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DEPARTMENT OF ELECTRICAL ENGINEERING

M TECH, END SEMESTER EXAMINATION

Monsoon Semester 2022-23

EE6301D - POWER ELECTRONIC CIRCUITS

Time: 3 Hours

Maximum Marks: 50

*Answer **all** questions*

1. A single phase diode full bridge rectifier is used to charge a battery of 24V, 200WH. The average charging current I_{dc} should be 5A. The primary input voltage is 240V, 50Hz and the transformer has a turns ratio of n = 2:1. Draw the circuit and obtain the following.

   (i) Conduction angle of diode
   (ii) Current limiting resistor value and its power rating
   (iii) Charging time
   (iv) PIV of diode

   Plot the following waveforms.

   (v) Charging current
   (vi) Drop across the current limiting resistor
   (vii) Drop across any one diode (6 marks)

2. Consider a single phase half controlled symmetrical converter connected to a 230V, 50Hz ac source and feeds a constant load current of 10A. If average output voltage $V_d = V_{d0}/2$, where, V_{d0} is the dc output voltage at $\alpha = 0$

   (i) evaluate the firing angle.
   (ii) sketch the waveforms for output voltage, current at ac side, current through T_1 and D_1, voltage across T_1 and D_1
   (iii) derive the expressions and obtain the values of ac side power factor and THD.
   (iv) find PIV, RMS and average current through any one diode and switch

   Explain what happens when one of the controllable device is damaged. (8 marks)

3. A 3 phase controlled bridge rectifier is operated from a 440V, 50Hz supply system and feeds a ripple free current to the load. If the average output voltage is 75% of the maximum possible average output voltage, **derive** and calculate

   (a) firing angle of the converter,
   (b) the RMS and average device currents and
   (c) the input power factor.

   Sketch the required waveforms. (8 marks)

4. For a single phase bridge inverter, the 3^{rd}, 5^{th}, 7^{th} and 11^{th} harmonics of output voltage have to be eliminated and the fundamental component be controlled to 80% of dc input. Describe how SHE method can be implemented to achieve this.
Obtain the equations to solve for notch positions in one cycle of output voltage.
(6marks)

5. An R-L load is connected through a full bridge inverter to a 200V dc source. It is required to have an RMS value of fundamental component as $160/\sqrt{2}$V with no harmonics up to 15^{th} order. Explain with circuit diagram and required waveforms, a suitable PWM technique that can be used for the same. Sketch the waveforms of gating signals, load voltage and load current. Indicate the devices conducting in each interval.

Derive the relationship between fundamental output voltage and dc input voltage.

Why back connected diodes across the switches are necessary?

Explain how the magnitude and frequency of the output voltage can be controlled.

Obtain the expression for dc source side current.

Explain the effect of blanking interval on average output voltage. (10marks)

6. .A three phase star connected load which requires phase voltages as $v_{an} = 80\sin 100\pi t$, $v_{bn} = 80\sin(100\pi t - 2\pi/3)$, $v_{cn} = 80\sin(100\pi t - 4\pi/3)$ is connected to a dc source of 240V through a three phase bridge inverter circuit. Explain how space vector PWM scheme with a switching frequency of 2.5kHz is implemented to achieve this condition. At t = 8ms, find the magnitude and position of the reference vector. Derive and obtain the dwell periods at this position.
What is the advantage of this scheme over SPWM scheme? (8marks)

7. What are the advantages of current controlled inverter over voltage controlled inverter? Explain the hysteresis current control scheme implemented for a single phase inverter feeding an induction motor load (4 marks)