King Fahd University of Petroleum & Minerals
Electrical Engineering Department

EE 203 – Exam I (062)
March 24, 2007

Name	
ID	

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Section	1	2	3	4 5	6 7

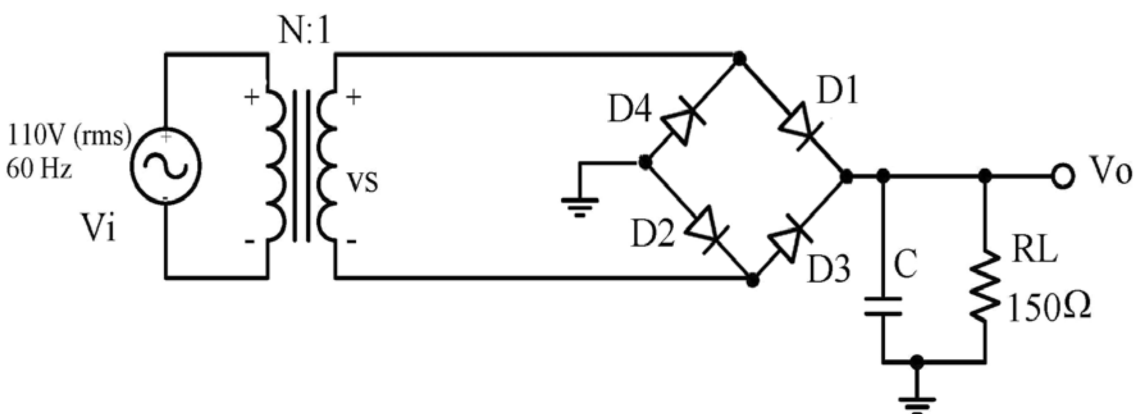
- **Solve <u>all</u> problems.**
- **Total exam time is 90 minutes.**

Problem	**Grade**
1 (35 points)	
2 (30 points)	
3 (35 points)	
Total (100 points)	

Problem (1)

It is required to use a bridge peak-rectifier (as shown below) to design a dc power supply that provides an average dc output voltage of 10V on which a maximum of ± 0.6V ripple is allowed. The diodes available have 0.7V drop when conducting.

a) Find the peak value of the transformer secondary output **(10 points)**
b) Find the transformer turns ratio to provide the necessary secondary voltage **(10 points)**
c) Find the required value of the filter capacitor. **(10 points)**
d) Find the maximum reverse voltage that will appear across each diode. **(5 points)**



a)
$V_{o(av)} = 10V$
$V_r = 1.2V$
$V_{o(peak)} = V_{o(av)} + 0.5\ V_r = 10.6V$
$V_{S(peak)} = V_{o(peak)} + 2V_D = 12V$

b) $V_{S(rms)} = \dfrac{V_{s(peak)}}{\sqrt{2}} = 8.48V$

$N = \dfrac{V_{i(rms)}}{V_{s(rms)}} = 13$

c)
$$C = \frac{V_{o(peak)}}{2\, fRV_r} = \frac{10.6}{2*60*150*1.2} = 490uF$$

d)
The maximum reverse voltage appears across the diode =PIV

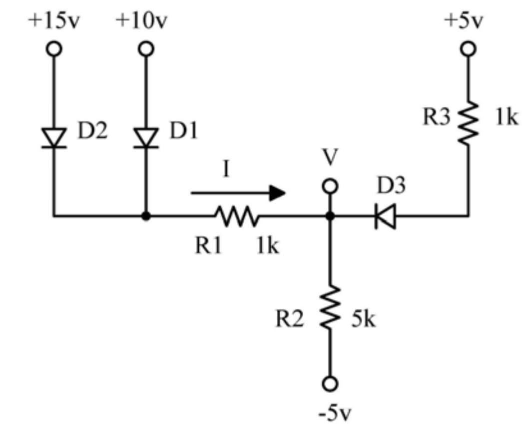
$PIV_{D1} = PIV_{D2} = PIV_{D3} = PIV_{D4} = V_{S(peak)} - V_D = (12) - 0.7 = 11.3V$

Problem (2)

A:

For the shown circuit, assuming that the conducting diode has a constant voltage drop $V_D = 0.7V$,

