

Name :

Roll No. :

Invigilator's Signature :

CS/M.Tech (EE)/SEM-1/EEP-101/2009-10
2009
POWER ELECTRONICS – I

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

Answer any five questions.

5 × 14 = 70

1. a) A voltage source of $v(t) = 230 \cos \omega t$ volts is applied to a converter. The input current given by $i(t) = 6 + 13 \cos(314t - 45^\circ) + 5 \cos(3 * 314t + 45^\circ) + 2 \cos(5 * 314t - 60^\circ)$. Calculate
- i) the power absorbed by the load, assuming that the converter absorbs no power
 - ii) the distortion factor of the input current
 - iii) the THD of the input current
 - iv) the input power factor of the converter.

$$1 \frac{1}{2} + 1 \frac{1}{2} + 1 \frac{1}{2} + 2$$



b) A *d.c.-d.c.* flyback converter has a turns ratio

$N_2/N_1 = 1.8$. The *d.c.* supply voltage $V_d = 12$ V. The

required output voltage V_o is 18 V. The switching

frequency of the converter, $f_s = 100$ kHz. The maximum

load up to which the converter transformer core is

required to demagnetise completely in each switching

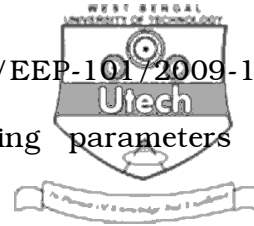
period is 120 W.

i) Find the duty cycle D for the maximum load power of 120 W.

ii) Find the maximum leakage inductance L_m the transformer can have.

iii) Find the capacitance C to keep the peak-peak output voltage ripple ΔV_o within 0.5% of V_o .

$$2\frac{1}{2} + 2\frac{1}{2} + 2\frac{1}{2}$$



2. a) A Cuk converter has the following parameters :

$$V_d = 10 \text{ V}, D = 0.6, L_1 = 1 \text{ mH}, L_2 = 2 \text{ mH},$$

$$C_1 = C = 20 \text{ mF}, f_s = 25 \text{ kHz}, R = 12 \Omega.$$

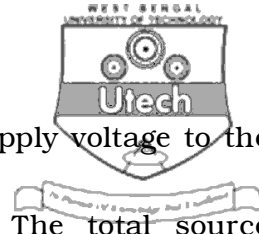
i) Assuming continuous conduction, calculate the output voltage, V_o .

ii) Calculate the average, maximum and minimum currents in L_1 and L_2 .

iii) Calculate the ΔV_o in the output voltage. 3 + 3 + 3

b) A E_s d.c. source, R_s and the gate of a SCR are connected in series. $E_g = 7.5 + 1.8 I_g$. Gate pulse train has 10 V, $T_{on} = T_{off} = 75 \mu s$. Find R_s to limit the peak power dissipation in gate to 2 W. Also calculate average power dissipation in gate.

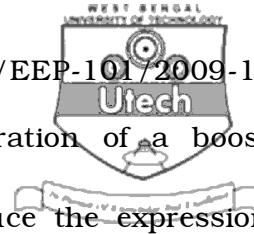
5



3. For a single-phase bridge rectifier, the supply voltage to the rectifier is 240 V (rms) at 50 Hz. The total source inductance to the rectifier is $L_s = 2$ mH. Assume the load current at all times is smooth and ripple free.

- i) Calculate the *d.c.* load voltage when the source inductance is neglected.
- ii) Calculate the overlap angles μ when the load current is 20 A and 40 A and the source inductance is not neglected.
- iii) Calculate the *d.c.* output voltage of the rectifier for the load currents in (ii).
- iv) Sketch the output voltage waveforms for the loads in (ii)
- v) Sketch the input voltage waveforms to the rectifier for the loads in (ii).

2 + 3 + 3 + 3 + 3



4. Draw the circuit and explain the operation of a boost regulator with different waveforms. Deduce the expression ΔV_c and ΔI . Also find out the conditions for continuous inductor current.

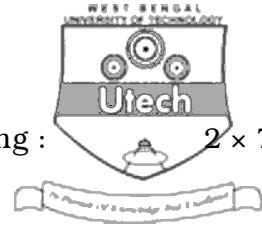
5. a) A three phase bridge rectifier supplies a load at a *d.c.* voltage of 300 V and current of 30 A from a 415 V three phase supply via a delta-star transformer. Determine the required diode and transformer specification. Assume all diode forward drops of 0.7 V and smooth ripple-free load current. 9

- b) A 10 V *d.c.* source, $R = 200 \Omega$, $L = 1 \text{ mH}$ and a SCR are connected in series, SCR $I_L = 15 \text{ mA}$. SCR gets fired or not ? Justify. If not, find minimum gate pulse duration. 5

6. a) Explain a practical driver circuit for MOSFET or IGBT. 6

- b) Explain the disturbances in commercial power supply and power conditioning in terms of power quality problems. 8

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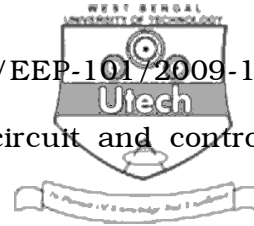
7. Write short notes on any *two* of the following :

2 × 7

- a) 12-pulse converter
 - b) Power factor improvement of converter
 - c) Protection and cooling of power devices
 - d) Designing of a transformer or an inductor for converter.
8. Develop a dynamic model of a current controlled boost converter feeding a purely resistive load from either a pure D.C. or a 1-phase, 230 V, 50 Hz. Plot the phase and bifurcation diagram.
9. How a chopper based closed loop D.C. drives systems is developed using microprocessor ? Explain in detail.

OR

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Design a chopper circuit (both power circuit and control circuit) for the following specifications :

Input : 220 V DC

Load : Highly inductive load with rated current of 30 A at

220 V DC

Operating frequency of chopper : 25 kHz

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