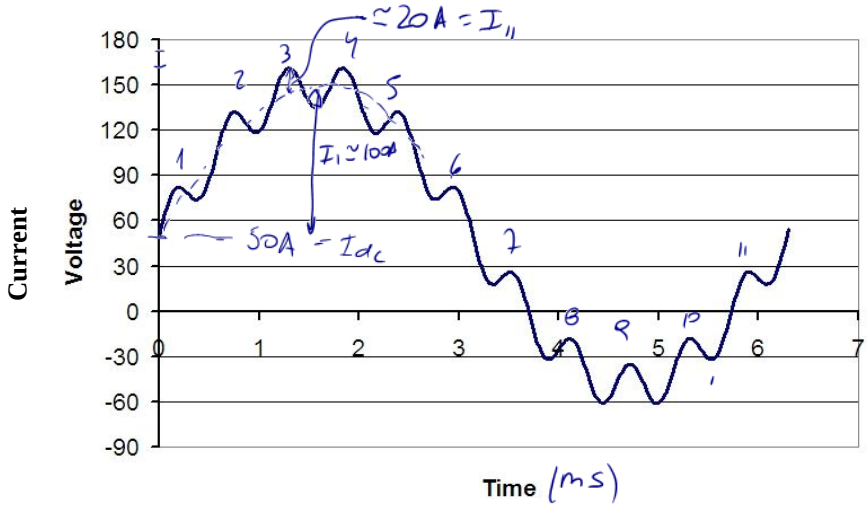
EE462L – Spring 2014, Test 1

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 favor…. Sometimes I may not be able to find a right answer to a problem if the solution is messy. You have 75 minutes to complete the test.

Problem 1 (20 points)

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 higher harmonic component with respect to that of the lower harmonic component? Consider that this current is circulating through a 48 V battery (i.e., the voltage at the source is constant). What is the average power provided by the battery to the circuit? What is the power factor observed at the battery?



$f_H \simeq 11 f_L$

$f_L = \frac{1}{6.28 \cdot 10^{-3}} = 159\ Hz \rightarrow f_H \simeq 1.75\ kHz$

$P \simeq 48 \cdot 50 = 2.4\ kW$

$pf = \frac{P}{I_{rms} V_{rms}} = \frac{2.4\ kW}{I_{rms}\ 48} = \frac{50}{I_{rms}} = \frac{50}{87.75} \simeq 0.57$

$I_{rms}^2 = I_{dc}^2 + \sum_k \frac{I_k^2}{2} = 50^2 + \frac{I_1^2}{2} + \frac{I_{11}^2}{2} =$

$= 50^2 + \frac{100^2}{2} + \frac{20^2}{2} = 7700 \rightarrow I_{rms} \simeq 87.75\ A$

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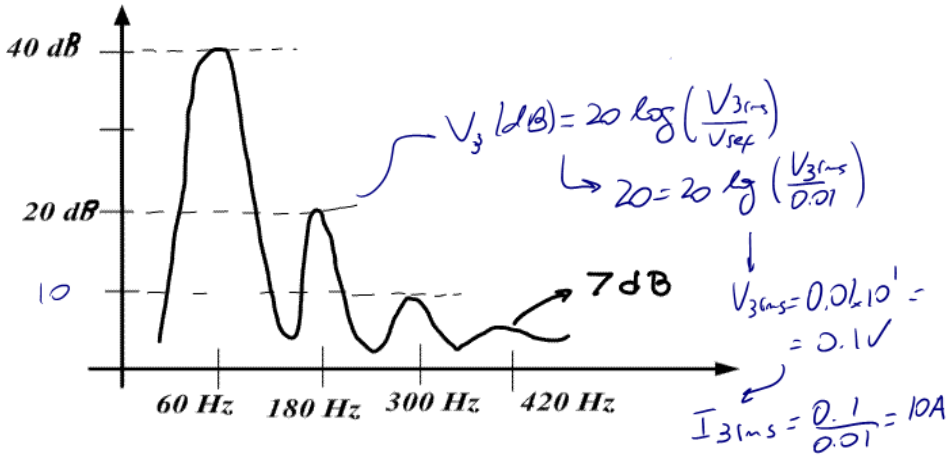
Problem 2 (25 points)

The figure shows an oscilloscope screen capture of a current measured using a 0.01 ohm resistor. Please calculate the current 3rd harmonic component and the THD. The values in the screen capture are measured with respect to a 10 mVrms reference.



