Name: ____________________________________________ 

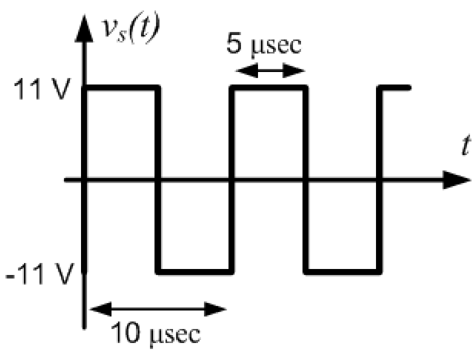
EE462L – Spring 2013, Test 1

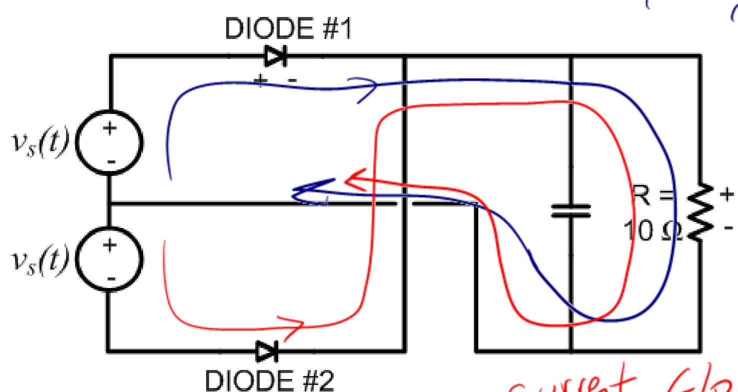
Please, show all your work on the test sheets. A correct answer without supporting work gets no credit. One sheet of notes is permitted. Write your name in all pages. Do not un-staple. Please **be neat**; it works in your advantage…. Sometimes I may not be able to find a right answer to a problem if the solution is messy. You have 50 minutes to complete the test.

**Problem 1 (30 points)**

For the circuit in the figure below sketch the current and voltage across diode #1 and across the output load resistance R. When sketching these plots consider that the conduction losses in each diode is 0.5 W (so these diodes are not ideal switches. Still, you can assume that the diodes start conducting as soon as a positive forward bias voltage is applied to them). Be sure to indicate relevant values on the plots. What is the power efficiency of this circuit? Note: this problem has two numerically valid solutions. Of these two solutions choose the one that you consider is more reasonable.

current flow when $v_s>0$




current flow when $v_s<0$

My "guesses" about how the circuit operates

Consider the loop when $v_s>0$

$$v_s = v_{D_1} + v_R \longrightarrow 11V = v_{D_1} + IR = v_{D_1} + I\,10$$

Since $P_{loss}$ in each diode is $\frac{1}{2}$W the

$$P_{loss\,D_1} = \frac{1}{2}W = v_{D_1} I \frac{T_{on}}{T} = v_{D_1} I \frac{1}{2} \longrightarrow 1 = v_{D_1} I$$

