Mittuniversitetet
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Försättsblad Prov Original

Kurskod	Provkod	Tentamensdatum
ET027G	T101	2018-06-11
Kursnamn	Elektroteknik GR (B), Kraftelektronik	
Provnamn	Skriftlig tentamen	
Ort	Sundsvall	
Termin	V18	
Ämne	Elektroteknik	

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Re-examination in Power Electronics (ET027G)

Date and Time: 11th June 2018 and 8:00 – 12:00 (alt 09:00 – 13:00)

Responsible Teacher: Kent Bertilsson, Tel: 010-142 8915, Email: Kent.Bertilsson@miun.se

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Permitted aids: *Scientific Calculator, Eng-Swe Lexicon, Formula collection attached*

Maximum points: 46p

Preliminary grading levels: A ≧42p, B≧38p, C≧34p, D≧29p, E≧23p; F<23p

- *Start every new exercise on a blank paper*
- *Written text and figures should be clearly drawn and graphs in scale with labeled axes.*
- *The solution should be logically written and used equations should be motivated.*
- *The calculations should be sufficiently complete to show how the final result was obtained.*
- *Each task must be concluded with a clearly written answer (underline the obtained answer).*
- *If you don't get an answer in one part of the exercise that is required for continuing calculations in later sections you can calculate with variables only.*

Good Luck

Kent

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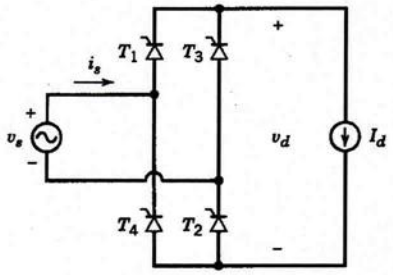
1) Short questions.
   a. What is the advantages and disadvantages of linear and switched mode converters (2p)
   b. Order the switching devices MOSFETs, Bipolar transistors, IGBT and Thyristors in each of the three categories 1) power rating, 2) switching speed and 3) drive complexity. (6p)
   c. Describe the differences in harmonics between a square wave modulated and a pulse width modulated inverter (2p)

   Tot 10p

2) Assume a constant current of 10A in diode rectifier is switched with duty cycle of 60% with a forward voltage drop of 0.9V.
   a. How much is the losses reduced replacing this with a synchronous rectifier with a MOSFET with r_{dson}=10mΩ (3p)
   b. How much is the efficiency increased assuming this is used in a flyback converter with Pout=200W and previous efficiency of 91%. (3p)

   Tot 6p

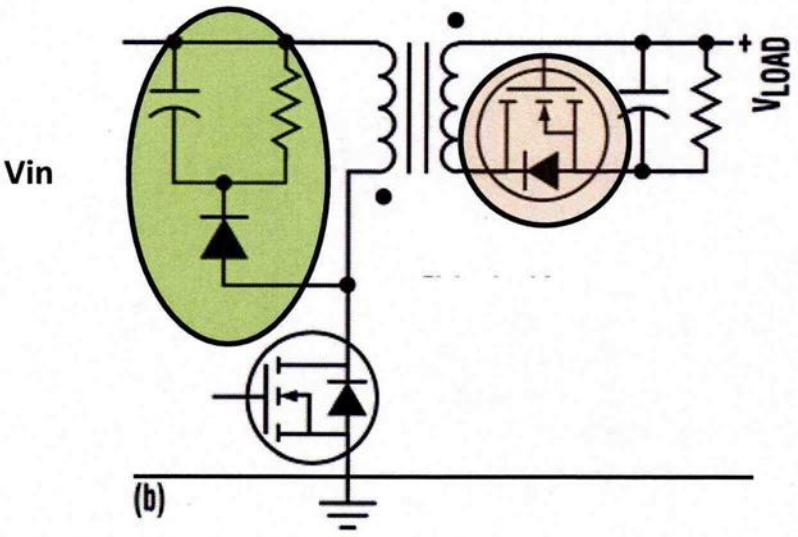
3) The thyristor based inverter below drives a large inductor that can be treated as a current source. The input is fed by the Swedish grid with 50Hz AC voltage with V_{RMS}=230V. The firing angle of the thyristors is 30°.



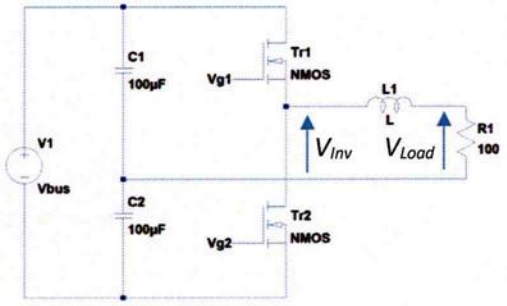
a. Draw the wave forms for the input voltage, load voltage and the source current (3p)
b. Calculate the average load voltage, V_d (1p)
c. Calculate the displacements, distortion and total power factor for the circuit (2p)
(Tot 6p)

