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EI 181502

Roll No. of candidate | | | | | | | | | | |

21/2/22 2021

B.Tech. 5th Semester End-Term Examination

EE

POWER ELECTRONICS

(New Regulation & New Syallbus)

Full Marks – 70 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Question No. 1 and any *four* from the rest.

1. Answer the following questions : (10 × 1 = 10)

(i) The di/dt rating of an SCR is specified for its

(a) Decaying anode current (b) Decay gate current

(c) Rising gate current (d) Rising anode current

(ii) The average on-state current of an SCR is 20 A for a resistive load. If an inductance of 5 mH is included in the load, then the average on-state current would be

(a) More than 20 A (b) Less than 20 A

(c) 15 A (d) 20 A

(iii) For reliable commutation in class-B commutation circuit, the peak value of the capacitor current would be

(a) equal to the main thyristor current

(b) equal to the load current

(c) more than the load current

(d) less than the load current

(iv) In single phase full converter, if output voltage has peak and average value of 325 V and 133 V respectively, then the firing angle is

(a) 40° (b) 140°

(c) 50° (d) 130°

[Turn over

(v) In 3-ϕ semi-converter, for a firing angle 90° with continuous conduction, each SCR and diode will conduct respectively for

(a) 30°, 60° (b) 60°, 30°

(c) 90°, 90° (d) 30°, 30°

(vi) For a 3-ϕ bridge inverter in 180° conduction mode, the sequence of SCR conduction in the first two steps, beginning with the initiation of thyristor 1 is,

(a) 6, 1, 2 and 2, 3, 1 (b) 2, 3, 1 and 3, 4, 5

(c) 3, 4, 5 and 5, 6, 1 (d) 5, 6, 1 and 6, 1, 2

(vii) In type-A Chopper, source voltage is 100 V dc, on period is 100 μs, off period is 150 μs with RLE load having R = 2 Ω, L = 2 mH and E = 10 V. For continuous conduction, average output voltage and average output current for the chopper are respectively :

(a) 40 V and 15 A (b) 66.66 V and 28. 33 A

(c) 60 V and 25 A (d) 40 V and 20 A

(viii) A PWM switching scheme is used in single phase inverter to :

(a) Reduce the total harmonic distortion with modest filtering

(b) Minimize load current in dc side

(c) Increase the life of battery

(d) Reduce lower order harmonics and increase high order harmonics

(ix) A load resistance of 10 Ω of 1-ϕ voltage controller, the source voltage is 200 V rms. For a firing angle of 90°, the value of thyristor current is

(a) 20 A (b) 15 A

(c) 10 A (d) 5 A

(x) The function of the tap changing transformer in line interactive UPS is to

(a) Regulate voltage (b) Regulate current

(c) Power regulation (d) Filtering

2. (a) A separately excited dc motor when fed from 1-ϕ full converter with firing angle 60° runs at 1000 rpm. If the motor is connected to 1-ϕ semi-converter with same firing angle, find the speed of the motor. (5)

(b) What is pulse width modulation? List the various PWM techniques.

For a single phase modulation used in inverter, show that the output voltage can be expressed as,

$$V_0 = \sum_{n=1,3,5}^{\infty} \frac{4V_S}{n\pi} \sin\frac{n\pi}{2} \sin nd \sin wt$$

Where, 2 d is the pulse width. (10)

3. (a) Describe the turn-on and turn-off process of GTO with two transistor model. (6)

(b) Explain the thyristor gate characteristics with gate firing circuit. (4)

(c) The trigger circuit of a thyristor has a source voltage of 15 V and the load line has a slope of 120 V/A, the minimum gate current to turn on the SCR is 25 mA. Compute (5)

(i) source resistance required I gate circuit

(ii) the trigger voltage and trigger current for an average gate power dissipation of 0.4 W.

4. (a) Derive the expression for maximum and minimum load current, duty cycle to limit the continuous conduction for type-A chopper with continuous conduction with suitable waveforms. (6)

(b) Discuss how the voltage across the commutating capacitor is reversed in a commutating circuit. (4)

(c) For the class-B commutating circuit, supply voltage is 230 V, load current I_o is 200 A, circuit turn-off time for main thyristor is 25 μs and reversal current is limited to 150% of I_o. Determine the values of commutating components C and L. (5)

5. (a) Power electronics devices are now replacing the heavy and bulky conventional electromechanical devices. Briefly explain the following PE devices that replace which electromechanical devices : (8)

(i) AC voltage controller

(ii) Chopper

(iii) Rectifier

(iv) Inverter.

(b) Explain the symmetrical and asymmetrical configuration of single phase semi-converter with output current and voltage waveforms with RL load. (7)

6. (a) A 230 V, 50 Hz, one pulse SCR controller converter is triggered at a firing angle of 40° and the load current extinguishes at an angle of 210°. Find the circuit turn off time, average output voltage and the average load current for :

(i) $R = 5\ \Omega$ and $L = 2$ mH

(ii) $R = 5$, $L = 2$ mH and $E = 110$ V. (5+7)

(b) A single-phase full wave ac voltage controller feeds a load of R = 20 Ω with an input voltage of 230 V, 50 Hz. Firing angle for both the thyristors is 45°. Calculate. (3)

(i) Rms value of output voltage

(ii) Average thyristor current

7. (a) Describe the operating principle of single phase to single phase step-up cycloconverter with the help of bridge type configuration. (6)

(b) What are the advantages and disadvantages of SMPS? (4)

(c) Briefly explain the function of the following components in regulated power supply : (5)

(i) Rectifier

(ii) Voltage