$V_{1rms} = 0.01 \times 10^2 = 1 \longrightarrow I_{1rms} = 100A$

$V_{5rms} = 0.01 \times 10^{1/2} = 0.032 \longrightarrow I_{5rms} = 3.2A$

$V_{7rms} = 0.01 \times 10^{7/20} = 0.01 \times 2.24 = 0.0224 \longrightarrow I_{7rms} = 2.24A$

$$THD = \sqrt{\frac{I_3^2 + I_5^2 + I_7^2}{I_1^2}} = 0.107$$

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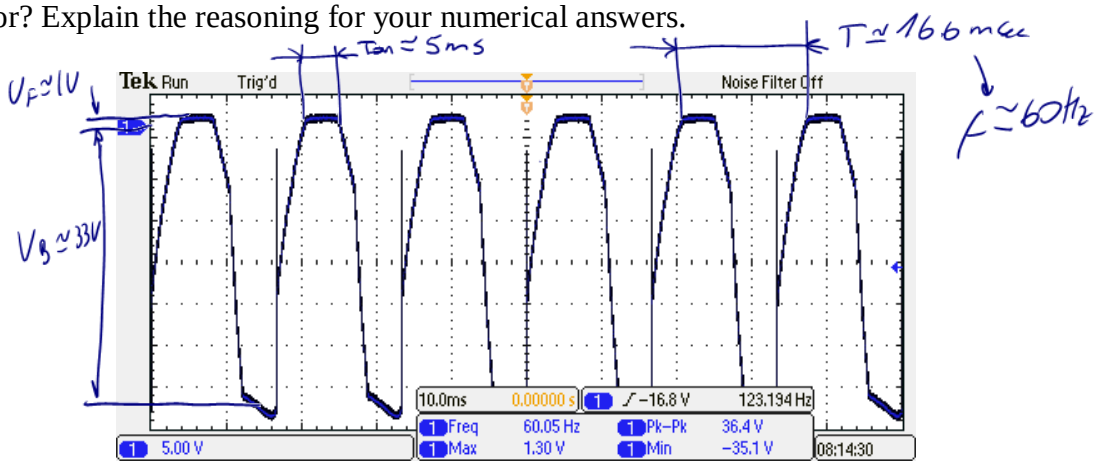
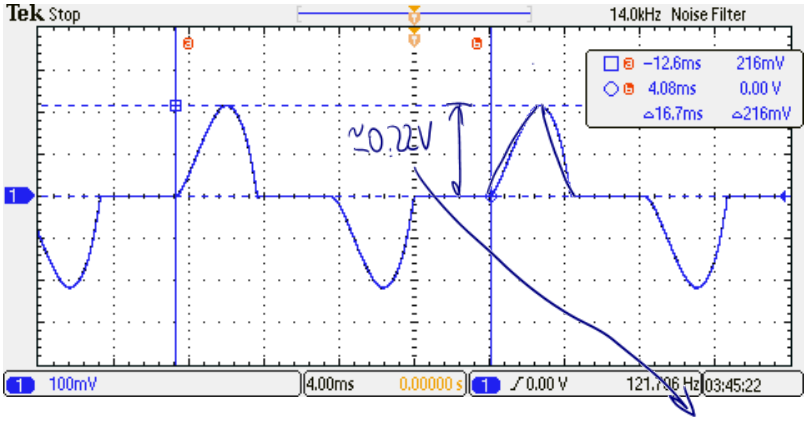
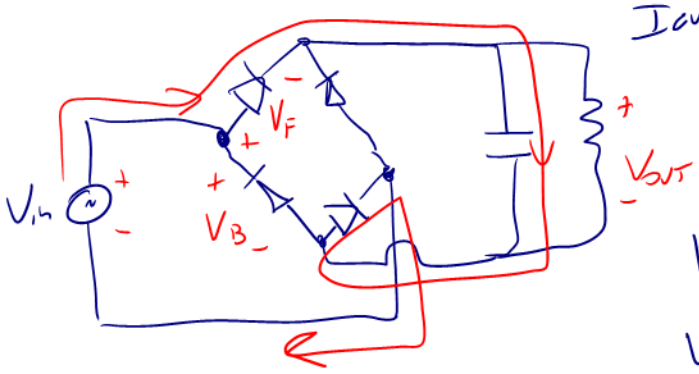
Problem 3 (25 points)

The figures below show scope captures of a diode's voltage (top) and input current (bottom – measured with a 0.01 ohm resistor) in a DBR circuit. What is the dc voltage applied to the load? What is the total conduction losses in the 4 diodes? What is the circuit efficiency if the load is a 5 Ω resistor? Explain the reasoning for your numerical answers.







$T_{on} \simeq 5ms$ $T \simeq 16.6ms$ $f \simeq 60Hz$

$V_F \simeq 1V$ $V_B \simeq 33V$

$I_{Ave}|_{T_{on}} \simeq \frac{0.22}{0.01}\frac{1}{2} = \frac{22}{2} = 11A$

$V_B = V_F + V_{out}$

$V_{out} \simeq 33 - 1 = 32V$

$P_{out} \simeq \frac{32^2}{5} \simeq 205W$

$P_{Loss} = 4 V_F I_{Ave}|_{T_{on}} T_{on} f = 4 \times 1 \times 1 \times 5 \times 10^{-3} \times 60 = 13.2W$

$\eta = \frac{205}{205 + 13.2} \simeq 0.94$

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Problem 4 (5 points each)
Please, select the correct answer for the following questions. **Provide a justification for your answers.**

