

## B.Tech DEGREE EXAMINATION, DECEMBER 2023

Fifth Semester

### 18EEEC302J - POWER ELECTRONICS

(For the candidates admitted during the academic year 2020 - 2021 & 2021 - 2022)

**Note:**

- i. **Part - A** should be answered in OMR sheet within first 40 minutes and OMR sheet should be handed over to hall invigilator at the end of 40<sup>th</sup> minute.
- ii. **Part - B** and **Part - C** should be answered in answer booklet.

**Time: 3 Hours**

**Max. Marks: 100**

#### PART - A (20 × 1 = 20 Marks)

Answer all Questions

Marks BL CO

- |   |   |   |   |
|---|---|---|---|
| <p>1. For an SCR, dv/dt protection is accomplished by ----</p> <p>(A) L in series with SCR                      (B) R in series with SCR</p> <p>(C) R across SCR                                (D) C across SCR</p>  | 1 | 2 | 1 |
| <p>2. For a power diode, the reverse recovery time is 3 μs and the rate of fall of diode current is 30 A/ μs. Find the peak reverse current</p> <p>(A) 80 A    (B) 90 A</p> <p>(C) 100 A    (D) 60 A</p>                            | 1 | 2 | 1 |
| <p>3. MOSFET is a                      device.</p> <p>(A) Semi controlled                              (B) Fully controlled</p> <p>(C) Uncontrolled                                 (D) Semi and fully controlled</p>   | 1 | 1 | 1 |
| <p>4. The voltage blocking capability of IGBT is determined by ----</p> <p>(A) Body layer                                      (B) Metal layer</p> <p>(C) Drift layer                                        (D) Injection layer</p>  | 1 | 1 | 1 |
| <p>5. A single-phase semi-controlled converter is a                      quadrant converter</p> <p>(A) Dual    (B) Tri</p> <p>(C) Quadruple                                        (D) Single</p>   | 1 | 1 | 2 |
| <p>6. A single-phase full wave-controlled rectifier is used to supply RL load with a continuous load current. With a firing angle of 90°, find the output voltage</p> <p>(A) 33 V    (B) 66 V</p> <p>(C) 0 V     (D) 11 V</p> | 1 | 2 | 2 |
| <p>7. A three-phase full controlled converter has an input supply frequency of 50 Hz, then the ripple frequency in output voltage is ----</p> <p>(A) 50 Hz    (B) 300 Hz</p> <p>(C) 100 Hz    (D) 150 Hz</p>                        | 1 | 2 | 2 |
| <p>8. The three phase semi converter will work like a six-pulse converter for a firing angle less than ----</p> <p>(A) 45°     (B) 60°</p> <p>(C) 90°     (D) 120°</p>  | 1 | 2 | 2 |
| <p>9. The widely used control method for managing power in DC-DC converters is ----</p> <p>(A) Firing angle control                              (B) Integral cycle Control</p> <p>(C) Pulse width modulation                              (D) Frequency modulation</p>   | 1 | 1 | 3 |
| <p>10. Buck-Boost converter acts as Boost converter when the duty cycle is equal to -----</p> <p>(A) 0.8     (B) 0.1</p> <p>(C) 0.2     (D) 0.4</p>   | 1 | 2 | 3 |

