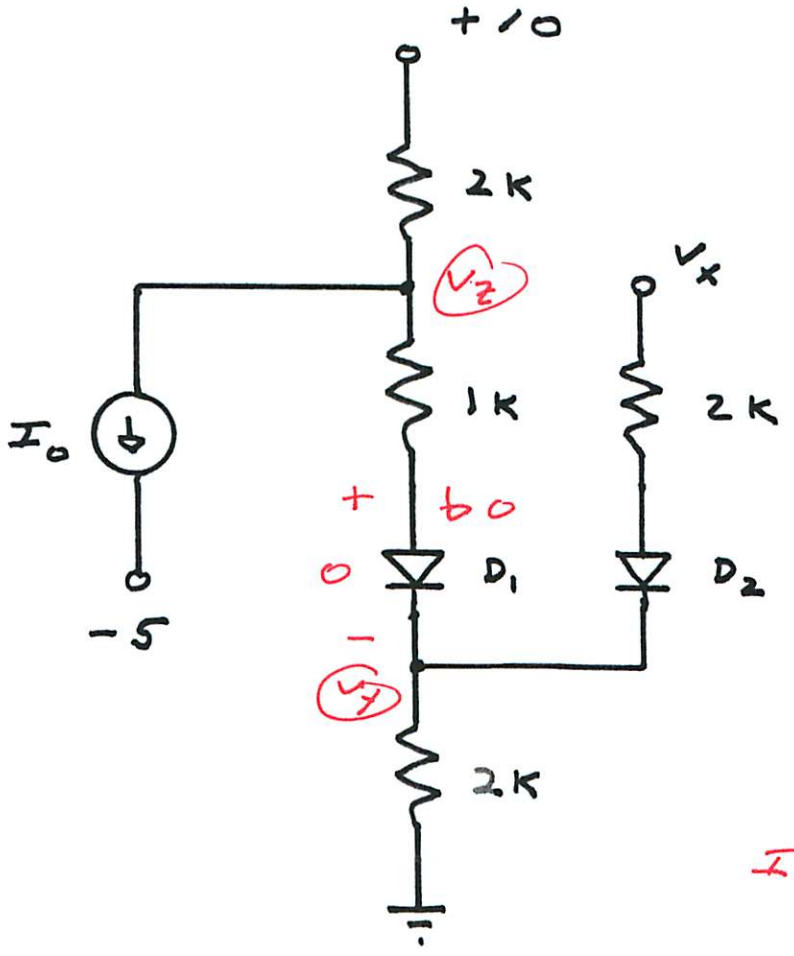
Problem 1

A. Determine the value for I_o that puts D_1 at breakpoint if $v_x = +4$ V.

B. Determine the value for I_o that puts D_1 at breakpoint if $v_x = -4$ V.



$V_x = 4\,V \rightarrow D_2$ on

$\rightarrow V_y = 2V$

$V_z = 2V$

$I_o = \frac{10-2}{2} = 4mA$

$V_x = -4V \rightarrow D_2$ off $\quad V_y = V_z = 0$

$I_o = \frac{10-0}{2} = 5\,mA$

115 V rms

amplitude = $115\sqrt{2} = 162$ V

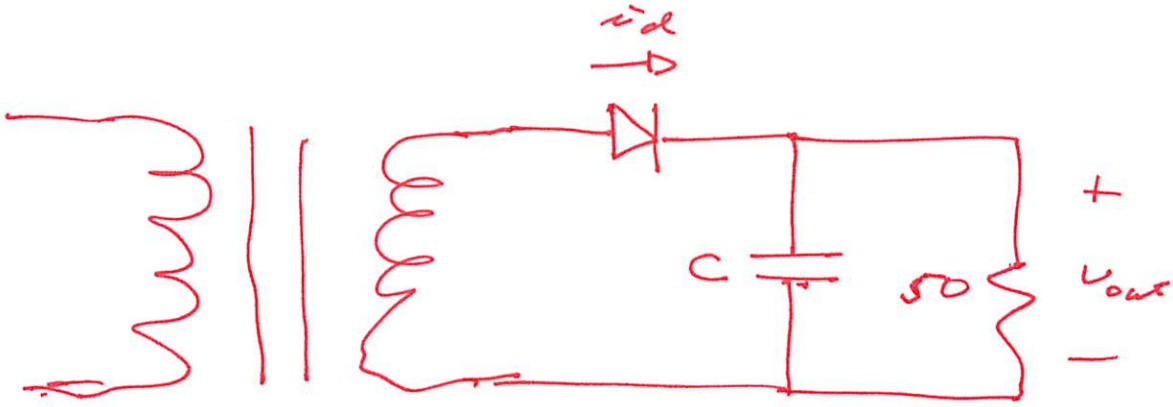
↑ 60 Hz

Problem 2

You have been asked to design a power cube that will plug into a wall outlet. The design must meet the following specifications:

- The output is 10 V dc with no more than 0.5-V ripple.
- Acceptable loads will require up to 2 Watts. $\frac{V^2}{R} = 2$ $\frac{100}{R} = 2$ ↳ $R = 50\,\Omega$
