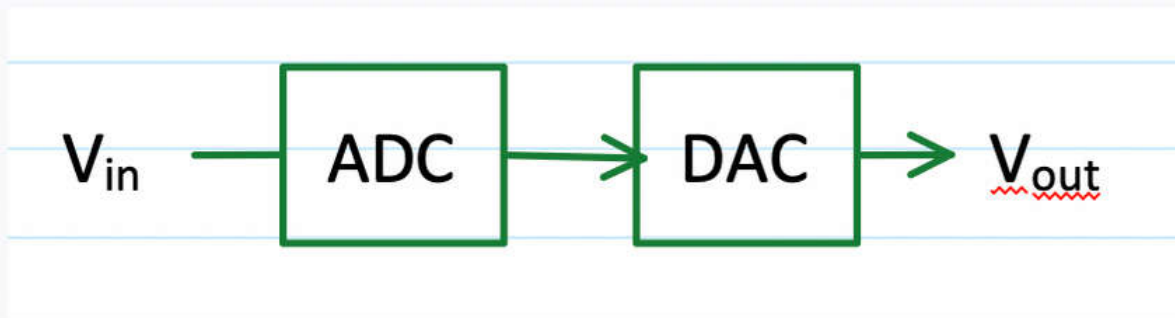


Q1 Data Converters

10 Points



Bit resolution is 3, full scale voltage is 8V for both ADC and DAC. Determine the lower limit and upper limit of the input voltage interval that gives the same V_{out} as $V_{in}=5.4V$, but satisfies $V_{in} < V_{out}$.

Q2 Digital data

5 Points

Find out the number of seconds it takes to download 10 binary GB data using a 10 GBPS (giga bits per second) connection. Keep two digits after the decimal point.

Enter your answer here

Q3 Solid state electronics

10 Points

A 20 nm long resistor is doped with $N_A = 10^{16}/cm^3$. $n_i = 10^{10}/cm^3$. $v_{sat} = 10^7 cm/s$. $\mu_n = \mu_p = 200 cm^2/(V \cdot s)$.

Q3.1

3 Points

Should we add donors or acceptors to achieve a target $n = 10^{17}/cm^3$?

- ☐ donors
- ☐ acceptors

Q3.2

3 Points

At what concentration?

Enter your answer here

Q3.3

4 Points

What is the highest voltage in Volt we can apply without breaking Ohm's law? Keep 1 digit after the decimal point. Number only.

Enter your answer here

Q4 Source/drain

5 Points

The two contacts of a n-type semiconductor are biased at 1V and 5V, check all that are true.

☐ The 1V side acts as source of electrons

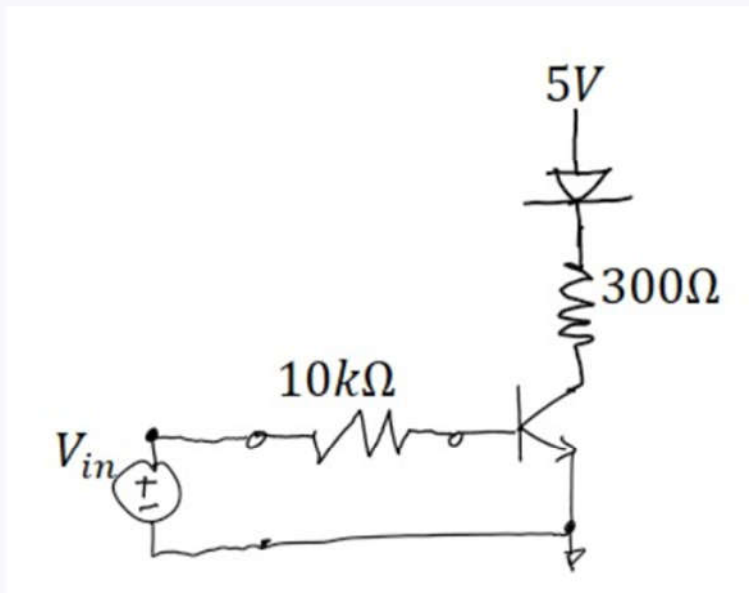
☐ Current flows from 5V to 1V

☐ The 5V side acts as source of electrons

☐ Electrons drift from 5V to 1V

Q5 NPN Switch

10 Points



$\beta_F = 200$. $V_{BE,on} = 0.8V$. $V_{ce,sat} = 0.2V$. Load diode turn on voltage is $1.8V$.

