Test 2 MAKE-UP

EE315 Spring 2017—Dr. B

NAME Solution Key

DO ALL YOUR WORK ON THIS EXAM. USE THE BACK SIDES of EXAM PAPER IF NECESSARY BUT POINT ME WHERE YOU DID THAT.

- ***Your Equation sheet must be turned in with the Exam.***
- ***NO Cell PHONE Calculators allowed. Other calculators ok.***
- ***Closed books/closed lecture notes.***
- ***Each Problem worth 18 points.***
  - ***A good engineer is someone who is good with math but without the personality of an accountant,***

EE315 SPRING TERM 2017

TEST 2 MAKEUP- 29 MARCH 2017

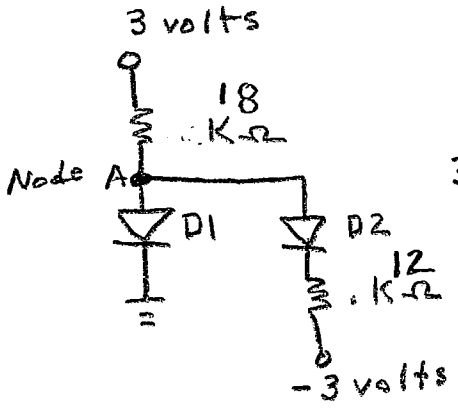
NAME Solution Key

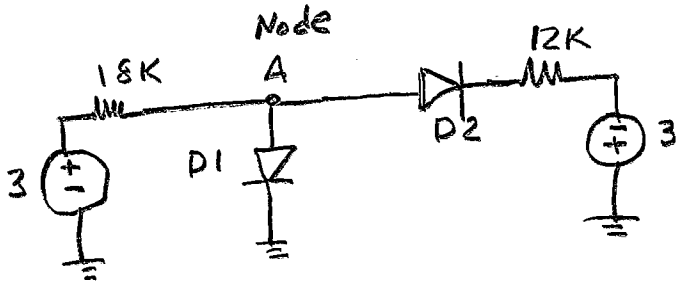
CIRCLE TRUE OR FALSE (1 point each)

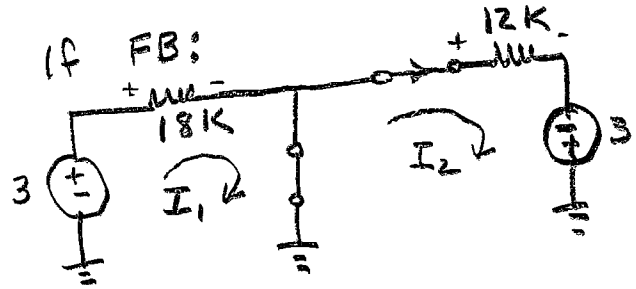
1. (T/(F)) Thermal voltage for a semiconductor diode depends on temperature (in ~~Centigrade~~ Kelvin degrees), Boltzmann's Constant, and charge on the electron.
2. (T/(F)) An extrinsic semiconductor does not have any doping to change the conductivity of the material. intrinsic
3. (T/(F)) A semiconductor diode has only two states; either forward biased or electrically biased. reversed
4. ((T)/F) At room temperature, thermal voltage for silicon is 25 microvolts.
5. ((T)/F) A depletion region in a semiconductor diode is a region free of charge carriers.
6. ((T)/F) A semiconductor diode is formed by a p-n junction.
7. ((T)/F) A Zener diode must be reversed biased to perform and operate as a Zener diode.
8. ((T)/F) A "hole" is the empty space where an electron was but the space still has an effective mass and electrical charge.
9. (T/(F)) A reversed biased semiconductor diode is, ideally, a ~~short~~ open circuit.
10. (T/(F)) An "n region" in a semiconductor diode is a region where an excess of ~~positive~~ negative charges are available for conduction.

2. A newly hired EE recently graduated from Loachapoka University School of Engineering tells you that both diodes in circuit below are forward biased. Is the EE correct? YES or NO?

Show your work!! NO CREDIT FOR GUESSING







$3 - 18K\, I_1 = 0$

$I_1 = 3/18K = 1.67 \times 10^{-4}$ Amp

$-12K\, I_2 + 3 = 0$

$I_2 = 3/12K = 2.5 \times 10^{-4}$ Amp

For D1

$I_{D1} = I_1 - I_2 = 1.67 \times 10^{-4} - 2.5 \times 10^{-4}$

$= -.83 \times 10^{-4}$

Since I_{D1} is negative direction, D1 cannot be forward biased.

Engineer is Incorrect!