- The design has to be cheap with a minimum number of discrete parts. ↳ ½-wave rectifier + C

Draw the circuit inside the power cube and indicate the important component specifications.



N : 1

step down

$N = \frac{163}{10} = 16.3$

$\frac{V_{ripple}}{V_{max}} = \frac{T}{RC} = 0.05$

$C = \frac{1}{60 \times 50 \times 0.05}$

$= 6.67$ mF

$\cos\phi = 1 - \frac{V_{ripple}}{V_{max}} \longrightarrow \phi = 18.2°$

$i_d(max) = V_{max} C \omega \sin\phi$

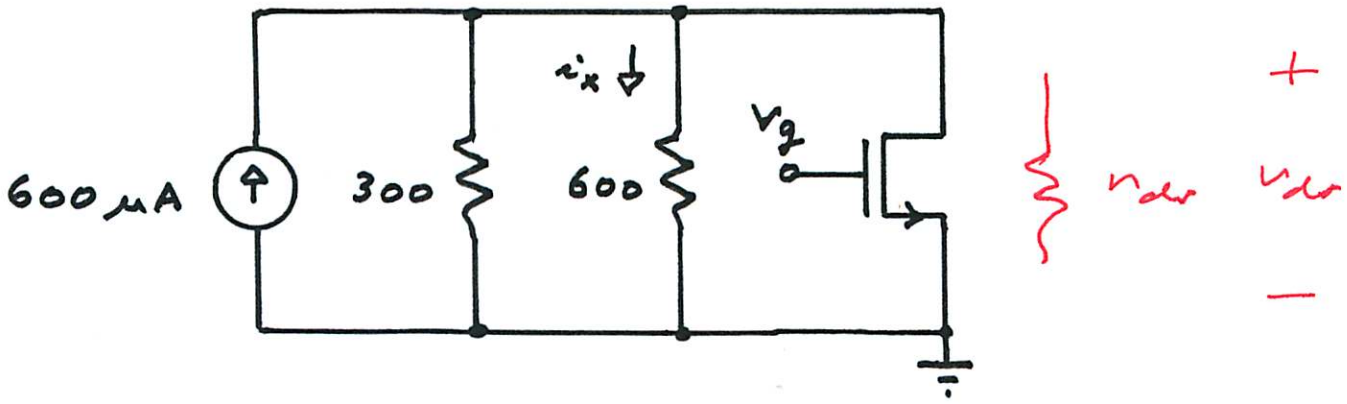
$= 10 \times 6.67 \times 10^{-3} \times 2\pi \times 60 \times \sin\phi$

$= 7.85$ A

Problem 3

The MOSFET has $K'W/L = 2$ mA/V^2 and $V_T = 1$ V.

Estimate V_g such that $i_x = 100$ μA.