Q5.1

2 Points

At what V_{in} (in Volt) does the transistor BE junction turn on? Write only numerical answer. Use 1 decimal place.

Enter your answer here

Q5.2

4 Points

At what V_{in} (in Volt) does the transistor enter saturation? Use 2 decimal places.

Enter your answer here

Q5.3

2 Points

Imagine sweeping V_{in} from 0 to 5V. Sketch how the base current varies.



Please select file(s)

Select file(s)

Q5.4

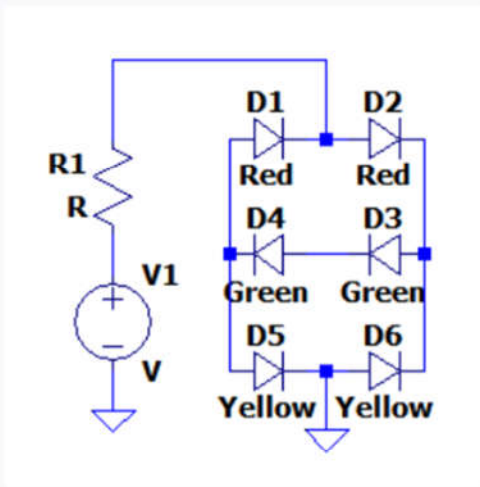
2 Points

What is the transistor current gain at $V_{in} = 4V$? Use two decimal places.

Enter your answer here

Q6 Diode circuit analysis

10 Points



Turn on voltage is 1.5V for all diodes (LEDs).

Q6.1

3 Points

Find the diode forward voltage in Volts for D6 when $V_1 = 15V$. $R = 200\Omega$. Use 1 decimal place.

Q6.2

4 Points

Why is R around a few hundred Ω , instead of a few Ω ?

Enter your answer here

Q6.3

1.5 Points

Find the diode forward voltage in Volts for D4 when $V_1 = 15V$. Use 1 decimal place.

Enter your answer here

Q6.4

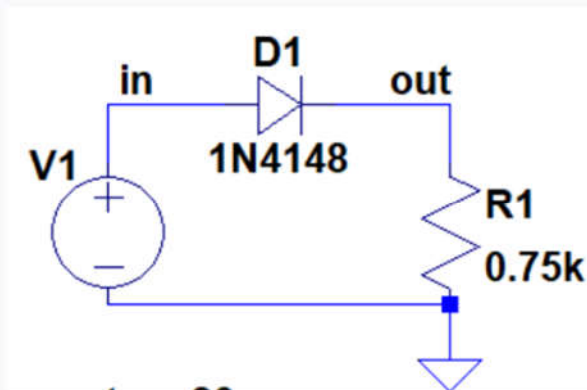
1.5 Points

Find the diode forward voltage in Volts for D3 when $V_1 = -15V$. Use 1 decimal place.

Enter your answer here

Q7 Diode circuit transients

10 Points



Diode turn on voltage is $0.7V$. Diode capacitances are significant and must be considered in your answers below. Consider switching V1 from 5V to -10V:

Q7.1

3 Points

What is $V(\text{out})$ right before the switching? Use 1 decimal place.

Enter your answer here

Q7.2

4 Points

What is $V(\text{out})$ right after the switching? Use 1 decimal place.

