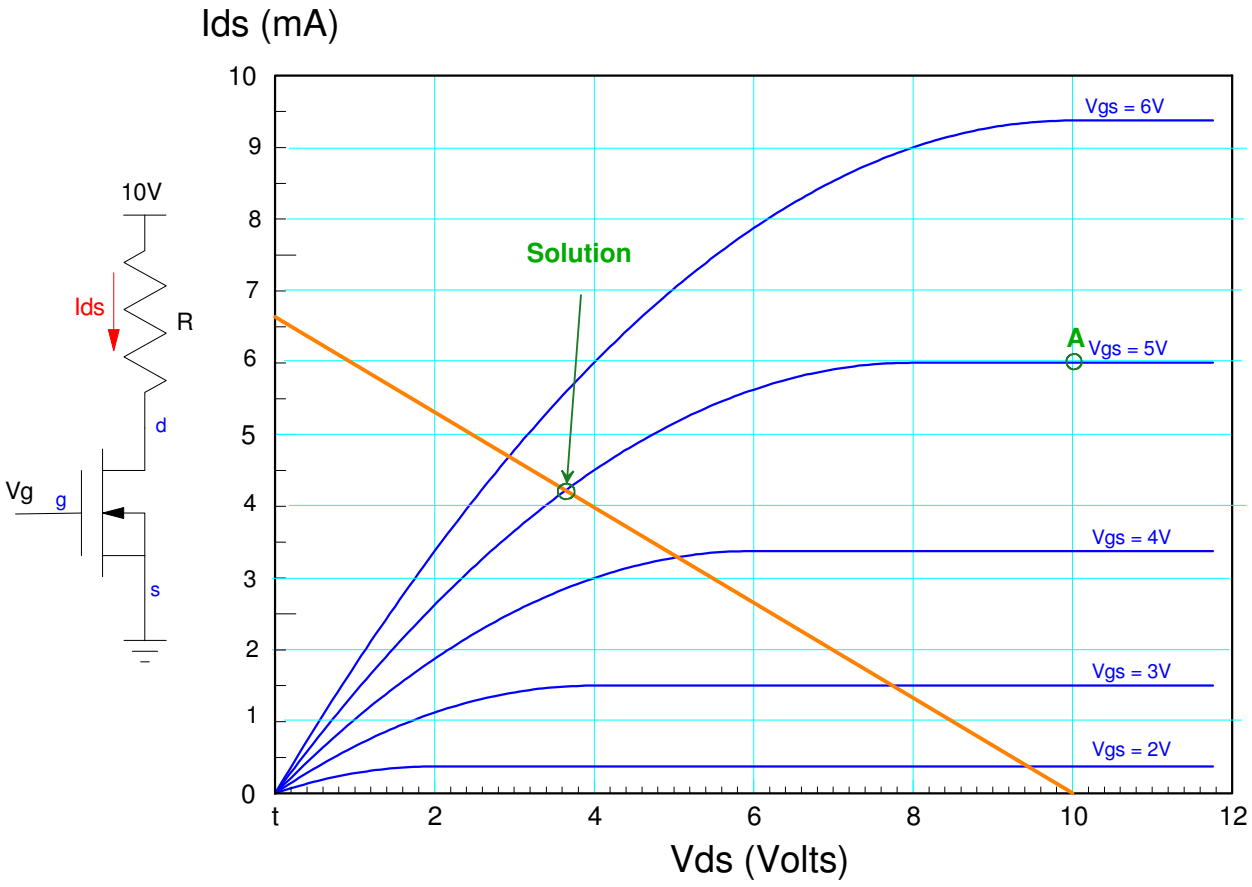


MOSFET & Load Lines

For the following MOSFET

- Determine the transconductance gain, kn,
- Draw the load line for the following circuit.
- Mark the operating point for Vgs = 5V

R 1000 + 100*mo + day	kn A / V2	Load Line show on graph	Vds Vg = 5V	Ids Vg = 5V
1514	**0.00075**	x-intercept = 10V y-intercept = 6.6mA	**3.6V** from graph	**4.2mA** from graph



kn: Pick a point (A) in the saturated region

$$I_{ds} = \frac{k_n}{2}(V_{gs} - V_{th})^2$$

$$6mA = \frac{k_n}{2}(5V - 1V)^2$$

$$k_n = 0.75\frac{mA}{V^2}$$

MOSFETs

For the following MOSFET circuit, assume

- $k_n = 0.5\ A/V^2$
- $V_{th} = 2.00V$

Determine the operation point (Vds, Ids) for Vg = 10V

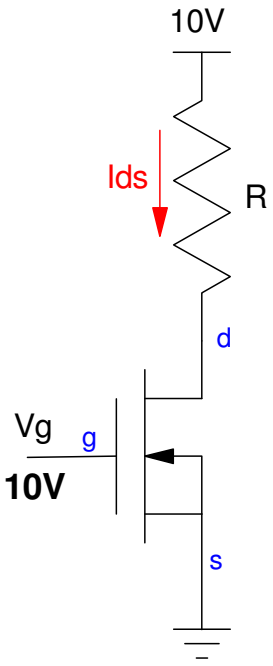
R 1000 + 100*mo + day	Vds Vg = 10V	Ids Vg = 10V
1514	**0.0016 V**	**6.6039 mA**

Ohmic Region: $V_{ds} < V_{gs} - V_{th}$

$$I_{ds} = k_n\left(V_{gs} - V_{th} - \frac{V_{ds}}{2}\right)V_{ds}$$

Saturated Region: $V_{ds} > V_{gs} - V_{th}$

$$I_{ds} = \frac{k_n}{2}(V_{gs} - V_{th})_2$$



Assume ohmic, Write 2 equations for 2 unknowns

$$I_{ds} = 0.5\left(10 - 2 - \frac{V_{ds}}{2}\right)V_{ds}$$

$$V_{ds} + 1514 I_{ds} = 10$$

Solving gives two solutions

Ids = 6.6039mA

Vds = 0.0016V

Rds = Vds / Ids = 0.25 Ohms

and

Ids = -3.97mA

Vds = 16.001V

The former is the correct solution