Current divider

$$100\,\mu A = 600\,\mu A \frac{\frac{1}{600}}{\frac{1}{300} + \frac{1}{600} + \frac{1}{r_{ds}}}$$

$$\rightarrow \quad r_{ds} = 200\ \Omega$$

$$r_{ds}^{-1} = \underbrace{\frac{1}{200}}_{5\times10^{-3}} = K'\frac{W}{L}(V_{SG} - V_T) = 2\times10^{-3} \times (V_S - 1)$$

$$\rightarrow \quad V_S - 1 = \frac{5}{2} \qquad V_S = 3.5\ V$$

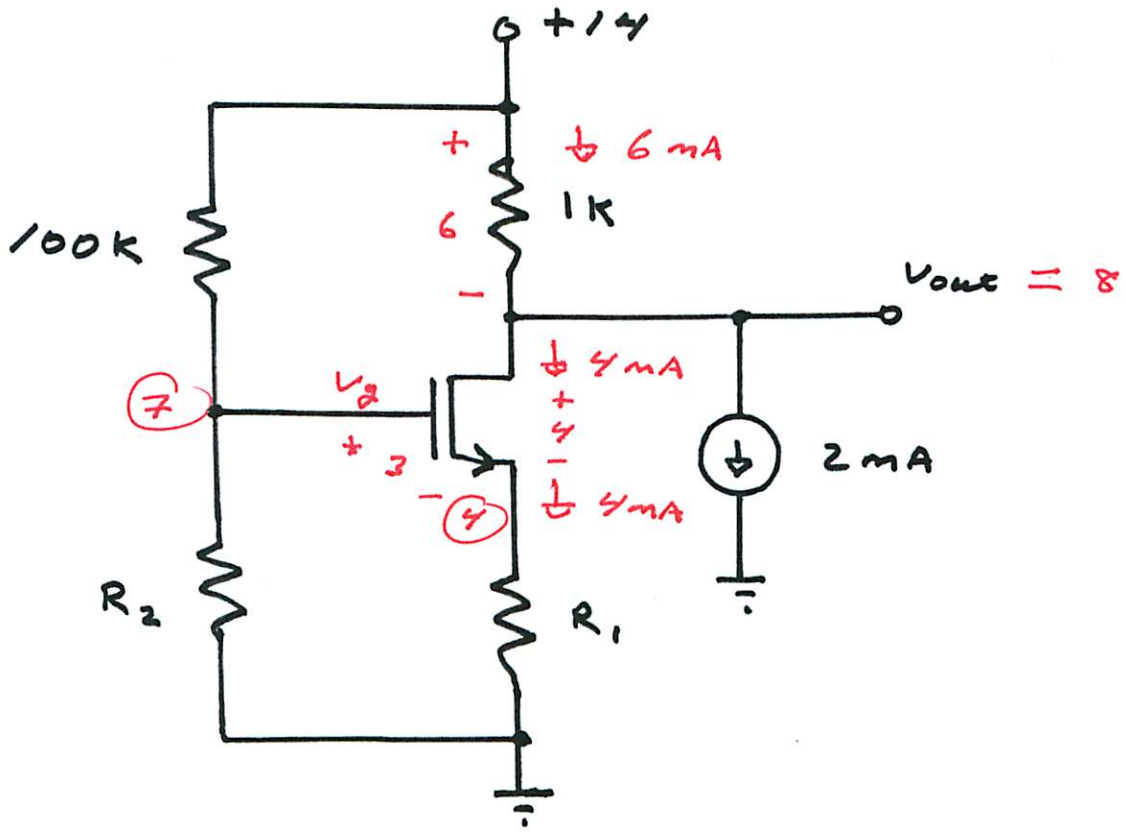
$300 \,//\, 600 \,//\, r_{ds} = 100\ \Omega$

$\rightarrow \quad V_{ds} = 0.06\ V \quad \rightarrow$ negative V

Problem 4

The MOSFET has $K'W/L = 2$ mA/V^2 and $V_T = 1$ V.

The MOSFET operates with v_{ds} 2 V higher than that needed to ensure the saturation mode, and $v_{out} = 8$ V. Complete the design.



