Nirma University

Institute of Technology

Semester End Examination (IR), Dec-2015

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. Section wise separate answer book to be used.
4. Draw neat sketches wherever necessary.
5. Notations and symbols have their usual meanings.
6. Assume suitable data, if necessary.

Section – I

Q.1 (A) What is switched mode power supply? How it differs from linear power supply? List at least two scenarios which incorporate use of them. [4]

OR

(A) How non ideal boost converter differs from ideal boost converter? How and what way non idealities affect the working of such converters? [4]

(B) Draw the power schematic of Cük converter along with input side circuit and output side circuit during on time and off time of the switch and thus sketch following quantities. [6]

a) Gate pulses	b) Input inductor current	c) Switch current
d) Output voltage	e) Input capacitor current	f) Input capacitor voltage
g) Voltage across main switch	h) Voltage across diode	i) Output inductor current

(C) A buck-boost converter that is switching at 50 kHz is applied with an input voltage that varies between 5 V and 10 V. The output is required to be regulated at 15 V. A load resistor of 15 Ω is connected across the output. If the maximum allowable inductor current ripple is 10 % of the average inductor current, estimate the value of the inductance to be used in the circuit. If the output voltage ripple specification is 1 % of the output voltage, estimate the output capacitor value. [4]

(D) Answer the following True/False and correct it if FALSE. [3]

Flyback converter is isolated buck-boost converter.

Tertiary winding is required in ideal forward converter.

Output voltage polarity of Cük converter is same as buck-boost converter.

Q.2 (A) Answer the following briefly. [5]

(i) Why is isolation needed between output circuit and input circuit of dc to dc converter?

(ii) What is flux walking in push-pull circuit?

(B) A buck converter is given with following specifications: [4]
Duty cycle=40%, Output current=10 A, Output voltage=25 V, Switching time=20 μs, Inductance=20 μH, On-state resistance of switch=20 mΩ, forward voltage drop of diode=1 V. Calculate, (i) peak to peak current ripple (ii) energy stored in an inductor (iii) switch power loss (iv) diode power loss

(C) A forward converter is switched at 50 kHz with a duty cycle of 0.35. It is supplying 60 W load at an output voltage of 10 V. The input to the forward converter is derived from 230 V mains by using a capacitor input filter rectifier. Estimate the turns ratio of the transformer. The peak magnetizing current is 20 mA. If the output inductor current ripple is 10 % of the average inductor current, calculate the peak current requirement for the main switch. [4]

(D) With neat illustrative circuit and waveforms, discuss the concept of zero voltage switching. [4]

OR

(D) A push-pull converter is switched at 50 kHz with a duty cycle of 0.4. It is supplying a 48 W load. The secondary to primary turn ratio of centre tap transformer is 5. The input to the push-pull converter is 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. [4]

Q.3 (A) The boost converter is sometimes modified as shown in figure-1 to obtain a larger conversion ratio than would otherwise occur. The inductor winding contains a total of (n_1+n_2) turns. The switch is connected to a tap placed n_1 turns from the left side of the inductor, as shown. The tapped inductor can be viewed as a two winding (n_1:n_2) transformer, in which two windings are connected in series. The inductance of the entire (n_1+n_2) turn winding is L. Determine, (i) an analytical expression for the conversion ratio M=(V_o/V_{in}). You may assume that the transistor, diode, tapped inductor and capacitor are lossless. You may also assume continuous conduction. (ii) sketch M(D) vs. D for n_1=n_2 and compared to the nontapped (n_2=0) case. [4]

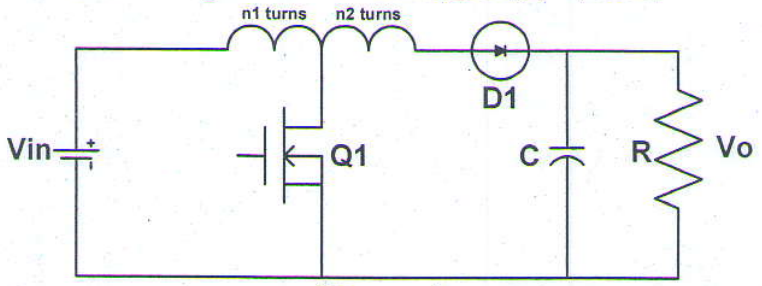


Figure - 1

(B) Design linear power supply with following specifications. [7]
Input voltage: 150 V to 270 V ac, 50 Hz Output voltage: 15 V
Peak to peak voltage ripple: 750 mV Output current: 3 A
Zener Specifications: 4.7 V with max. power 750 mW and max. zener current of 70 mA
a) Compute transformer turns ratio.
b) Filter capacitor value.

c) Maximum power dissipation in transistor.
d) Values of various resistors.
e) Power dissipation in transistor when ordinary short circuit protection is provided using R_{sense}=1 Ω under rated supply conditions.
f) Design foldback short circuit protection to limit short circuit current to 1000 mA.

