Nirma University
Institute of Technology
Semester End Examination (RPR), May - 2018
B.Tech. in Electrical Engineering, Semester – V
EE504: POWER ELECTRONIC CONVERTERS

Roll / Exam No. _____ Supervisor's initial with date _____

Time: 3 Hours Max. Marks: 100

Instructions:
1. Attempt all questions.
2. Figures to right indicate full marks.
3. Draw neat sketches wherever necessary.
4. Notations and symbols have their usual meaning.
5. Assume suitable additional data if required.

Q.1 (A) Explain the operation of push-pull converter based switched mode power supply. Derive the expression for output to input voltage and draw waveforms for: (6)
a) Primary Voltage b) Inductor voltage c) Inductor current
d) Secondary voltage

(B) A half-bridge converter is switched at 60 kHz with a duty cycle of 0.4. It is supplying a 40 W load. Each centre tap secondary to primary turn ratio is 5. The dc link of the half bridge converter is from a 12 V battery. The output inductor value is 10 mH. The output inductor current ripple is 10 % of the load current. Compute, (i) output voltage (ii) peak current through the primary switch (iii) voltage developed across primary switch when it is OFF. (iv) Average current of the secondary diodes. (4)

(C) With neat illustrative circuit and waveforms, discuss the concept of zero current switching. (4)

(D) A boost converter is transferring power from 50 V source to 250 V source. Switching frequency is 30 kHz, duty cycle is 50 %. Inductance in a circuit is 100 µH. Calculate the power transfer by this circuit. Assume steady state conditions achieved. (4)

OR

(D) A buck converter is used to convert a 100 V dc supply to 75 V output. The inductor is 200 µH with a resistive load 2.2 Ω. If the main switch has an on time of 50 µs and current is continuous, calculate, (i) the switching frequency (ii) the average input and output current (iii) the minimum and maximum values of the output current (4)

Q.2 (A) Discuss various control strategies to be adopted for voltage control in chopper circuits. (4)

OR

(A) A step-up chopper has input voltage of 200 V and output voltage of 600 V. If conducting time of the thyristor chopper is 80 µs, compute pulse width of the output voltage. (4)

(B) Draw the power schematic of voltage commutated chopper and sketch following waveforms associated with it. (6)

i. Gate pulses ii. Capacitor current iii. Main thyristor current
iv. Capacitor voltage v. Load voltage vi. Voltage across main thyristor

(C) Analyze in detail with illustrative waveforms operation of two quadrant choppers – type C and type D. (6)

Q.3 (A) State requirements of a power supply. Analyze operating principle of linear power supply & discuss drawbacks of same. Also, mention how switch mode power supply helps in overcoming these drawbacks. (6)

(B) For a current commutated chopper, peak commutating current is twice the maximum possible load current. The source voltage is 230 V dc & main SCR turn-off time (t_q) is 30 µsec, while circuit turn-off time (t_c) is 60 µsec. For maximum load current of 200 A & x = 2, calculate (1) Values of commutating inductor & capacitor (2) Peak commutating current. (4)

OR

(B) Discuss voltage regulator of linear power supply with adjustable output using operational amplifier. (4)

(C) Explain with schematic and illustrative waveforms operation of buck converter for continuous & discontinuous conduction mode. (6)

Q.4 (A) Discuss the various application of inverter with respect to induction motor, UPS and induction heating. (6)

(B) Discuss single pulse modulation and multiple pulse modulation technique applied to single phase bridge inverter. (4)

OR

(B) A single phase square wave inverter is fed from 300 V dc link feeding 10 ohm resistive load. Calculate the following: (4)

1) Peak value of load voltage
2) RMS value of load voltage
3) Total harmonic distortion in load voltage
4) RMS value of load current

(C) Explain different types of wind machines and power electronic converter systems used for grid connected wind energy systems. (7)

Q.5 (A) A three phase six step inverter is fed from 600 V dc link feeding star connected R-L load of 7 Ω and 10 mH per phase assuming fundamental frequency of 50 Hz. Calculate the following: (4)

1) Peak value of line voltage
2) RMS value of line voltage
3) Total harmonic distortion in line voltage
4) RMS value of phase current

OR

(A) ZVS buck converter operates in half wave mode with dc supply voltage 36 V, output voltage 24 V, resonant frequency 500 kHz and output power 30 W. Determine the following. (4)

1. Values of resonant component L_r and C_r
2. Peak voltage rating of the resonant capacitor
3. Charging and discharging period of capacitor

(B) What are the advantages of PWM technique? Compare the harmonic spectrum of unipolar and bipolar PWM techniques. (4)

(C) With neat circuit and waveforms, analyze the operation of zero current switching resonant converter. (4)

(D) Why switching losses occur in switched mode converters? How does resonant switching converters overcome this issue? (4)

Q.6 (A) Answer following briefly. (7)

(i) Why input dc voltage to inverter is fed from uncontrolled diode bridge rectifier?

(ii) Explain term "dead time" with respect to inverter circuit. What consequences will it lead if not provided?

(B) Draw output line voltage, pole voltage and phase voltage waveform of three phase voltage source inverter for 180^0 mode of conduction and derive line voltage equations for the same. (5)

(C) Explain operation of UPS. Compare on-line and off-line UPS. (5)

OR

(C) Why maximum power point tracking is used in photovoltaic systems? What are the problems caused due to shading of PV modules connected in a string and explain the role of by-pass diodes in solving the same. (5)

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