$$11 = v_{D_1} + 10\frac{1}{v_{D_1}}$$

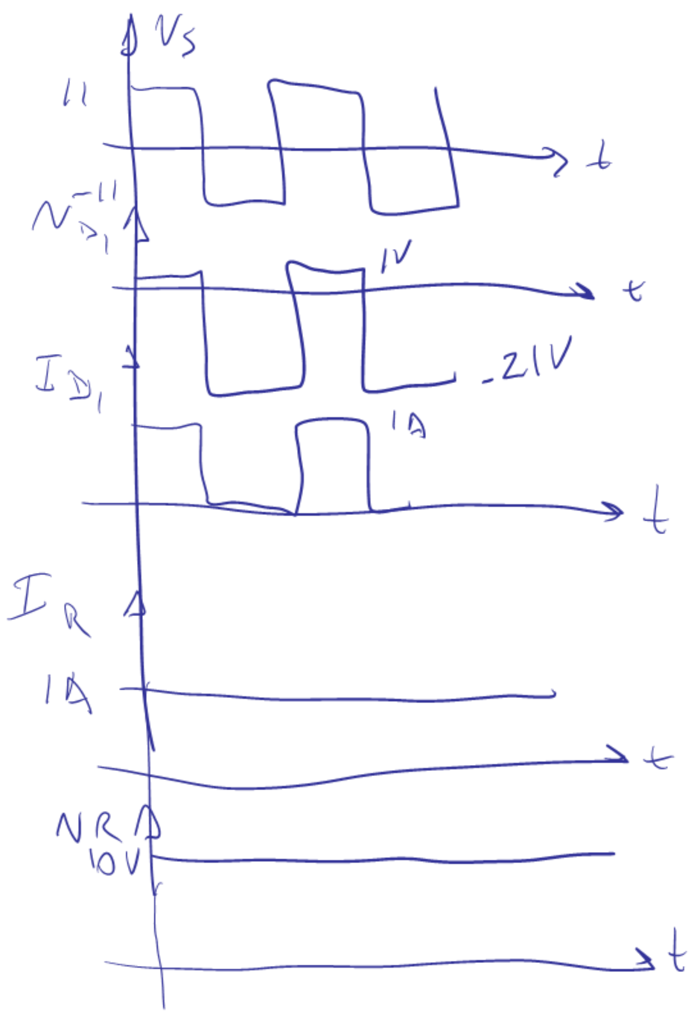
$$v_{D_1}^2 - 11 v_{D_1} + 10 = 0$$

$$V_{D_1} = \frac{11 \pm \sqrt{121 - 40}}{2} = \frac{11 \pm 9}{2} \begin{cases} 10 \\ 1 \end{cases}$$

Most reasonable solution

$$V_{D_1} = 1V \longrightarrow I = 1A$$

$$\left.\begin{array}{l} P_{OUT} = I^2 R = 1^2 10 = 10W \\ P_{loss} = 2 \times 0.5W = 1W \end{array}\right\} \eta = \frac{P_{OUT}}{P_{in}} = \frac{10}{11} \simeq 0.91$$



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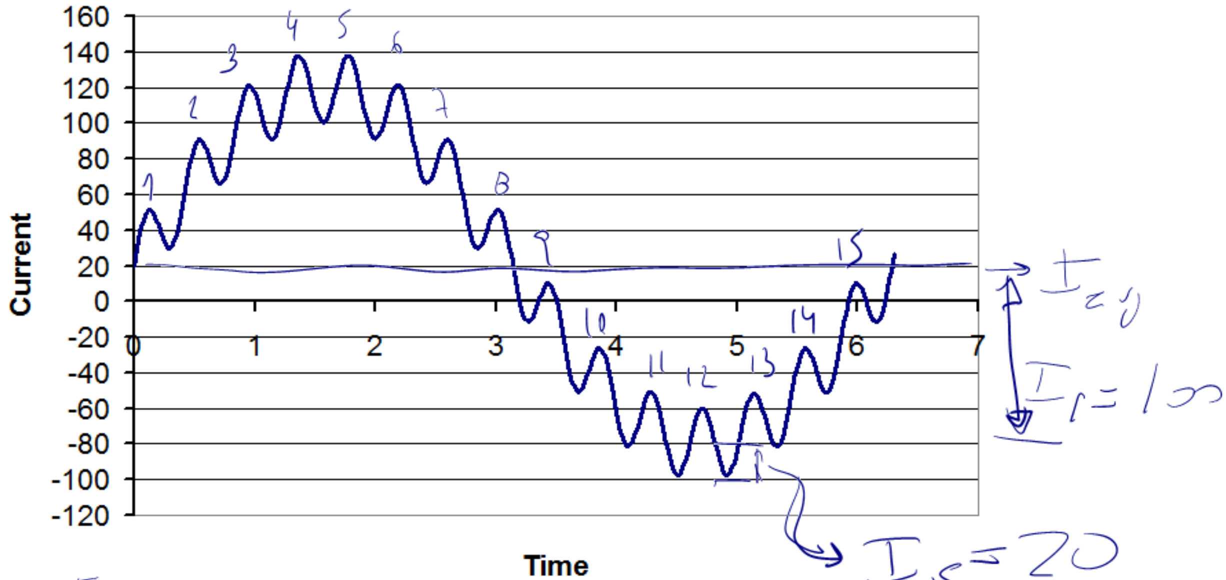
**Problem 2 (30 points)**

$f_h = 15 f_f$

Consider the current waveform in the figure shown below. Indicate the average current and the amplitude of the sinusoidal components. What is the frequency of the harmonic component with respect to that of the fundamental? If this current is measured at the output of a 10 V dc voltage source connected to some load, what is the average power that is provided by this 10 V dc voltage source to the load? Can the load be a resistor?
Sketch the FFT graph in dB considering that this current is measured with a 0.01 ohm resistance and that the reference voltage for the oscilloscope is 1 V.




