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Reg. No. : .....

Name : .....

First Semester M.Tech. Degree Examination, March 2013
(2008 Scheme)
ELECTRICAL ENGG.
Power Control and Drives
EDC 1002 : Power Converters and Analysis

Time: 3 Hours Max. Marks: 100

Instructions : *Answer* ***any five full*** *questions.*
Suitable *assumptions may be made.*

1. a) Figure 1 shows a half-controlled rectifier. T1 and T2 are thyristors and D1 and D2 are diodes. The firing angles of T1 and T2 are always controlled in closed loop to obtain the desired operating point. The load current is 50A ripple free dc. The load voltage is set to 180V dc. The supply is 230V AC, 50Hz. Neglect the source impedance. 10

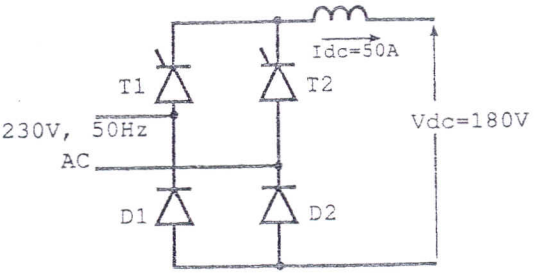

Figure 1 : A Half Controlled Converter

i) Calculate the firing angle α at the operating point specified.

ii) Sketch the current waveforms through T1 and D1. Evaluate the average current through each one of them.

iii) If the input voltage varies around the nominal voltage of 230V by $\pm 10\%$, evaluate the range of variation in the firing angle to maintain the output voltage at 180 V dc.

P.T.O.

b) Figure 2 shows a diode-bridge rectifier with capacitive filter. The input voltage is 230 V, 50 Hz, sinusoidal waveform and the current taken from the source is discontinuous as shown in figure. The load resistor is drawing a smooth direct current of 5A. The diodes conduct for a time of 1.5 ms as shown in figure. The peak of source current is marked Ipk. **10**

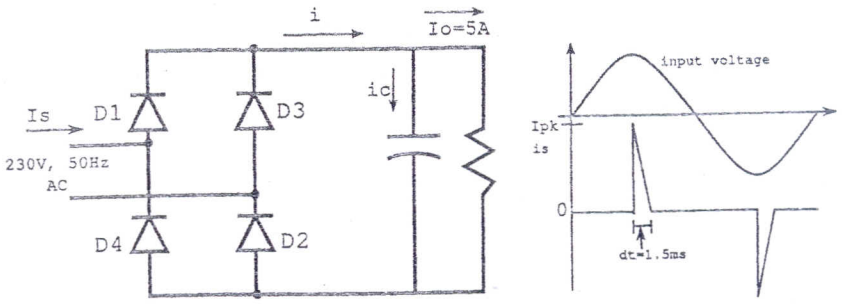

Figure 2 : An un-controlled Rectifier

i) Evaluate the peak source current, Ipk.

ii) Sketch the current waveforms ic (through capacitor and i (through dc link, before the capacitor).

iii) Evaluate the average current through a diode.

2. a) Explain with neat waveforms and circuit diagram, the principle of operation of Ćuk converter. Obtain the voltage transfer ratio of this converter for continuous conduction mode, by applying inductor volt-seconds balance in the inductors present. Give the waveforms of currents in the inductors. Obtain expressions for input inductor current ripple and output capacitor voltage ripple. **12**

b) A boost dc-dc converter operates from an input dc supply of 100V and is used to charge a battery of 160V. The switching frequency is 20 kHz. Assuming continuous conduction mode, evaluate the minimum value of inductance that will give a peak-to-peak ripple of less than 100 mA in inductor current. If the battery current is 20A, what is the average value of the inductor current ? **8**

3. a) Explain the principle of operation of a push-pull dc-dc converter with circuit diagram and relevant waveforms. Derive the voltage transfer ratio of this converter. **12**

b) Draw the circuit diagram of a flyback converter. Assume ideal elements and repetitive conditions. The data for the converter as follows :
Input dc voltage = 100 V,
switching frequency = 20 kHz,
duty cycle = 0.3,
number of turns in the coupled-inductor (flyback transformer) primary = 80,
number of secondary turns = 20.
Assume continuous conduction :
i) Sketch the waveforms of the voltages across the primary and secondary of the coupled-inductor. Mark salient points/features. 5
ii) Determine the output dc voltage. 3

4. a) A pulse width modulated square wave inverter works from a 120 V dc input. The inverter frequency is 2 kHz. It is operated with a duty cycle of 80%. Determine :
a) the r.m.s. value of the AC output voltage;
b) the r.m.s. value of the fundamental frequency component of the output AC voltage; and
c) the r.m.s. value of the total harmonic component of the output voltage. 10

b) Describe the operation of a single-phase Current Source Inverter feeding a purely inductive load with necessary waveforms and relevant equations. 10

5. a) Explain Sinusoidal Pulse Width Modulation. What are the features of this PWM method ? 6

b) Explain Selective Harmonic Elimination in inverters. 8

c) Explain the need of isolation in Switched Mode Power Supplies. Do certain topologies demand gate-drive isolation for proper operation of the converter ? Give an example to substantiate the answer. 6

6. a) Give the operating waveforms of a three-phase bridge inverter which is operating with 180° conduction mode. If the dc link voltage is 560 V, evaluate the r.m.s. values of output line-to-neutral voltage and line-to-line voltage. 10

b) A forward converter with a demagnetising winding is designed to operate with a maximum duty ratio of 0.7. Calculate the voltage rating of the switch in terms of the input voltage V_g. 5

c) Define the terms Total Harmonic Distortion and Displacement Power Factor. 5