(C) Explain the operation of the forward converter with tertiary winding and derive its transfer function with following waveforms. [5]

a) Switch voltage
b) Primary current
c) Secondary current
d) Diode voltage
e) Tertiary current
f) Inductor current

OR

(C) Explain the operation of flyback converter and derive its transfer function with following waveforms. [5]

a) Switch voltage
b) Primary current
c) Secondary current
d) Diode voltage
e) Switch Voltage
f) Core flux

Section - II

Q.4 (A) Draw all possible circuit configuration to obtain variable dc supply from ac and/or dc supply. [4]

OR

(A) With the help of neat and illustrative waveforms, briefly explain the different control strategies used for choppers. [4]

(B) Draw the power schematic of current commutated chopper and draw the variations in following quantities with respect to time. [6]

a) Main thyristor current
b) Capacitor current
c) Current of diode across main thyristor
d) Capacitor voltage
e) Load voltage
f) Gate pulses

(C) A first quadrant chopper is operating with supply voltage of 200 V. On-time and off-time of main switch is 1 ms and 1.5 ms respectively. Compute average and rms output voltages. Also compute form factor for same. [3]

(D) An industrial application requires dc motor to run in forward direction for some time and then load is suddenly removed from the motor. Now application demands motor to run in reverse direction for some time followed by sudden removal of load. Kindly suggest a circuit that does this job in most energy efficient way. [3]

Q.5 (A) A three phase bridge inverter is fed from 200 V dc source. The inverter is operated in 180^0 mode of conduction & it is supplying resistive star connected load with R = 10 Ω. The inverter frequency is 50 Hz. Determine: (a) instantaneous line to line voltage & line current in terms of fourier series, (b) rms line voltage, (c) rms phase voltage. [6]

(B) [8]

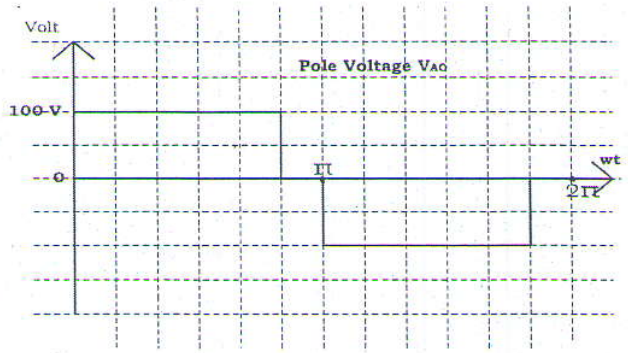


Figure - 2

Above figure-2 shows pole voltage of phase A for the three phase voltage source inverter. Draw pole voltage of remaining two phase, gate signal, phase voltage and line voltage of three phases.

(C) Answer the following. [4]

(i) Sinusoidal PWM techniques is most widely used compared to other PWM techniques. Why?

(ii) In three phase voltage source inverter, all tripplen harmonics are eliminated. True or False? Justify your answer with proper reason.

OR

(C) Draw and explain block diagram of off-line UPS. [4]

Q.6 (A) A single phase full bridge inverter has load of R = 4 Ω, L = 35 mH & C = 155 μF. The dc input voltage is 230 V & output voltage frequency is 50 Hz. Determine: (a) an expression for load current up to 5th harmonic component, (b) rms value of fundamentals load current, (c) fundamental load power. [6]

(B) Draw and explain circuit diagram of interconnection of solar power generation system with grid and enlist essential condition of synchronisation of solar system with grid system. [6]

(C) A UPS is driving a 600 W load which has a lagging power factor of 0.8 and efficiency of the inverter is 80 %. The battery voltage is 24 V dc. Assume that there is a separate charger for battery. Determine (a) kVA rating of inverter (b) wattage of the inverter (c) Ah rating of battery for a backup time of 30 min. [4]

OR

(C) Draw a circuit diagram for external control of dc input of inverter. Circuit diagram should consist of AC Voltage controller and explain same in brief. [4]

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