$I_{15} = 20$

$I_{avg} = 20$

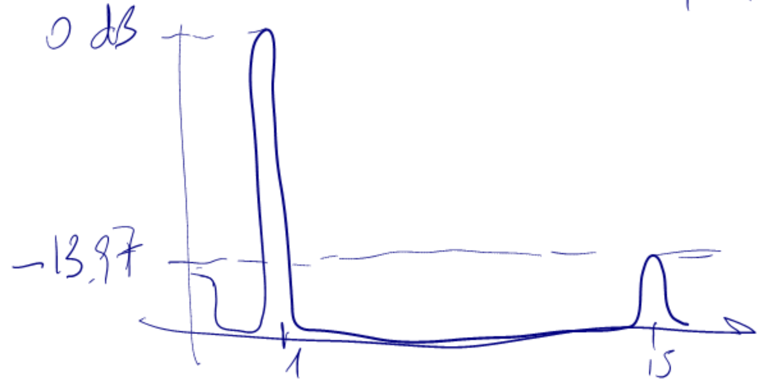
$P = V_{dc} I_{avg} = 10 \cdot 20 = 200W$

It can't be a resistor because it is a non linear load

$V_{avg} = 0.01 \times 20 = 0.2 V \longrightarrow 20 \log\left(\frac{0.2}{1}\right) = -13.97$

$V_1 = 0.01 \times 100 = 1 V \longrightarrow 20 \log\left(\frac{1}{1}\right) = 0$

$V_{15} = 0.01 \times 20 = 0.2 V \longrightarrow 20 \log\left(\frac{0.2}{1}\right) = -13.97$



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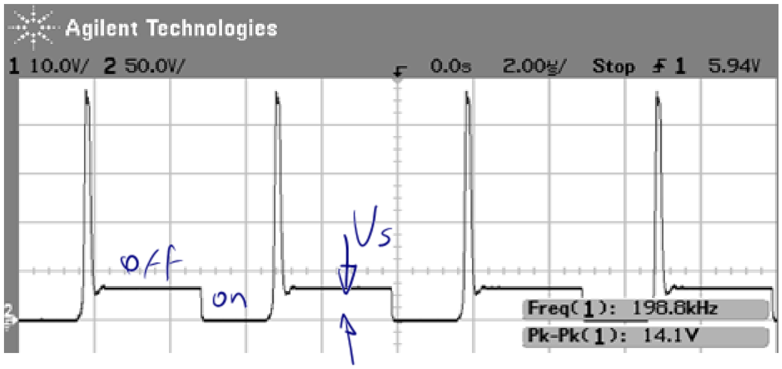
**Problem 3 (25 points)**

Consider the following oscilloscope trace measured in a circuit like the one with a load you used in the MOSFET firing circuit.




a) During Turn OFF of your MOSFET, a high over-voltage transient (spike) is seen in which waveform?

a. $V_{GS}$

b. $V_{GD}$

c. $V_{DS}$

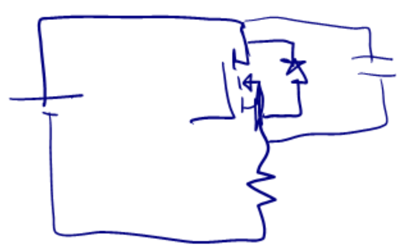
b) What is the cause of this high transient overvoltage value? What is the cause of the subsequent ringing? → Cgs combined with circuit's parasitic inductances and capacitances

c) How do we mitigate the voltage spike? Please sketch the resulting circuit (only the power portion of it). What is the source's voltage (consider that the vertical scale in the figure above is 50 V/division)?

d) In the figure above indicate when the MOSFET is on and when is off.

c) By adding a capacitor in parallel to the MOSFET

$V_S = 35V$



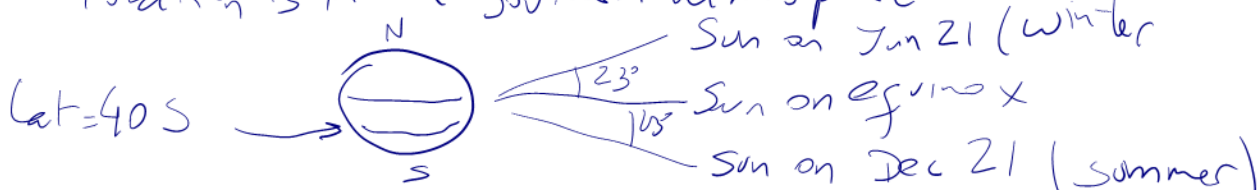
**Problem 4 (5 points each)**

Please, select the correct answer for the following questions. **Provide a justification for your answers.**

4.1) The largest hydroelectric facility in Chile is the 500 megawatt (MW) Pangue Power Plant, located on the Bío-Bío River (38°03′S, 71°19′W). They have proposed increasing generation by adding a large solar array (solar PV system); however, they need some help in knowing how to maximize their solar output. Their array is fixed (so no axis-tracking equipment is installed); however, they can change their solar panel tilt angle, seasonally.
Which orientation below will generate the most solar output on an annual basis?