3. A step down transformer has the following data:

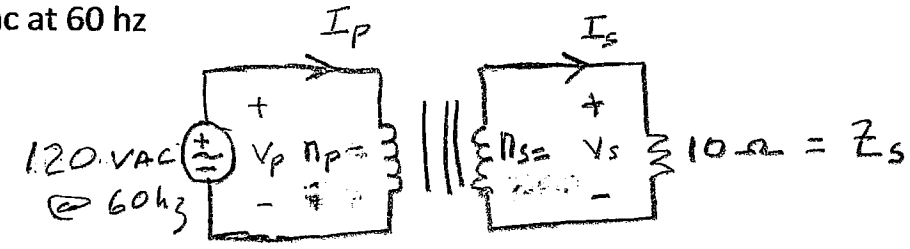
Vp = 120 volts ac at 60 hz

Np = 400

Ns = 200

Zs = 10 ohm

FIND Vs, Is, and Ip



$n_p = 800$

$n_s = 400$

Recall $\frac{N_p}{N_s} = \frac{V_p}{V_s} = \frac{I_s}{I_p}$

Then $\frac{800}{400} = \frac{120}{V_s} \Rightarrow$ **V_s = 60 volts**

Then $I_s = \frac{V_s}{10} = \frac{60}{10} =$ **6 Amps**

Then $\frac{N_p}{N_s} = \frac{I_s}{I_p} \Rightarrow I_p = \frac{N_s I_s}{N_p} = \frac{400}{800}(6)$

I_p = 3 Amps

4. A diode operating in forward bias has a voltage drop of 0.7 volts at 1.2 mA milliamp. The diode is then operated at 0.5 milliamp. What is the new value of diode voltage? Assume $V_T = 25$ millivolts.

$$I_D = I_S \left(e^{V_D/V_T} - 1\right)$$

$$1.2 \times 10^{-3} = I_S \left(e^{.7/.025} - 1\right) = I_S \, e^{28}$$

$$I_S = \frac{1.2 \times 10^{-3}}{1.4462 \times 10^{12}} = 8.297 \times 10^{-16} \text{ Amp}$$

then $I_D\big|_{.5\,mA} = 8.297 \times 10^{-16} \left(e^{V_D/.025} - 1\right)$

$$.0005 = 8.297 \times 10^{-16} \, e^{V_D/.025}$$

$$6.026 \times 10^{11} = e^{V_D/.025}$$

$$27.124 = V_D/.025$$

$$\boxed{V_D = 0.678 \text{ volts}}$$

5. A Zener shunt regulator is shown below. Datasheet for the Zener shows:

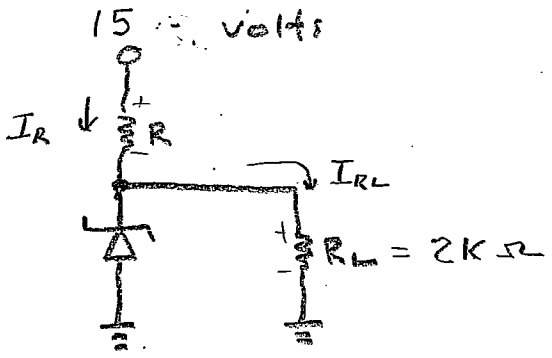
Vz = 6.0 volts at Iz = 5 milliamp and rz= 10 ohm.

(a) Find V_{zo} for the Zener diode

(b) Find the current through RL at that Zener voltage

(c) Find the current through R

(d) Find value for R



(a) $V_z = V_{zo} + r_z I_z$

$V_{zo} = V_z - r_z I_z$

$= 6 - 10(.005)$

$V_{zo} = 5.95$ volts

(b) $I_{RL} = \frac{6}{2K} = 3$ mA

$R_L I_{RL} + R I_R - 15 = 0$

$I_{RL} = 3$ mA

(c) so $I_R = 3\text{mA} + 5\text{mA} = 8$ mA

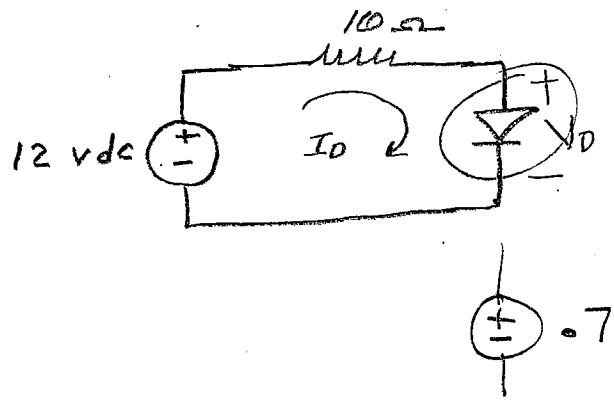
(d) so $2K(.003) + R(.008) - 15 = 0$

$6 + .008R - 15 = 0$

$.008R = 9$

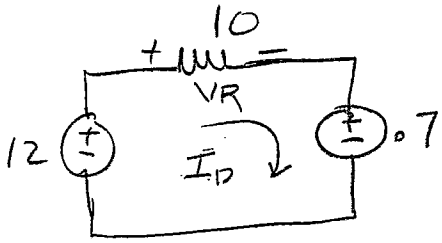
$R = 1125\ \Omega$

6. Using the Constant Voltage Drop Model for a Semiconductor Diode in the circuit below:



(a) Compute I_D

(b) If the 12 vdc SOURCE is Replaced by a 12 v peak sinusoid waveform, sketch V_D waveform.



(a) $I_D = \frac{12 - .7}{10} = \frac{11.3}{10} =$ **1.3 Amp**

(b)