Enter your answer here

Q7.3

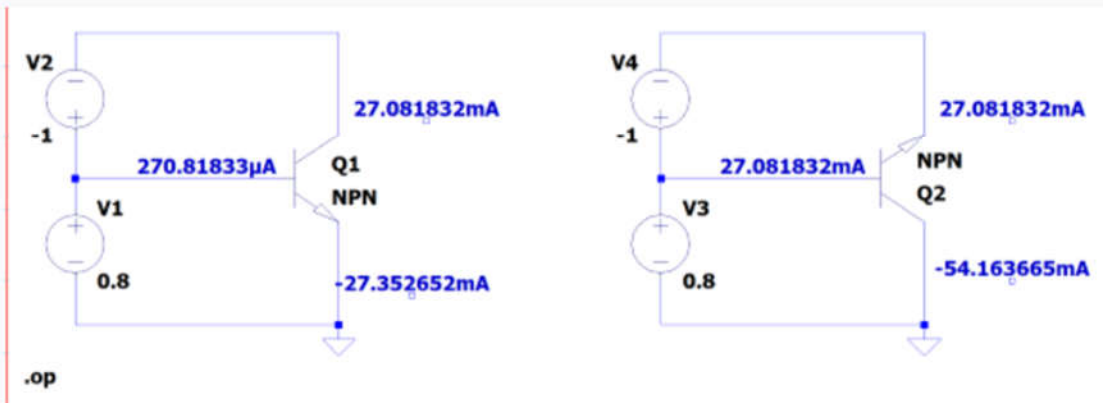
3 Points

What is the diode current in mA right after the switching? Current is positive if it flows into the positive terminal of the diode. Use two decimal places.

Enter your answer here

Q8 Transistor operation modes

10 Points



Temperature is 300K. $\phi_t = 0.0258V$. All terminal currents are labeled using operational point data.

Q8.1

5 Points

Find forward current gain β_F .

Q8.2

5 Points

Find reverse current gain β_R .

Q9 PNP Design

10 Points

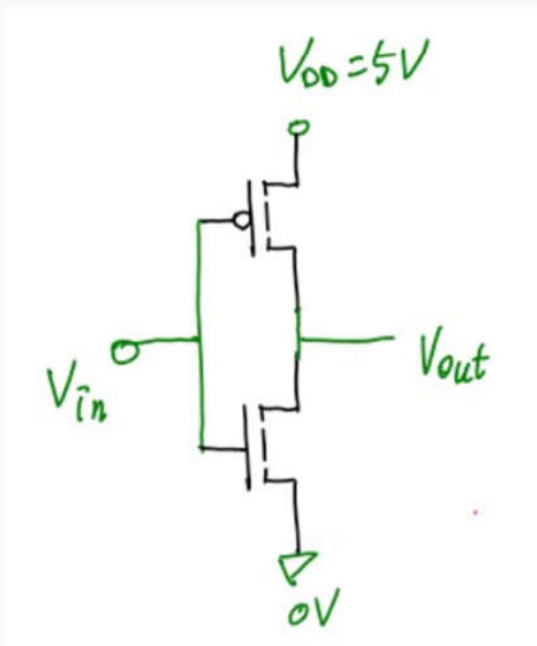
Design a 4-resistor PNP biasing circuit to achieve: $V_{EC} = 3V$. $I_C = 5mA$. $\beta_F = 100$. $V_{CC} = 15V$. $\phi_t = 0.0258V$. $I_S = 10^{-15}A$. Make feedback resistor voltage drop 5V. Your design should include a schematic with clear label of 1) resistance value 2) current through 3) voltage across for each resistor. Upload a file of your solution.

 Please select file(s)

Q10 Fet

10 Points

Given NMOS $W/L=2/1$, $V_{TO}=1V$, $K_P=50 \mu A/V^2$. PMOS $W/L=4/1$, $V_{TO}=-1V$, $K_P=25 \mu A/V^2$. $V_{DD}=5V$.



Q10.1

4 Points

At $V_{in} = 0V$, determine the V_{out} that can make the NMOS and PMOS currents equal. Describe your thought process. What is the NMOS and PMOS current? Supply current?

Enter your answer here

Q10.2

4 Points

At $V_{in} = 5V$, determine the V_{out} that can make the NMOS and PMOS currents equal. What is the NMOS and PMOS current? Describe your thought process.

Enter your answer here

Q10.3

2 Points

Calculate the on-resistance of the NMOS when $V_{in} = V_{DD}$.

Enter your answer here

Q11 MOS Capacitance

10 Points

Q11.1

3 Points

Out of the intrinsic C_{gs} , C_{gd} , which is larger when $V_{GS}=V_{DS}=V_{DD}$? Is the transistor in saturation or linear?

Enter your answer here

Q11.2

3 Points


Out of the extrinsic C_{gs} , C_{gd} , and C_{gb} , which ones are proportional to channel width? which are proportional to channel length?

Enter your answer here

Q11.3

4 Points

How do the transistor intrinsic channel C_{gs} and C_{gd} vary with increasing V_{ds} from 0 to V_{DD} ? Assume V_{gs} is well above threshold voltage. Sketch the curves. At what biasing condition is C_{gs} equal to $\frac{1}{2}C''_{ox}WL$?

 Please select file(s)

Select file(s)