$i_d = 4 = \frac{1}{2}(2)(v_{gs} - 1)^2 \longrightarrow v_{gs} = 3, -1$

saturation edge $\longrightarrow v_{ds} = v_{gs} - 1 = 2$ V

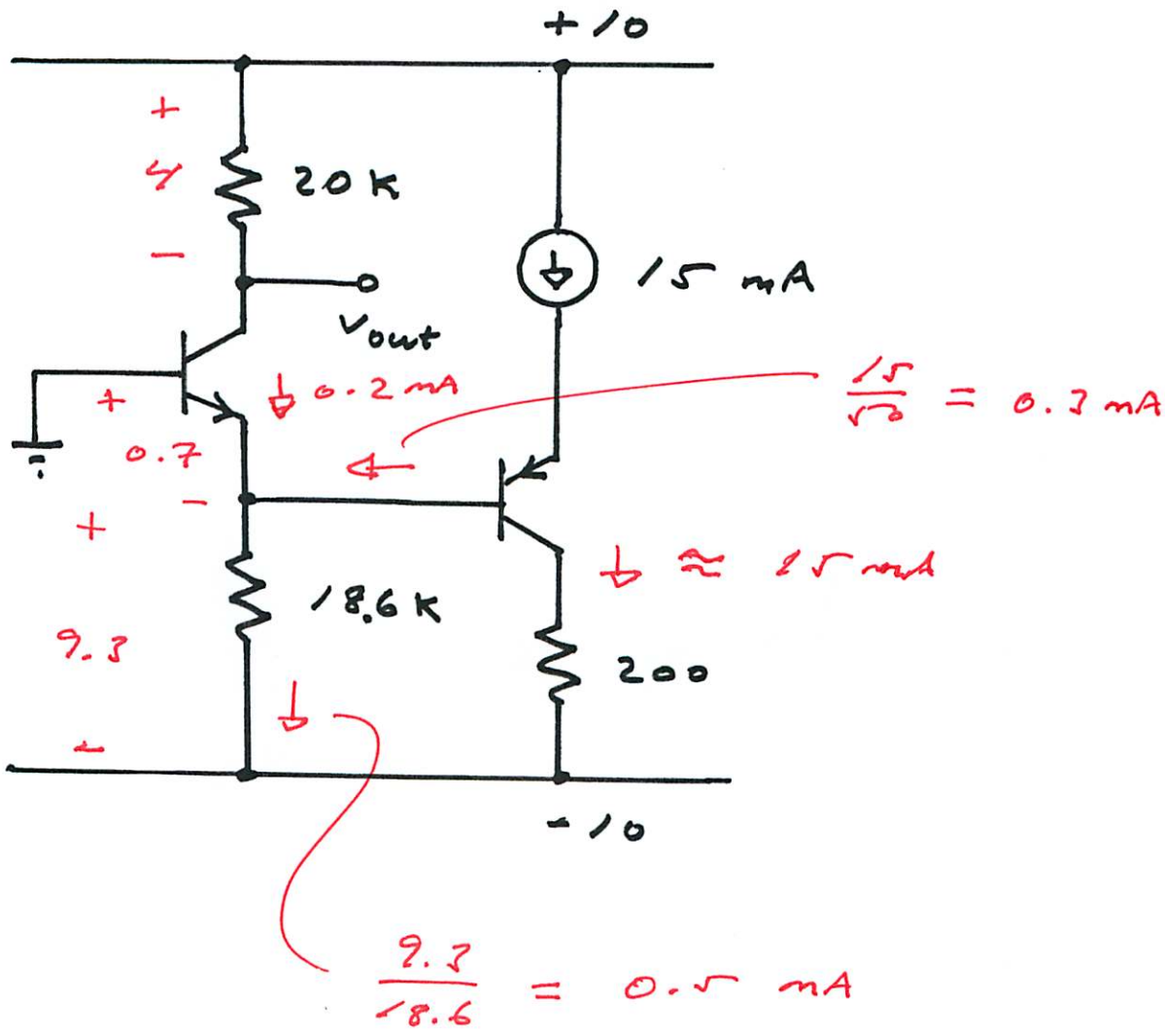
so $v_{ds} = 4$ V

$$r_1 = \frac{4\text{V}}{4\text{mA}} = 1\text{K}$$

$v_g = 7$ V $\longrightarrow$ $r_2 = 100$K

Problem 5

The BJTs have $\beta_F = 50$. Determine v_{out}.



$V_{out} = 10 - 4 = 6\ V$