TSTE19
Power Electronics

Examination (TEN1)

Time:	Wednesday 22 August 2012 at 8.00 - 12.00
Place:	TER1
Responsible teacher:	Kent Palmkvist, ISY, 28 13 47, 0705 23 31 59 (kentp@isy.liu.se) Will visit exam location at 9 and 11.
Number of tasks:	6
Number of pages:	4
Allowed aids:	Calculator
Notes:	A pass on the exam requires approximately 30 points. Remember to indicate the steps taken when solving problems.
Exam presentation:	Tuesday 4 September 2012 12.30-13.30 (Kent Palmkvist's office)

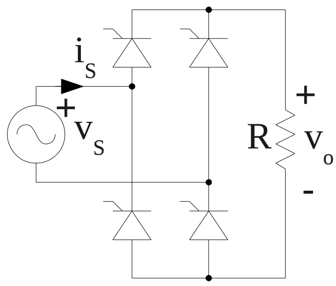
1. a) Is the speed of a synchronous motor dependent on the voltage or frequency of the driving voltage? (2)

b) Why is a third winding added to the transformer in a practical forward converter? (2)

c) How does the voltage and current of a diode behave during reverse recovery? (2)

d) What does the acronym ZVS-CV stand for? (2)

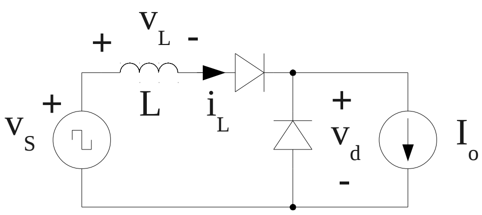
e) Is the power factor dependent on the voltage amplitude? (2)

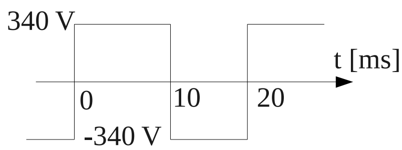


2. The thyristors in the circuit above have a firing angle of 45°. The voltage source v_s is 220V rms. The resistance is 500Ω.

a) Draw the voltage vs and current is of the voltage source. Indicate angles, peak voltages and peak currents. (6)

b) Calculate the average of the output voltage v_o. (6)





3. In the circuit above is v_s a square wave as shown to the right. L = 136 mH, I_O = 5 A.

a) Draw the inductor voltage v_L and current i_L. (6)

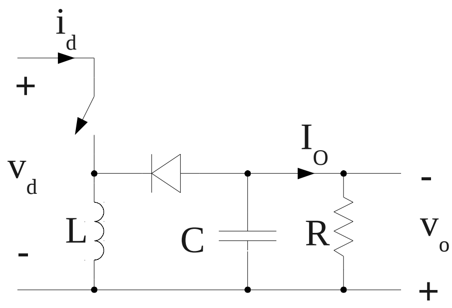
b) How long time does it take for the current commutation to complete? (6)

c) What is the average output voltage v_d? (4)

4. A single-phase full-bridge AC-DC converter have a maximum output current rating of 100 A and maximum input voltage rating of 200 V. The diodes have a forward voltage of 0.7 V.

a) How much power is dissipated by the diodes? (4)

b) What is the minimum output voltage if a 90% efficiency is to be reached when the converter supplies maximum output current? (4)

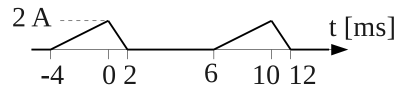


5. A 3V negative output voltage (V_O) is generated using the buck-boost converter below. The input voltage V_d is 12V. The converter is running in continuous conduction mode. Assume C is large. L = 38.4 μH , T_s = 20 μs.

a) Calculate the switch ratio D. (6)

b) What is the minimum output current in which the converter still is operating in continuous conduction mode? (6)

c) What is the average of the input current i_d if the output current I_O is 2 A? (4)



6. The simplified view of the current from a full-bridge rectifier is shown above.

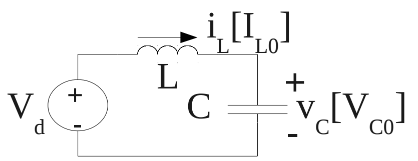
a) What is the amplitude of the fundamental, 2nd and 3rd harmonics of the current? (8)

Formula collection TSTE19 Power Electronics

Fourier series coefficients using symmetri, Table 3.1

Even	$f(-t)=f(t)$	$b_h=0$	$a_h=\frac{2}{\pi}\int_0^{\pi} f(t)\cos(h\omega t)\,d(\omega t)$
Odd	$f(-t)=-f(t)$	$a_h=0$	$b_h=\frac{2}{\pi}\int_0^{\pi} f(t)\sin(h\omega t)\,d(\omega t)$
Half-wave	$f(t)=-f(t+\frac{1}{2}T)$	$a_h=b_h=0$ for even h	
		$a_h=\frac{2}{\pi}\int_0^{\pi} f(t)\cos(h\omega t)\,d(\omega t)$ for odd h	
		$b_h=\frac{2}{\pi}\int_0^{\pi} f(t)\sin(h\omega t)\,d(\omega t)$ for odd h	
Even quarter-wave	Even and half-wave	$b_h=0$ for all h	
		$a_h=\frac{4}{\pi}\int_0^{\frac{\pi}{2}} f(t)\cos(h\omega t)\,d(\omega t)$ for odd h	
		$a_h=0$ for even h	
Odd quarter-wave	Odd and half-wave	$a_h=0$ for all h	
		$b_h=\frac{4}{\pi}\int_0^{\frac{\pi}{2}} f(t)\sin(h\omega t)\,d(\omega t)$ for odd h	
		$b_h=0$ for even h	

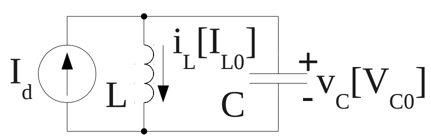
Undamped series resonant circuit, equations 9-3, 9-4



$$i_L(t)=I_{L0}\cos\omega_0(t-t_0)+\frac{V_d-V_{c0}}{Z_0}\sin\omega_0(t-t_0) \qquad (9\text{-}3)$$

$$v_c(t)=V_d-(V_d-V_{c0})\cos\omega(t-t_0)+Z_0 I_{L0}\sin\omega_0(t-t_0) \qquad (9\text{-}4)$$

Undamped parallel resonant circuit, equations 9-20, 9-21



$$i_L(t)=I_d+(I_{L0}-I_d)\cos\omega_0(t-t_0)+\frac{V_{c0}}{Z_0}\sin\omega_0(t-t_0) \qquad (9\text{-}20)$$

$$v_c(t)=Z_0(I_d-I_{L0})\sin\omega(t-t_0)+V_{c0}\cos\omega_0(t-t_0) \qquad (9\text{-}21)$$

Integration rules

$$\int_a^b f(x)dx=\int_A^B f(g(t))g'(t)dt \quad \text{if } a=g(A),\ b=g(B), \text{ and } g \text{ is monotone in } [A,B]$$

$$\int_a^b \sin(x)dx=[-\cos(x)]_a^b$$

$$\int_a^b \cos(x)dx=[\sin(x)]_a^b$$