4) The converter below has Vin=200V, Duty cycle=40% is working in continuous conduction mode. The primary winding have 100 turns and the secondary 10 turns and the converter is loaded with 10Ω.

a. What type of converter is shown (1p)
b. Calculate the output voltage, V_o (1p)
c. What is the functionality of the transistor in the right circle (1p)
d. What is the functionality of the circuit elements in the left oval (1p)
e. Sketch the waveforms for the primary switch current, I_{Sw}, Rectifier current, I_{Rect}, Switch voltage, V_{Sw}, The amplitude for the voltages should be clearly shown. The mean currents should be correct and clearly visible. (6p)
Tot 10p

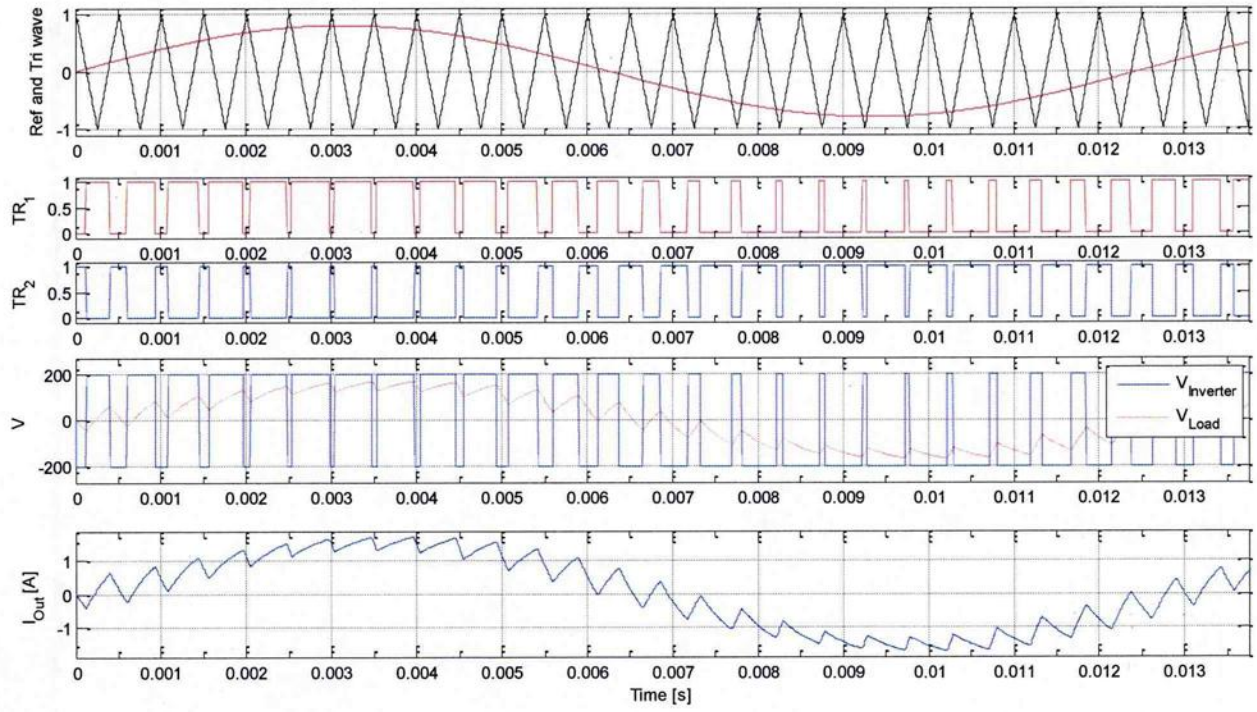


5) A single phase inverter according to the figure below is driving a 100Ohm load. A triangular and sinusoidal shown waveform (1st graph) are used to generate the switching pattern for the two switches (2nd and 3rd graph). The 4th graph shows the output from the inverter before and after the inductor and the resulting current is shown in the 5th graph.



a) Determine the switching frequency and the inverter output frequency (1p)
b) Determine the amplitude and frequency modulation ratios, m_A and m_f (1p)
c) Determine the bus voltage, V_{Bus} (1p)
d) Determine the size of the inductor L1 used. (3p)
e) A single phase synchronous motor marked 60Hz, 1400rpm is connected to the driver. Determine the motor speed in rpm. (2p)

Tot 8p



6) A transistor is dissipating 10W in losses under steady state. According to datasheets for the transformer and heatsink the thermal resistances are $R_{Th\ junction-case} = 0.5K/W$, $R_{Th\ case-sink} = 1.5K/W$, $R_{Th\ sink-ambient} = 3K/W$. The ambient is expected to be at most 30°C.

   a. Draw a thermal schematic of the situation. (2p)
   b. What is the highest junction temperature of the transistor (2p)

Under a surge event the losses can reach 1000W for 10us. Assuming that it is only the chip temperature that response to the surge and the corresponding thermal capacitance is 0.01 J/K.

   c. Estimate the temperature the chip reach during such surge (2p)

Tot 6p