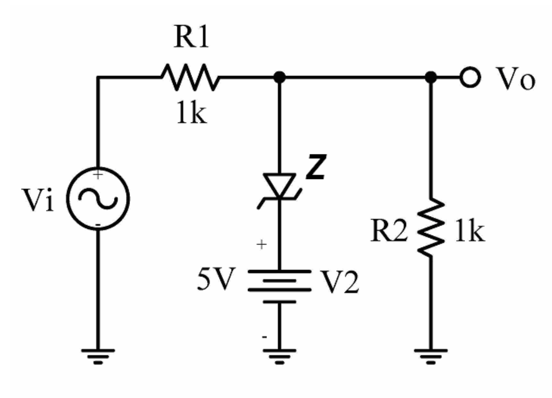
a) Find I_D for all the diodes. **(10 points)**
b) Determine the values of I and V. **(5 points)**



B:

For the shown diode circuit, assuming that Z has V_z=3.3 V, r_z=0 Ω, and a forward drop voltage of 0.7V.

a) Draw the voltage transfer characteristics (V_o versus V_i) to cover the input range ±15V. **(8points)**
b) If V_i is a sinusoidal waveform with peak value of 15 V, sketch V_o versus time for one period. Label all the critical voltage levels. **(7 points)**



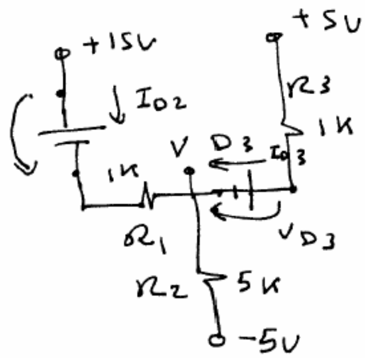
1-a)

Since D_1 & D_2 share the same cathode node ⇒

D_1 is off as it has less anode voltage.

Assume both Diodes (D_2 & D_3) ON

Using nodal at V



$$\therefore \frac{14.3-V}{1} + \frac{4.3-V}{1} + \frac{-5-V}{5} = 0$$

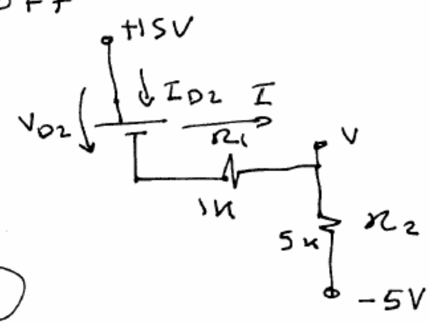
$$\therefore V = \boxed{8.91V}$$

check

$$\therefore I_{D2} = \frac{15-8.91-0.7}{R_1} > 0$$

$$I_{D3} = \frac{5-0.7-8.91}{R_3} < 0 \Rightarrow \text{Wrong Assumption}$$

Then D_2 is ON & D_3 is off



$$I = \frac{15-0.7-(-5)}{R_1+R_2}$$

$$= \boxed{3.22\ mA}$$

$$V = -5 + IR_2 = \boxed{11.1V}$$

check:

$I_{D2} = +3.22mA > 0$, $V_{D3} = -6.1V < 0$, $V_{D1} = -4.3 < 0$

Diode	Status	Q-point (I_D, V_D)
D_1	OFF	(0, -4.3V)
D_2	ON	(3.22 mA, 0.7V)
D_3	OFF	(0, -6.1V)

2- B:

$V_Z = 3.3V$, $r_Z = 0$, $V_{D\,on} = 0.7V$

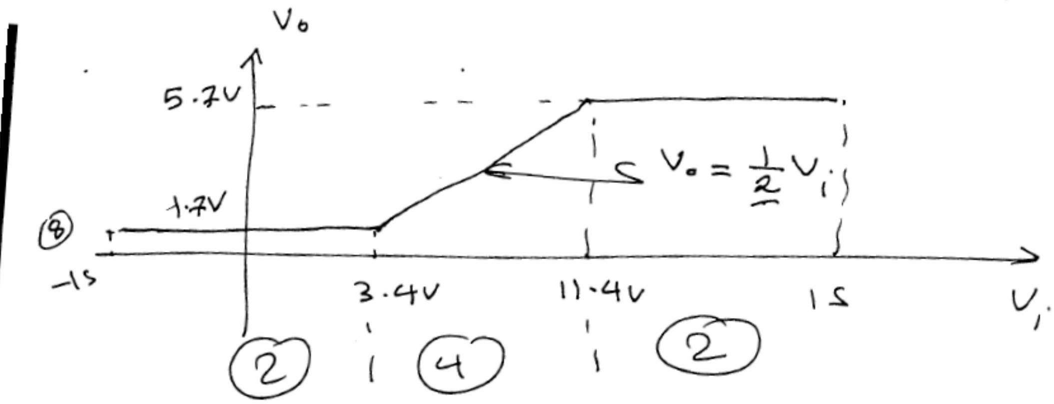
a)

