

EE362L – Spring 2010, 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**. Otherwise, you may end up loosing credit for correct answers if I cannot find or understand them. You have 50 minutes to complete the test.

Problem 1 (30 points)

Consider that you are measuring the harmonic content of a current signal with a 5 A, 100 mV shunt resistance, and your measurements with respect to a 1 mVrms reference are:

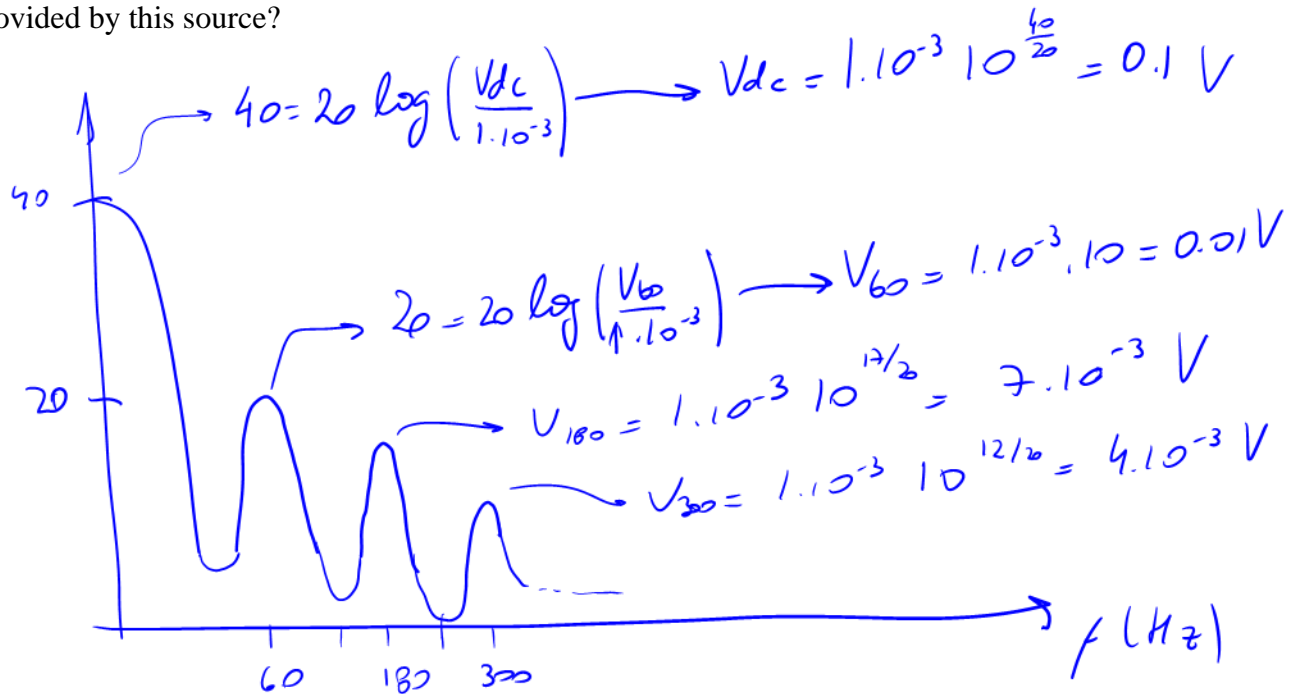
$$V(0 \text{ Hz}) = 40 \text{ dB}$$

$$V(60 \text{ Hz}) = 20 \text{ dB}$$

$$V(180 \text{ Hz}) = 17 \text{ dB}$$

$$V(300 \text{ Hz}) = 12 \text{ dB}$$

Sketch the FFT graph and calculate the current corresponding to each component. If this is the current measured at the output of a 12 Vdc voltage source, which is the power provided by this source?



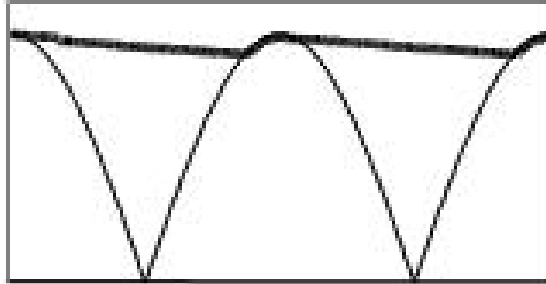
$$I_{dc} = \frac{0.1 \cdot 5}{0.1} = 5 \text{ A}, \quad I_{60} = \frac{0.01 \cdot 5}{0.1} = 0.5 \text{ A}, \quad I_{180} = \frac{7 \cdot 10^{-3} \cdot 5}{0.1} = 0.35 \text{ A}, \quad I_{300} = 0.2 \text{ A}$$

$$P = 12 \cdot 5 = 60 \text{ W}$$

EE362L – Spring 2010, Test 1

Problem 2 (25 points)

The thick trace in the figure below represents the output of a DBR with a 5 kW load. The DBR is connected a regular wall outlet in Europe with a 220 Vrms voltage and a 50 Hz frequency. What capacitance is needed on the DBR output in order to have a peak-to-peak voltage ripple of 5% of the peak voltage? Suppose that you travel to the US where the line frequency is 60 Hz and the voltage is 120 Vrms. Does the voltage ripple change? If so, what's its new value?