a) Azimuth = $90^0$, Panel Tilt = $40^0$ (Spring/Fall), $40^0$ (Summer), $40^0$ (Winter)
b) Azimuth = $270^0$, Panel Tilt = $40^0$ (Spring/Fall), $40^0$ (Summer), $40^0$ (Winter)
c) Azimuth = $270^0$, Panel Tilt = $40^0$ (Spring/Fall), $20^0$ (Summer), $60^0$ (Winter)
d) Azimuth = $180^0$, Panel Tilt = $40^0$ (Spring/Fall), $20^0$ (Summer), $60^0$ (Winter)
e) Azimuth = $180^0$, Panel Tilt = $40^0$ (Spring/Fall), $60^0$ (Summer), $20^0$ (Winter)
f) Azimuth = $0^0$, Panel Tilt = $40^0$ (Spring/Fall), $20^0$ (Summer), $60^0$ (Winter)
g) Azimuth = $0^0$, Panel Tilt = $40^0$ (Spring/Fall), $60^0$ (Summer), $20^0$ (Winter)

→ Because it needs to be looking north because the location is in the southern hemisphere



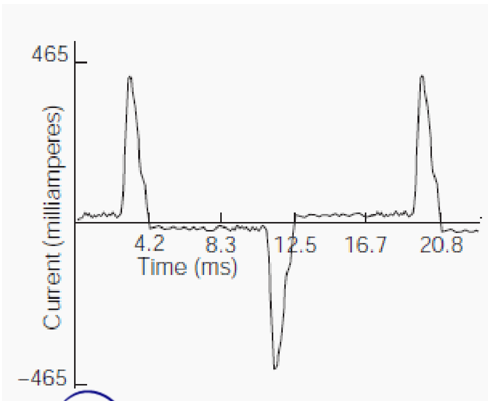

4.2) Indicate if the following statement is true or false

a) In the diode bridge rectifier project, one can calculate the power factor at the input of the diode bridge rectifier by taking the cosine of the difference between the phase angle of the 60 Hz sinusoidal voltage that is applied to the rectifier and the phase angle of the current that is taken by the rectifier.

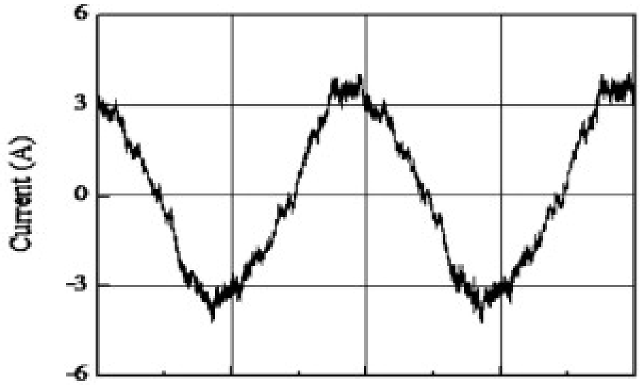
TRUE FALSE

→ Because the current waveform is not a perfect sinusoid

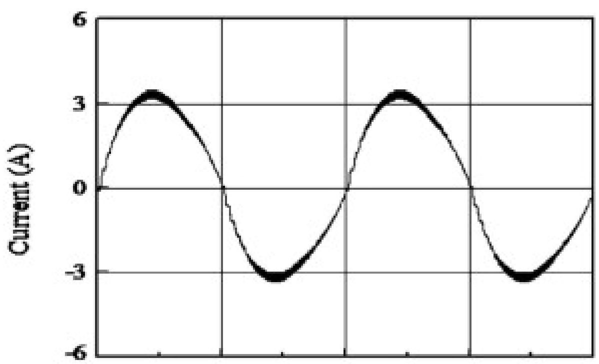
4.3) The figures below obtained from the web show current for various home electrical devices Based on these current waveforms shown below, which of the following loads have the worst current THD? Why?



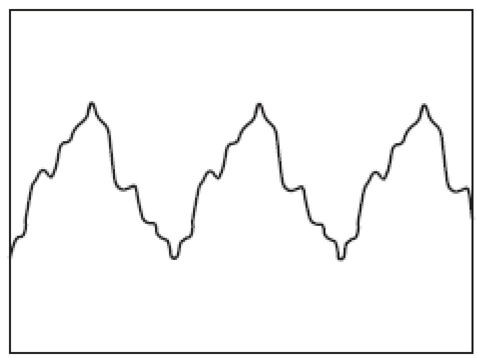

(a) Compact Fluorescent light




b) solar inverter #1




c) Solar inverter #2



(b) Ventilation fan

(a) Because is the waveform that looks the most different from a sinusoid