Zener is off if $3.4V < V_i < 11.4V$

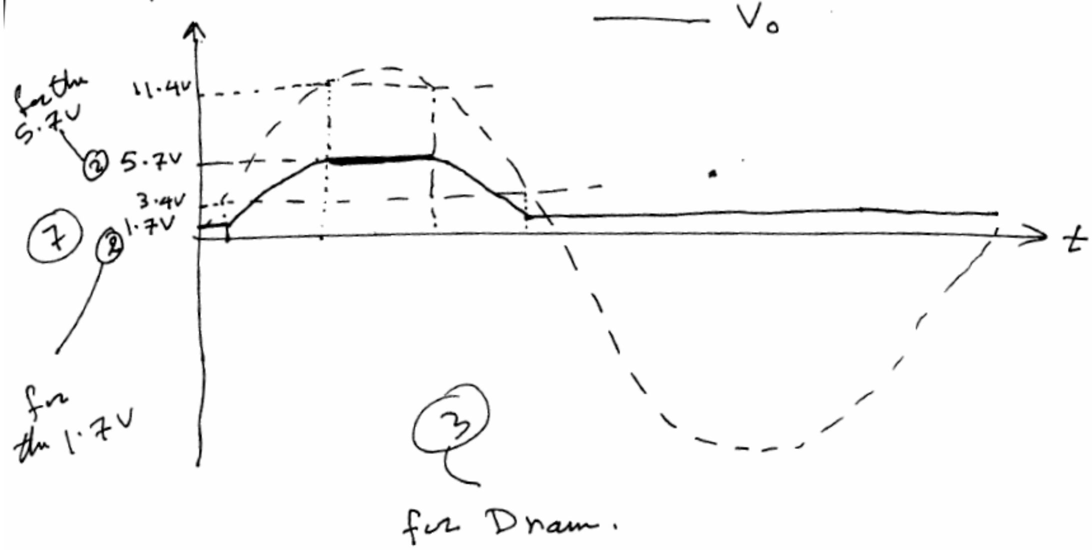
$\Rightarrow V_o = \frac{1}{2} V_i$

Zener is forward if $V_i \geq 11.4V \Rightarrow V_o = 5.7V$

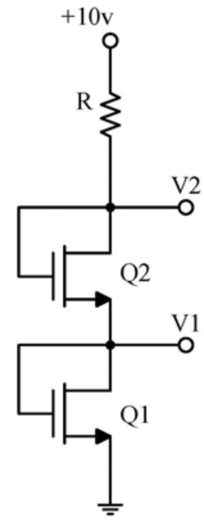
" " in Zener region if $V_i \leq 3.4V \Rightarrow V_o = 1.7V$



b)



Problem (3)



For the MOS circuit shown in the figure, λ=0, $|V_t|$=1 V, and μC_{ox}(W/L) = 1 mA/V^2.

1) If the voltage at V_1 is measured to be 2 volts, what is the voltage at V_2? **(10 points)**

2) According to part (1), what is the value of R? **(10 points)**

3) What is the range of R values that will cutoff the transistors? **(5 points)**

4) If R was completely removed (short circuit), how much will the current in the circuit increase? Is it safe? **(10 points)**

1) $I_{D1} = I_{D2}$; Both transistors in saturation because $V_{GS} = V_{DS}$ $\rightarrow V_{DS} > V_{GS} - V_t$

$K_1 = K_2$

$V_{t1} = V_{t2}$

$(V_{GS1} - V_{t1})^2 = (V_{GS2} - V_{t2})^2$; $V_{S2} = V_{D1} = V_{G1}$

$\rightarrow V_{G2} = 2 V_{G1}$

$V_2 = V_{G2} = 2 V_{G1} = 2 V_1 = 4$ V.

2) $I_{D1} = I_{D2} = 0.5m\,(2-1)^2 = 0.5$ mA

$R = (10-4)/0.5m = 12\ K\Omega$

3,4) No values of R can cutoff transistors.

5) with R removed: $V_{G2} = 10$ V , $V_{G1} = 5$ V.

$I_D = 0.5m\,(5-1)^2 = 8$ mA

Reasonable current, but on the high side.