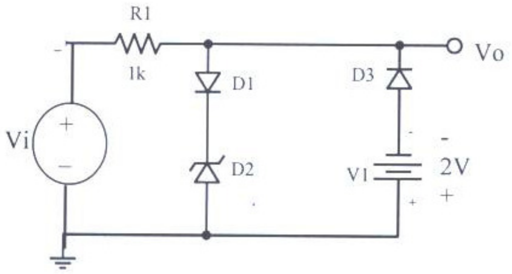
Problem 1: [10 Marks]

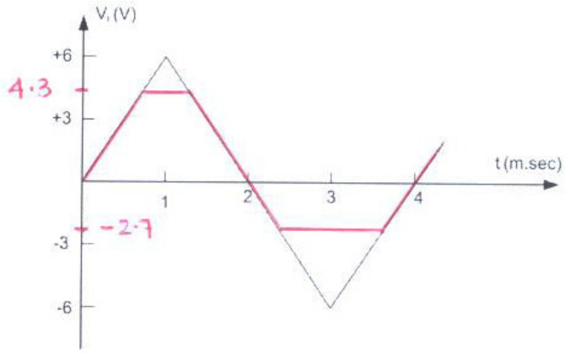
For the diode circuit shown, the zener diode has V_z=3.6V and r_z=0 Ω. all diodes may be modeled by the constant voltage drop (CVD) model with V_D=0.7V when conducting in forward mode.

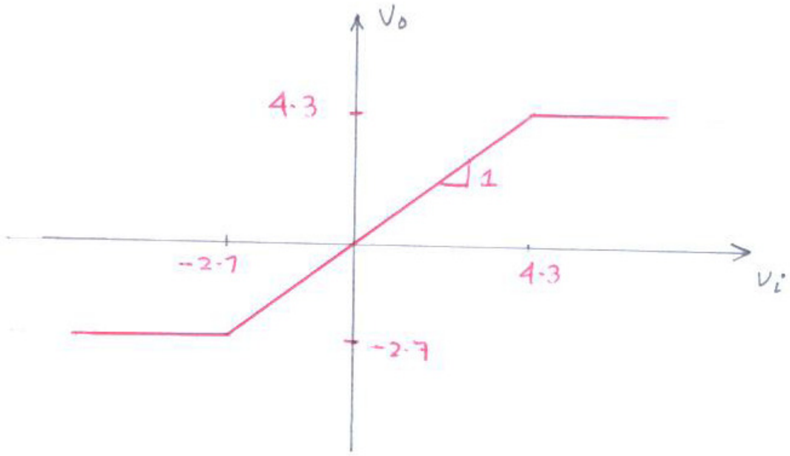
a) Draw the voltage transfer characteristics (V_o versus V_i) to cover the input range ±6V. *[5Marks]*

b) If the input signal v_i is a triangular waveform as shown, sketch v_o versus time. *[5 Marks]*

Label all the critical voltage levels in your sketches.







In the positive cycle of v_i, D_3 is always OFF.

, D_2 turns ON at breakdown of 3.6 V

D_1 turn ON at 0.7V

so $V_o = V_{D1} + V_{D2}$ = **4.3**

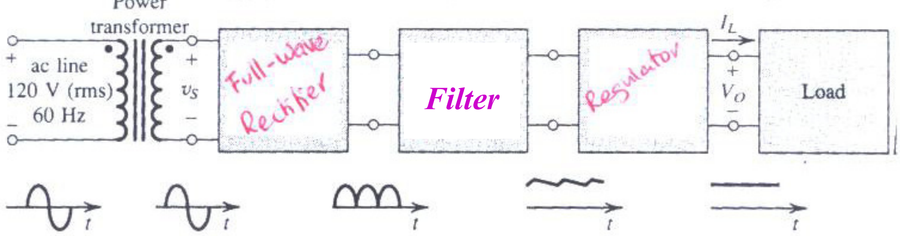
In the negative cycle of v_i, D_1 is always OFF.

, D_3 turns ON when the n-side becomes at −2.7V.

so $V_o = V_{D3} - 2 = -2.7$ V

Problem 2: [10 Marks]

a. For the DC power supply shown below, label the different building blocks. *[2 Marks]*



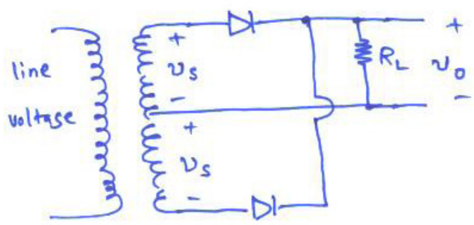
b. It is required to design a rectifier circuit to provide an average voltage of ≈15.4V to a 1kΩ load. The circuit operates from a 120V rms 60Hz houshold supply through a center-tapped tramsformer.

Available components: *[8 Marks]*

- Silicon diodes that can be modeled by a constant voltage drop of 0.7V
- A center-tapped tramsformer with a turns ratio that can be adjusted to one of the following values: 1:5, 1:6, 1:7, 1:8 or 1:10

a. Draw the rectifier circuit.
b. Find the required turns ratios.
c. What is the peak voltage and current at the load side.

(a)



(b)

$v_{O(ave)} \approx 2(V_p - V_{DO})/\pi = 15.4\text{ V}$

$\Rightarrow V_p = 24.9\text{ V}$

turns ratio $= \dfrac{120\sqrt{2}}{24.9\text{ V}} = 6.7$

≈ 7

so $V_p = 24.2\text{ V}$

(c) $v_{O(max)} = 24.2\text{ V} - 0.7$

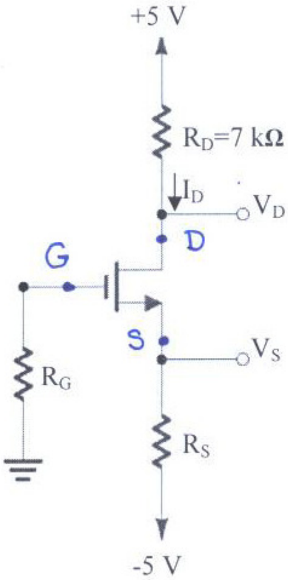
$= 23.54\text{ V}$

$I_{L(max)} = \dfrac{23.54}{1K} = 23.54\text{ mA}$

Problem 3: [10 Marks]

For the circuit shown below, the enhancement NMOS transistor parameters are: V_t=**2V, and** $\mu_n C_{ox}$**=200 uA/V², W/L=20.**

a. Design R_S so that V_S=-2.5V;
b. Calculate drain current I_D, and voltage V_D.
c. Find R_D that makes transistor at the edge of saturation mode.



From the circuit

$V_G = 0$

Given $V_S = -2.5\text{ V}$

so : $V_{GS} = 2.5\text{ V}$

Assume Saturation : $I_D = k(V_{GS} - V_t)^2$

$= 2m\,(2.5 - 2)^2$

$= 0.5\text{ mA}$ ⇐

$\Rightarrow V_D = 5 - 7K(0.5m)$

$= 1.5\text{ V}$ ⇐

Check: $V_{DS} = 4 > V_{GS} - V_t$
> 0.5 Assumption is OK

so $R_S = \dfrac{-2.5 - (-5)}{0.5m} = 5\,K\Omega$

At the edge of saturation : $V_D = V_G - V_t$
$= -2\text{ V}$

$\Rightarrow R_D = \dfrac{5 - (-2)}{0.5m} = 14\,K\Omega$ ⇐