

UNIVERSITY OF SWAZILAND
FIRST SEMESTER EXAMINATION 2007/2008
FACULTY OF SCIENCE
DEPARTMENT OF ELECTRONIC ENGINEERING

TITLE OF PAPER: POWER ELECTRONICS AND DRIVES

COURSE NUMBER: EIN510

TIME ALLOWED: THREE HOURS

INSTRUCTIONS:

- 1. Answer any FOUR (4) of the following six questions.**
- 2. Each question carries 25 marks.**
- 3. If you think not enough data has been given in any question you may assume reasonable values.**

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THIS PAPER CONTAINS FOUR (4) PAGES INCLUDING THIS PAGE

QUESTION 1

A boost converter has an input supply voltage range of 22 to 28 V, a nominal output voltage of 48 V, and a maximum output power of 200 W, at 95% efficiency. Switching frequency $f_s = 100\text{kHz}$.

- (a) Select suitable values of boost inductor and output capacitor, assuming $\Delta I_L \approx 0.2I_{in}$ and $\Delta V_o < 48\text{mV}$.
- (b) Specify minimum current and voltage ratings for the boost transistor and diode.

[25 marks]

QUESTION 2

Fig. 1 shows the schematic of a full-bridge Buck-derived power supply. Assume a nominal input voltage of 100 V and $\frac{N_p}{N_s} = 0.2$. Obtain the open-loop transfer function of the power stage $\frac{V_o}{d}$.

[25 marks]

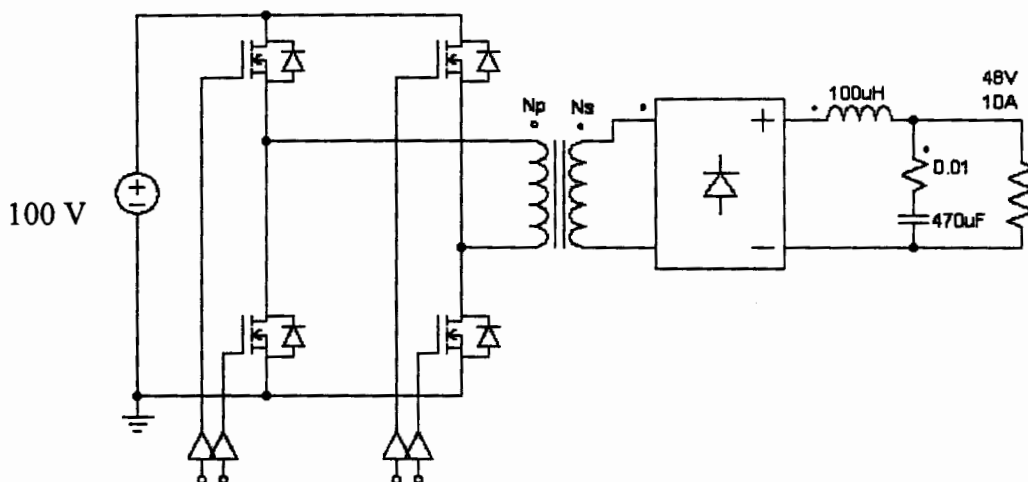


Fig. 1

QUESTION 3

- (a) The input dc voltage of a single-phase full-bridge SPWM inverter varies in a range of 380 to 420 V. For 230 V (rms) output, find the range of amplitude modulation ratios for the inverter.

[15 marks]

- (b) A three-phase square-wave one-leg inverter has a dc input of 500 V. Determine the line-to-line output voltage at fundamental frequency.

[10 marks]

QUESTION 4

- (a) The thyristor converter shown in Fig. 2 is fed with an input voltage of 230 V (rms) at 50 Hz. It is required to provide a dc current of 20 A to a coil of inductance 330 mH and resistance 5 Ω , as shown. Find the firing angle α . Assume $L_s = 0$.

[12 marks]

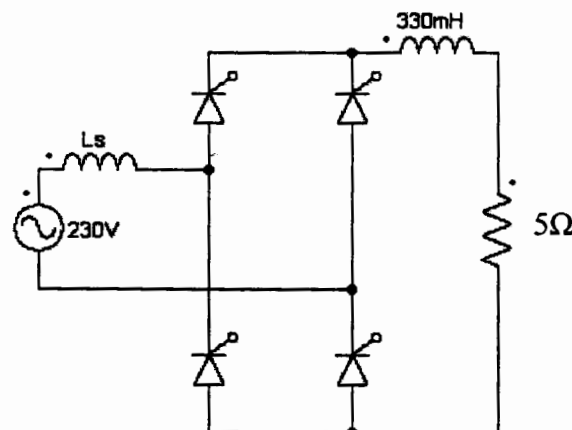


Fig. 2

- (b) A three-phase thyristor converter is supplied by a 400-V (line-to-line), 50-Hz source. Assume that $L_s = 0$. The desired output voltage is 400 V. Find the firing angle α .

[13 marks]

QUESTION 5

A 2 kW, 240 V 1500 RPM dc motor is connected to a 400-V, 3-phase, 50-Hz line using a thyristor converter. The full-load current is 10 A and the armature resistance is 0.5 Ω .

- (a) Calculate the firing angle required so that the motor develops its rated torque at 500 RPM. (Assume a source inductance of $L_s = 0$.)

[13 marks]

- (b) Calculate the reactive power absorbed by the converter when the motor develops full torque at 500 RPM.

[8 marks]

- (c) Name any two ways of minimizing the reactive power demand on the ac source.

[4 marks]

QUESTION 6

A 4-pole, 5-kW, 400-V motor is supplying its rated power to a centrifugal load at a 50-Hz frequency. Its rated speed is 1455 rpm. Calculate its speed when it is supplied by a 256-V, 32-Hz source. (Hint: For a centrifugal pump, $T_{em} \approx k(\text{speed})^2$.)

[25 marks]