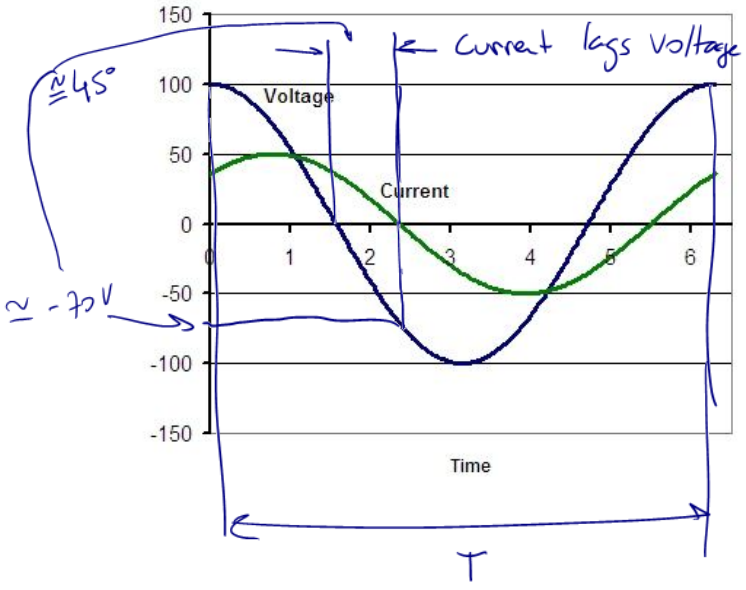
4.1) If you don't have a GPS system, is it possible to identify exactly and in a simple way the proper orientation of a solar panel at night?

a) No, I can't see the sun
b) Yes, I use the moon instead
c) Yes, but only if there are no clouds and I can see the polar star.
d) Yes, with a compass.

↳ The polar star indicates the north celestial pole

4.2) The next figure shows the voltage and currents of a given load. The load is:

a) A pure resistive load
b) A pure capacitive load
c) A pure inductive load
d) A resistive and capacitive load
e) A resistive and inductive load



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4.3) For the load in problem 4.2, what of the following answers is the closest to the average power dissipated through the load?

a) 0 W
b) 1 kW
c) 1.5 kW
d) 2.5 kW
e) None of the above

$P = \frac{100 \times 50}{2} \cos 45 = 1767\ W$

4.4) For the light dimmer circuit….. What needs to be done in order to make the light look brighter?

a) Increase the potentiometer resistance value
b) Decrease the potentiometer resistance value
c) Leave the potentiometer unchanged

τ is reduced

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4.5) For each of the following statements referring to a DBR capacitive filter, choose the correct answer

a) If the load is increased the voltage ripple also increases
TRUE FALSE

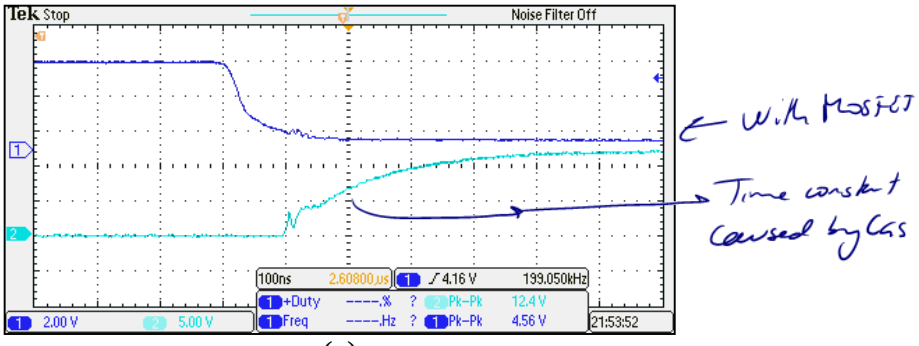
b) If the ac line frequency is increased then the filter capacitance needs also to be increased to achieve the same voltage ripple.
TRUE FALSE

c) If the input voltage is increased while keeping the output power unchanged the output voltage ripple increases.
TRUE FALSE

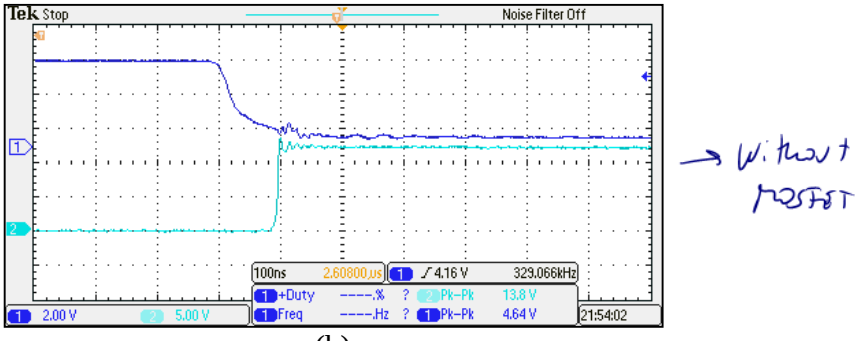
d) If the capacitance is increased, the voltage ripple increases
TRUE FALSE

$$\Delta V = \frac{P}{2Cf V_p}$$

4.6) The following two scope screen captures show the traces at the input of a MOSFET driver chip (top) and at its output (bottom). Which one shows a circuit with a MOSFET and which one shows a circuit without a MOSFET? Why?



(a)



(b)