ELL 855 High Power Converter

Minor 1 (Date: 27.08.2019)

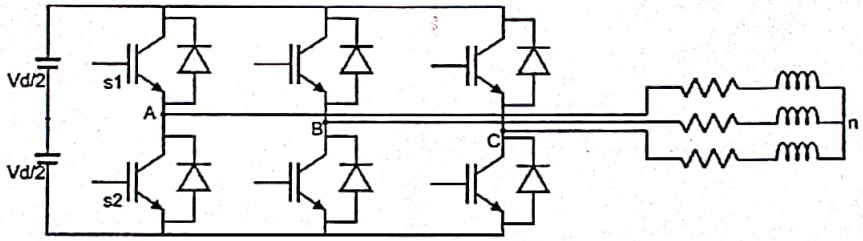
Marks: 20, Time: 1 hour, Make suitable assumptions if necessary.

Problem 1: (2+3+2+3=10 marks)

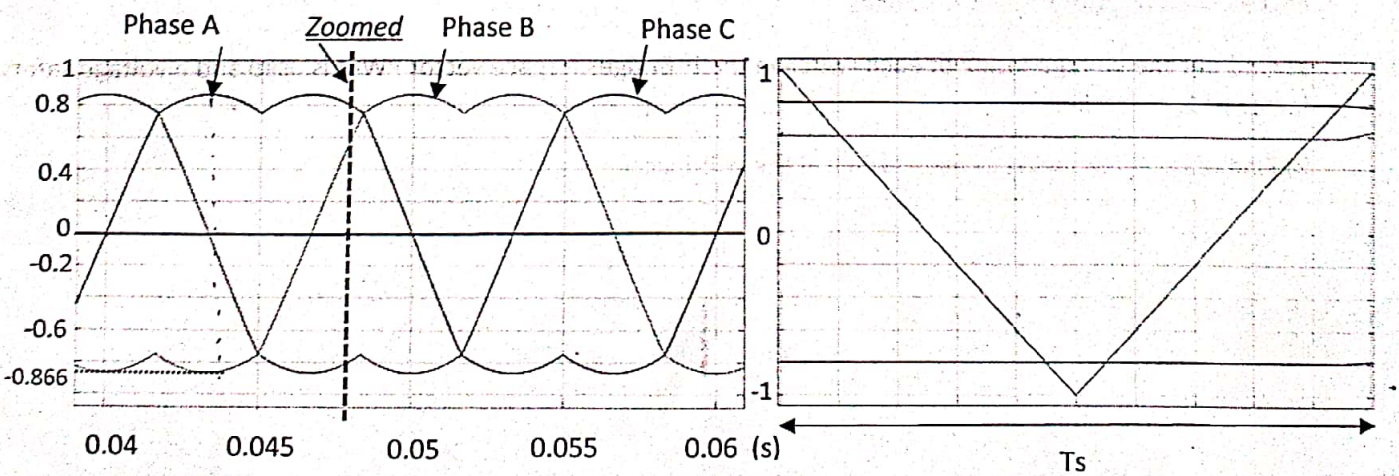
A three phase converter shown in figure (a) is used to drive a balanced R-L load (70+j30) at 50 Hz frequency. The dc bus voltage is 600V. The balanced modulating waves for three phases are shown in figure (b) used for Space Vector PWM of switches. A high frequency carrier spans between +1 and -1 at 10 kHz frequency. A zoomed view of the carrier period is shown in figure (c) with time period T_s= (1/10000) s.

Assume that the following logic is followed during switching: If $v_{mod} > v_{carrier}$, turn on S1; else turn on S2.

a) What is the fundamental rms voltage magnitude of V_{An}?
b) In the time period T_s, for how long duration of time is the switch S1 conducting?
c) In which sector is the switching happening during the period T_s? Why?
d) What are the instantaneous voltage magnitudes in the waveform of $v_{An}(t)$ during the period T_s?

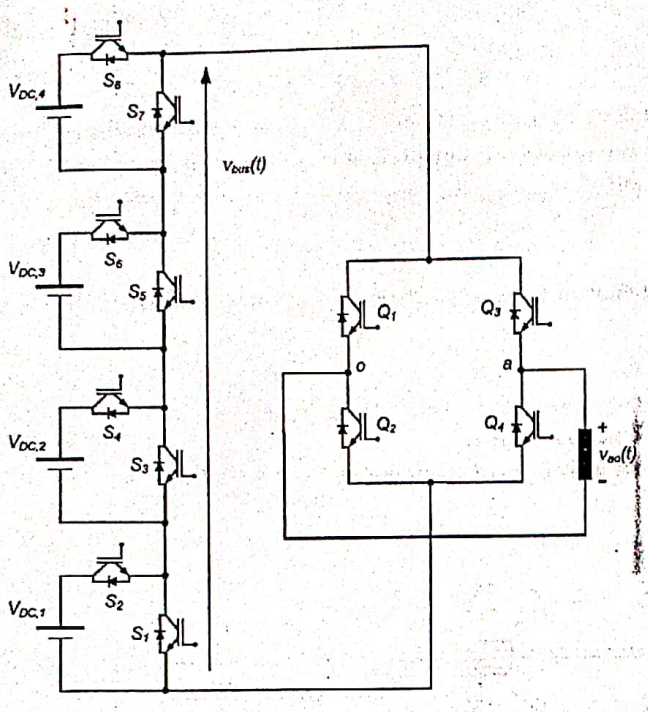


(a)



(b) (c)

Problem 2: (3+2=5 marks)



The figure shows a modified cascaded converter having 4 cells in half bridge configuration and one cell in full bridge configuration. Assume all the DC bus voltages to be equal in magnitude and equal to V_{DC}. It is desired to have single phase symmetrical AC voltage across the load ($v_{AO}(t)$) .

(a) List all the switches in the ON state that will produce a voltage of $+3V_{DC}$ across the load.
(b) What are the voltage ratings of switches S_7 and Q_3?

Problem 3: (3+2=5 marks)

Design a 3-phase Cascaded H-Bridge converter driving a 3.3 kV, 2 MW motor load with nominal power factor of 0.95 lag. Consider using 3 H-Bridges.

a) Find out the voltage rating of each switch in the H-Bridges if space vector PWM is used and a voltage safety factor of 1.28 is taken.

b) Find out current rating of each switch in the H-Bridges.