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Question Paper Code : 80575

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

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. What is an integral body diode?

2. Enumerate how the negative temperature co-efficient is being the reason for the secondary breakdown of power BJTs.

3. Outline a table relating pulse numbers, phase-controlled rectifier type and ripple frequency.

4. Differentiate between the circuit turn-off time Vs the device turn-off time.

5. 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.

6. Define hybridization ratio in HEV.

7. Define square wave.

8. State the principle of induction heating.

9. What is a matrix converter?

10. Define: Sub-harmonics and Inter-harmonics.

PART B — (5 × 13 = 65 marks)

11. (a) (i) Explain the two-transistor analogy of SCR and derive the anode current equation. (7)

(ii) Discuss any two commutation methods of SCR. (6)

Or

(b) (i) Explain the switching characteristics of power MOSFET. (4)

(ii) Discuss any three gate triggering circuit available for SCR. (9)

12. (a) Describe the working of single phase fully controlled rectifier feeding resistive load with help of mode diagrams and waveforms.

Or

(b) Investigate the effect of source inductance on the single phase and three phase full converter operations.

13. (a) 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.

Or

(b) Explain the working of class E chopper with the help of relevant mode diagrams and waveforms.

14. (a) With neat sketches, explain the operation of three phase voltage source inverter. Draw phase and line voltage waveforms on the assumption that each IGBT conducts for 180° and the resistive load is star connected.

Or

(b) Explain the working of single phase auto sequential CSI with mode diagrams and waveforms.

15. (a) (i) A $1-\Phi$ AC voltage full wave controller has, a resistive load of $R = 20\Omega$ and input voltage is Vs=230V, 50Hz, the delay angle of thyristor T_1 is $\alpha = 45°$ Determine,

(1) the rms value of output voltage,

(2) the input PF and load power

(3) the average and rms currents of thyristor (3)

(ii) Explain the working of three-phase to single phase cycloconverter. Also derive the relation for the rms value of the fundamental component of the output voltage to an m-base cycloconverter employing half wave converters. (10)

Or

(b) (i) 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

(1) the rms value of output voltage,

(2) the input PF, and

(3) the average and rms currents of thyristor (3)

(ii) Describe the working of two-stage sequence control of voltage controller for RL load. (10)

PART C — (1 × 15 = 15 marks)

16. (a) (i) A string of four series-connected thyristors is provided with static and dynamic equalizing circuits. This string has to withstand an off-state voltage of 10kV. The static equalizing resistance is $25000\,\Omega$ and the dynamic equalizing circuit has $R_c = 40\,\Omega$ and $C = 0.08\mu F$. The leakage currents for four thyristors are 21mA, 25mA, 18mA and 16mA, respectively. Determine voltage across each SCR in the off-state and the discharge current of each capacitor at the time of turn-on. (8)

(ii) A thyristor string is made up of number of SCRs connected in series and parallel. The string has voltage and current ratings of 11kV and 4kA respectively. The voltage arid current ratings of the available thyristor are 1800V and 1000A respectively. For a string efficiency of 90%, calculate number of series and parallel connected SCRs. (7)

Or

(b) (i) The single-phase full converter is connected to a 230V, 50Hz supply. The load current i_0 can be assumed to be continuous and its ripple content is negligible. The turns ratio of the input transformer is unity. (1) Express the input current in Fourier series; determine the harmonic factor, distortion factor, displacement factor, ripple factor and power factor of input current. (2) If the delay angle $\alpha = 45°$, calculate V_{oave}, V_{orms}, HF, PF, etc. (3) Construct all the waveforms relevant to full convener for discontinuous load current. (10)

(ii) A MOSFET used in a power converter is switched at 300kHz. The voltage across the device, when it is OFF is 100V and the load current carrier when it is ON is 3A. Assuming the MOSFET takes 100n seconds for turn off and operated at a duty cycle of 60%, design the turn off snubber for the MOSFET. Also design a turn ON snubber assuming the current rise time 500n seconds. (5)

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