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Question Paper Code : 50540

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2023.

Fifth Semester

Electrical and Electronics Engineering

EE 8552 — POWER ELECTRONICS

(Common to : Mechatronics Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define ODF in a power BJT.

2. *"Snubber circuit for an SCR should primarily consist of capacitor only But, in actual practice, a resistor is used in series with the capacitor"*- Interpret.

3. What is the relation between α, β and γ in single-phase fully controlled rectifier when operating with RL load?

4. What are the influences of pulse number of phase-controlled rectifiers on their output voltage ripple content?

5. What is a time ratio control?

6. A chopper is operating at a frequency of 2kHz on a 230V DC input, if the load voltage is 150V, calculate the conduction and non-conduction periods of thyristor in each cycle.

7. Mention the types of UPS.

8. What is meant by overmodulation in SPWM? Mention its necessity.

9. A single-phase voltage controller has input voltage of 230V, 50Hz and a load of $R = 15\,\Omega$. For 6 cycles ON and 4 cycles OFF, determine the rms value of output voltage

10. A three phase six-pulse, 50 kVA, 415 V cycloconverter is operating at a firing angle of 450 and supplying load of 0.8 power factor. Determine input current to the converters.

PART B — (5 × 13 = 65 marks)

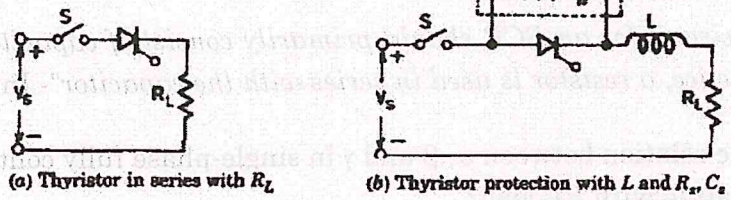
11. (a) (i) Discuss the basic structure and working of power IGBT. (6)

(ii) Draw the two-transistor model of SCR and derive an expression for anode current. (7)

Or

(b) (i) Explain in details the different SCR commutation methods. (9)

(ii) The figure shown beneath shows a thyristor controlling the power in a load resistance R_L. The supply voltage is 240 V dc and the specified limits for di/dt and dv/dt for the SCR are 50 A/μs and 300V/μs respectively. Determine the values of the di/dt inductance and the snubber circuit parameters R_S and C_S. (4)



(a) Thyristor in series with R_L (b) Thyristor protection with L and R_s, C_s

12. (a) Explain the single phase fully controlled rectifier while feeding a load current of severe discontinuity. (13)

Or

(b) (i) Explain the effect of source inductance in the performance of the single-phase fully controlled rectifier. (9)

(ii) Discuss the involvement of phase-controlled rectifiers in light dimmer application. (4)

13. (a) (i) With help of circuit diagram and waveforms explain the principle of working of boost converter. (8)

(ii) For a class chopper working with resistive load of R ohms, input voltage of V_{dc} and duty cycle α, express the following variables as functions of R, V_{dc} and α. (1 × 5 = 5)

(1) Average output voltage and *current*

(2) Output current at the commutation

(3) Average and RMS freewheeling diode currents

(4) RMS value of output voltage

(5) Average and RMS load currents

Or

(b) (i) Describe the working of L-type ZCS resonant dc to dc converter. (5)

(ii) Explain the working of class A chopper and arrive the output voltage relation. Also perform the steady state time domain analysis and obtain the output current equation. (8)

14. (a) (i) Draw the circuit diagram of 1ϕ auto sequential commutated current source inverter and explain its operation with equivalent circuits for different modes and necessary waveforms. (10)

(ii) Write short notes on the principle of UPS. (3)

Or

(b) Explain the principle of space vector PWM applied to three phase VSI using the space vector diagram. (13)

15. (a) Explain the basic principle of operation of a three-phase to single phase cycloconverter with circuit diagram and waveforms. Identify and mark the durations of rectification and inversion modes of converter groups for the *assumed load* angle. Obtain the fundamental rms value of output voltage/phase for an m-pulse cycloconverter. (13)

Or

(b) (i) With the suitable circuit, discuss about the matrix converter. (7)

(ii) A $1-\Phi$ AC voltage controller *has, a* resistive load of R = 10 Ω and input voltage is V_S = 120 V, 60 Hz the delay angle of thyristor T_1 is $\alpha = \frac{\pi}{2}$. Determine, (6)

(1) the rms value of output voltage V_0

(2) the input PF and

(3) the average input current.

PART C — (1 × 15 = 15 marks)

16. (a) (i) The buck regulator has an input range of V_S = 12 V. The regulated average output voltage is V_a = 5 V at R =500 Ω and the peak to peak output ripple voltage is 20 mV. The switching frequency is 25 kHz if the peak to peak ripple current of inductor is limited to 0.8 A determine (10)

(1) The duty cycle, K

(2) The filter inductance, L

(3) The filter capacitance, C and the critical value of L and C.

(ii) A single phase two pulse bridge converter feeds power to RLE load with R = 10 Ω, L = 10 mH E = 100 V, ac voltage is 250V, 50 Hz for continuous conduction. Find the average value of load current for a firing angle of 50°. In case one of the SCR's gets open circuited, find the new value of average load current assuming the output current as continuous. (5)

Or

(b) (i) A three-phase to single-phase cycloconverter employs a six-pulse bridge circuit and fed from 400V, 50Hz supply through a delta/star connected transformer whose per phase turns ratio 3:1. For a output frequency of 2Hz, the load reactance is $\omega_o L$ = 3 Ω. The load resistance is 4 Ω. The commutation overlap and thyristor turn-off limit the firing angle in the inversion mode to 165°. Compute (7)

(1) Peak value of rms output voltage

(2) rms output current

(3) output power

(ii) For a single-phase voltage controller feeding a resistive load, show that power factor is given by the expression $\left[\frac{1}{\pi}\left\{(\pi-\alpha)+\frac{1}{2}\sin 2\alpha\right\}\right]^{1/2}$. (8)