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Question Paper Code : 90523

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2022.

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 secondary breakdown in power BJT?
2. Differentiate Latching current from holding current.
3. Provide a table relating pulse numbers, phase-controlled rectifier type and ripple frequency.
4. What is IGR in the dual converter?
5. What is a time ratio control?
6. What are resonant converters?
7. What are integral body diodes?
8. What is THD?
9. A 3-phase full converter delivers a ripple free load current of 10 A with a firing angle delay of 45°. The input voltage is 3-phase, 400 V, 50 Hz. The source current is given by the following relation.

$$i(t) = \sum_{n=1,3,5}^{\infty} \frac{4I_o}{n\pi} \sin \frac{n\pi}{3} \sin(n\omega t - n\alpha)$$

Find the fundamental component of the source current amplitude.

10. What is integral cycle control?

PART B — (5 × 13 = 65 marks)

11. (a) Explain the working principle of IGBT with relevant circuit diagrams and characteristics. State merits and limitations of the same.

Or

- (b) Explain the two-transistor analogy of SCR and derive the anode current equation.

12. (a) Describe the working of 3- Φ fully controlled bridge converter in the Rectifying mode and in inversion mode. And derive the expressions for average output voltage and rms output voltage.

Or

- (b) Obtain the effect of source inductance in single-phase fully controlled rectifier and extend the discussion to three-phase converter.

13. (a) Explain the waveforms of type A chopper. Derive the expression for current ripple when it feeds RL load.

Or

- (b) Describe the working of four quadrant chopper.

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 thyristor conducts for 180° and the resistive load is star connected.

Or

- (b) Enumerate the working of the auto sequential commutated inverter with relevant diagrams.

15. (a) For a single-phase voltage controller feeding a resistive load, show that power factor is given by the expression.

$$\left[\frac{1}{\pi} \left\{ (\pi - \alpha) + \frac{1}{2} \sin 2\alpha \right\} \right]^{1/2}$$

Or

- (b) Discuss the operation of a single-phase to single phase cycloconverter for the output frequency one third of the input frequency.

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PART C — (1 × 15 = 15 marks)

16. (a) (i) A single phase semi-converter is operated from 230V, 50Hz supply. The load current with an average value of I_a is continuous with negligible ripple content. The turns ratio of the transformer is unity. If the delay angle is $\alpha = \pi/3$, calculate (1) the harmonic factor of input current, (2) displacement factor and (3) the input power factor. (10)
- (ii) For the single phase fully controlled bridge is connected to RLE load. The source voltage is 230 V, 50 Hz. The average load current of 10A continuous over the working range. For $R = 0.4\Omega$ and $L = 2mH$, Compute
- (1) Firing angle for $E = 120V$
- (2) Firing angle for $E = -120V$

Or

- (b) A single-phase voltage controller is employed for controlling the power flow from 230V, 50Hz source into a load circuit consisting of $R = 3\Omega$ and $\omega L = 4\Omega$. Calculate
- (i) The control range of firing angle. (3)
- (ii) The maximum power and power factor (3)
- (iii) The maximum value of rms load current (3)
- (iv) The maximum possible value of di/dt that may occur in the thyristor, and (3)
- (v) The conduction angle for $\alpha = 0^\circ$ and $\alpha = 120^\circ$ assuming a gate pulse of duration π radians. (3)