Nirma University

Institute of Technology

Semester End Examination (IR), December - 2016

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. Assume suitable additional data if required.
6. Notations and symbols have their usual meaning.

SECTION-I

Q.1 (A) With a neat circuit diagram & illustrative waveforms, explain operating principle of boost (step-up) chopper. What is the duty cycle if a boost chopper fed from 200 V dc supply provides output of 300 V dc? (6)

(B) Explain in detail with illustrative waveforms operation of type – A & four quadrant type –E chopper. (6)

OR

(B) Analyze the operation of parallel-capacitor turn-off (voltage commutated) chopper supplying R-L-E load. Also, draw neat waveforms for commutating capacitor current, commutating capacitor voltage, load voltage and load current. (6)

(C) The speed of a separately excited dc motor is controlled below base speed by type-A chopper. Supply voltage is 300 V dc. The armature circuit has R_a = 0.3 Ω & L_a = 15 mH. The motor constant is k = 0.2 V/rpm. Motor drives a constant torque load requiring an average armature current of 20 A. Considering continuous armature current, evaluate (1) Range of duty cycle and (2) Range of speed control. (6)

Q.2 (A) Discuss advantages and disadvantages of linear power supply. Explain operating principle of generic linear regulator & derive expression of it's efficiency. (6)

(B) Explain with neat power schematic and illustrative waveforms continuous as well as discontinuous conduction mode for buck-boost converter. (6)

(C) Discuss about positive & negative voltage regulators. Draw the pin diagram and connection diagram for 7815 voltage regulator. (4)

Q.3 (A) Explain the operation of half-bridge converter based switched mode power supply. Derive the expression for ratio of output to input voltage and draw waveforms for: (6)

a) Primary Voltage b) Inductor voltage c) Inductor current

Derive the expression of relationship between current handled by switches for full-bridge and half-bridge converter.

(B) Discuss in detail operation and derive the expression for ratio of output to input voltage of push-pull converter based switched mode power supply. Draw waveforms for: (6)

a)Primary Voltage b) Secondary voltage c) Inductor voltage

d) Inductor current

(C) Explain the operation of transistor based shunt and series dc-dc linear regulators. (4)

OR

(C) A current commutated chopper is fed from a dc source of 230 V. It's commutating components are L = 20 μH and C = 50 μF. Considering continuous load current of 200 A during the commutation process, calculate: (4)

a) Peak commutating current

b) Turn-off time of the main thyristor

SECTION – II

Q.4 (A) Answer the following. (Attempt any four) (Each carries 4 marks) (16)

i. Why VSC feeding purely reactive load is an attractive feature? Discuss an application for same.

ii. What are the essentials of well-designed PWM strategy for an inverter?

iii. What is redundancy in inverter switching? How it lead to bus clamping PWM technique?

iv. Prove that quarter wave symmetry is not valid, if a fundamental frequency sine wave and low amplitude even harmonic wave are added to obtain new modulating wave.

v. What is UPS? Compare on line and off line UPS.

Q.5 (A) Explain in detail operation of zero current switching resonant converter with circuit diagram and illustrative waveforms. (6)

(B) 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. Discuss the effect of by-pass diodes on the P-V curve. Also draw the schematic of stand-alone PV system. (6)

OR

(B) Discuss the role of maximum power point tracking in photovoltaic systems. Explain different types of power electronic converters used for grid connected photovoltaic systems. (6)

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

Q.6 (A) Draw schematic diagram of single phase switched mode (boost) rectifier and discuss the control strategies for same with necessary waveforms. (6)

(B) Discuss selective harmonic elimination technique by plotting contours of $V_5=0$ and $V_7=0$ along with variation of fundamental voltage from 0 pu. to 1 pu. for two switching per quarter. (6)

(C) Draw waveforms of sine-triangle PWM technique when modulation index approaching to one. What are the effects of this on machine performance? (4)

OR

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

(D) Describe briefly third harmonic injection PWM technique. (2)

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