Europe

$$\Delta V_{pp} = \frac{P}{2fCV_p} \rightarrow C = \frac{P}{2fV_p\Delta V_{pp}}$$

$$V_p = \sqrt{2} \cdot 220 = 311.17, \quad \Delta V_{pp} = 0.05 \cdot 311.17 = 15.55$$

$$C = \frac{5000}{2 \cdot 50 \cdot 311.17 \cdot 15.55} \approx 10 \text{ mF}$$

US

Yes, it changes

$$\Delta V_{pp} = \frac{P}{2fCV_p} = \frac{5000}{2 \cdot 60 \cdot 0.01 \cdot \sqrt{2} \cdot 120} = 24.55$$

↓
About 14% !!

Additional info:

Capacitance needed to reach 5% voltage ripple in the US

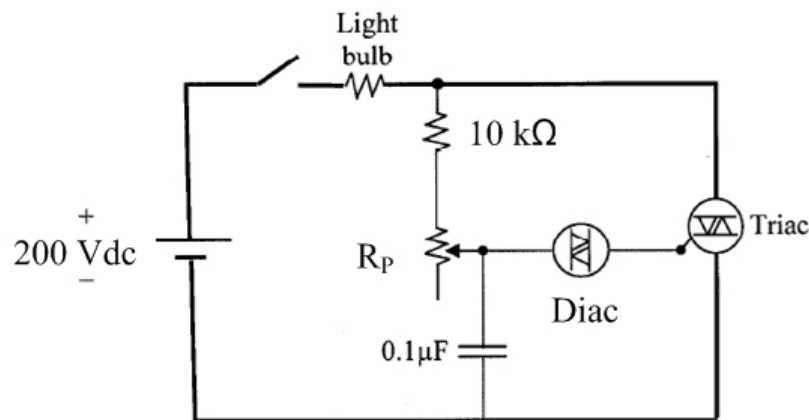
$$C = \frac{5000}{2 \cdot 60 \cdot \sqrt{2} \cdot 120 \cdot 0.05 \sqrt{2} \cdot 120} = 29 \text{ mF}$$

EE362L – Spring 2010, Test 1

Problem 3 (30 points)

The light dimmer circuit was modified by including a switch and replacing your ac source by a dc source. When the switch closes at $t = 0$, the capacitor is fully discharged. When the capacitor voltage reaches 50 V, the light bulb turns on and stays on. What is the value of R_p that makes the light bulb to go on at $t = 5$ milliseconds. Hint: you may ignore the light bulb resistance. The capacitor charges according to $v_C(t) = V_F \left(1 - e^{-\frac{t}{RC}} \right)$

where V_F is the fully charged voltage.



$$50 \text{ V} = 200 \left(1 - e^{-\frac{5 \cdot 10^{-3}}{1 \cdot 10^{-7} R}} \right)$$

$$\frac{50}{200} = 1 - e^{-5 / 1 \cdot 10^{-4} R}$$

$$e^{-5 / 1 \cdot 10^{-4} R} = \frac{3}{4}$$

$$-\frac{5}{1 \cdot 10^{-4} R} = \ln \left(\frac{3}{4} \right) = -0.287$$

$$R = \frac{5}{0.287 \cdot 10^{-4}} = 173803 \Omega$$

$$R_p = 173803 - 10000 = 163803 \Omega$$

EE362L – Spring 2010, Test 1

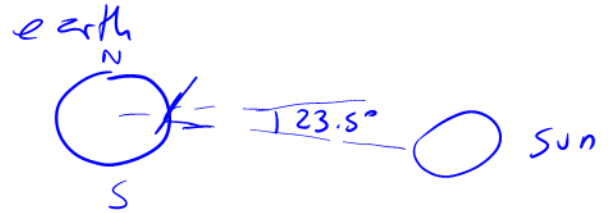
Problem 4 (5 points each)

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

4.1) Suppose you are on the equator and you want to maximize the solar radiation received on a solar panel on December 21. Then you will orient the panel in the following way:

- a) Azimuth 180° , Tilt 23.45°
- b) Azimuth 0° , Tilt 23.45°
- c) Azimuth 180° , Tilt 0°
- d) Azimuth 0° , Tilt 0°
- e) None of the above

Remember that azimuth 0° = North



4.2) Consider a gate drive circuit for a MOSFET. The saw-tooth signal at the PWM chip has varies between ground and 5 V. In order to obtain a constant duty cycle of 0.4 the amplitude of the control reference voltage is

- a) 0V
- b) 1 V
- c) 2 V
- d) 3 V
- e) 4 V
- f) 5 V
- g) None of the above



EE362L – Spring 2010, Test 1

4.3) For each of the following statements choose the correct answer

a) It is OK to connect an inductor in series with a switch

TRUE

FALSE

→ Inductors tend to behave like current sources

b) It is OK to connect a capacitor in series with a switch.

TRUE

FALSE

→ There are no issues with this

c) In steady state the average current through an inductor is zero.

TRUE

FALSE

→ The voltage is zero

d) In steady state the average voltage through an inductor is zero.

TRUE

FALSE

→ Because of the previous answer