S-81.2110 Power Electronics **Exam 21.12.2007**

You are allowed to use tables of mathematic equations in the exam.

Answer all five questions. You will receive two extra points from the accepted learning diaries during the academic year 2007-2008 if you have enrolled the course in fall 2007.

1. The supply voltage of a step-down/step-up converter (Buck-Boost) is 100 V and the output voltage needed is 250 V. You can assume that the capacitance used is large and inductance is 9 mH.
   d) Draw the circuit diagram of the converter (1 p.)
   e) Draw below each other's the waveforms of the current taken from the 100 V dc source, current of the inductance and the output current.
   f) Calculate the average, maximum and minimum values of the input current (100 V dc source) when output power is 1200 W and switching frequency is 60 kHz. (2 p.)

2. Draw the waveforms of liner current and dc voltage in a single phase thyristor rectifier when ac-line inductance $L_s = 0$ and $L_s > 0$. The load in the dc-side is an ideal dc-current source. Control angle can be selected freely in the drawings. Derive equation for the commutation angle and calculate the value of it when dc-current I_d = 10 A, rms value of line voltage V_s = 230 V, $\alpha = 2\pi/3$ rad, f_s = 50 Hz and L_s = 3 mH.

3. In the rectifier of the previous question $L_s = 0$. The other numerical values are the same. Derive equations for the fundamental component of line current and *THD* (Total Harmonic Distortion). Calculate the numerical values of them and *DPF* and *PF* (Power Factor) in this case. How much are active and reactive power?

4. A three-phase voltage sourced dc-ac inverter is operating in the quasi square-wave area (full output). Draw the waveforms of the line-to-line and line-to-neutral voltages of the output by deriving the necessary equations. Calculate the Fourier-series of the line-to-line voltage when the dc-voltage is 540 V. What is the rms value of the fundamental component of line-to-neutral voltage?

5. Compare line- and self-commutated converters with each others. Draw and example of a converter in both cases.

Fourier-sarja

$$f(t) = F_0 + \sum_{h=1}^{\infty} f_h(t) = \frac{1}{2}a_o + \sum_{h=1}^{\infty}\left(a_h \cos(h\omega t) + b_h \sin(h\omega t)\right)$$

$$F_0 = \frac{1}{2}a_0 = \frac{1}{2\pi}\int_0^{2\pi} f(t)d\omega t = \frac{1}{T}\int_0^{T} f(t)dt$$

$$a_h = \frac{1}{\pi}\int_0^{2\pi} f(t)\cos(h\omega t)\,d\omega t, \quad h = 0,1,\ldots,\infty, \quad b_h = \frac{1}{\pi}\int_0^{2\pi} f(t)\sin(n\omega t)\,d\omega t, \quad h = 1,\ldots,\infty$$

Please, fill in the course evaluation form before 23rd of December in http://palaute.ee.hut.fi
This link is also in the www-page of the course.
THANK YOU!