- |   |  |   |   |
|---|--|---|---|
| 11. A Cuk converter has an input voltage of 220V and output voltage of 880V. Find the duty cycle of the power electronic switch                                     | 1  | 2 | 3 |
| (A) 0.8   | (B) 0.1  |   |   |
| (C) 0.2   | (D) 0.4  |   |   |
| 12. Resonant converters are basically used to -----   | 1  | 2 | 3 |
| (A) convert a square wave into a sine wave  | (B) generate large peaky voltage                         |   |   |
| (C) eliminates harmonics  | (D) reduce the switching losses                          |   |   |
| 13. In case of 120° mode of operation of three phase inverter, _____ devices conduct at a time.   | 1  | 2 | 4 |
| (A) 2   | (B) 3  |   |   |
| (C) 4   | (D) 1  |   |   |
| 14. A single-phase full bridge inverter has a dc voltage source $V_s = 230$ V. Find the rms value of fundamental component of output voltage.                       | 1  | 2 | 4 |
| (A) 90 V  | (B) 207 V  |   |   |
| (C) 350 V   | (D) 196 V  |   |   |
| 15. Number of controlled semiconductor switches required to construct a five level diode clamped multi-level inverter per pole is -----                             | 1  | 2 | 4 |
| (A) 4   | (B) 8  |   |   |
| (C) 16  | (D) 32   |   |   |
| 16. In SPWM, the modulating signal is -----   | 1  | 1 | 4 |
| (A) Trapezoidal   | (B) Sinusoidal   |   |   |
| (C) Triangular  | (D) Saw – tooth  |   |   |
| 17. In HVDC system, 12 pulse converter is preferred, as a result it reduces the -----   | 1  | 2 | 6 |
| (A) Switching Complexity  | (B) Number of gate driver units                          |   |   |
| (C) Filtering Complexity  | (D) PWM requirement                                      |   |   |
| 18. Cycloconverters (CCs) require ----  | 1  | 2 | 5 |
| (A) natural commutation in both step-up and step-down CCs   | (B) forced commutation in both step-up and step-down CCs |   |   |
| (C) forced commutation in step-up CCs   | (D) forced commutation in step-down CCs                  |   |   |
| 19. A single-phase thyristor-based AC voltage controller operating with a firing angle (alpha) $\alpha$ feeds a R-L load. The conduction angle of thyristor is----- | 1  | 2 | 5 |
| (A) $\pi - \alpha$  | (B) $2\pi - \alpha$                                      |   |   |
| (C) $\pi - 2\alpha$   | (D) $\beta - \alpha$ , where $\beta$ is extinction angle |   |   |
| 20. Which of the following can be used as a light-dimming device with compact and efficient solution?   | 1  | 2 | 6 |
| (A) variable resistor   | (B) auto transformer                                     |   |   |
| (C) Silicon Controlled Rectifier (SCR)  | (D) Transformer  |   |   |

**PART - B ( $5 \times 4 = 20$  Marks)**

Answer any 5 Questions

Marks BL CO

- |  |   |   |   |
|--|---|---|---|
| 21. An IGBT used in the circuit has the following data: transient turn-on time ( $t_{on}$ )= 3 $\mu$ S and turn-off time ( $t_{off}$ )= 1.2 $\mu$ S, switching frequency = 1 kHz, collector to emitter voltage ( $V_{CE}$ )= 200 V, collector current ( $I_C$ )= 19.8 A. Calculate total switching power loss. | 4 | 3 | 1 |
| 22. A single-phase full wave controlled rectifier is employed in a AC to DC conversion application with R load. Compute average output voltage as a function of firing angle and maximum input AC voltage.   | 4 | 4 | 2 |
| 23. Explain in brief the operation of Type-C chopper with circuit diagram.   | 4 | 2 | 3 |

24.	A full bridge voltage source inverter (VSI) is adopted in an application to supply single phase AC load. The input of full bridge VSI is connected to a battery which provides DC link voltage of 96 V. Considering this data, determine the total harmonic distortion (THD) content in the output voltage of VSI. Also, sketch the circuit diagram and voltage waveform.	4	4	4
25.	Explain the operation of electronic ballast with necessary block diagram.	4	2	6
26.	Distinguish the operation of short-break UPS and no-break UPS, and draw its block diagram.	4	2	6
27.	Compare the output voltage of a single-phase full controlled converter with and without source inductance.	4	2	2

**PART - C (5 × 12 = 60 Marks)**

**Marks BL CO**

Answer all Questions

28.	(a) i. Analyze different modes of operation of a thyristor with the help of its static V-I characteristics. (8 Marks) ii. Distinguish latching and holding currents. Show these currents on static V-I characteristics of a thyristor. (4 Marks) (OR) (b) Explain the possible methods of turning on a TRIAC with suitable illustrations.	12	4	1
29.	(a) i. A single-phase semi converter is operated from 120 V, 50 Hz AC supply. The load resistance is 10 Ω. If the average output voltage is 25% of the maximum possible average output voltage, calculate (a) Firing angle, and (b) average output current. (8 Marks) ii. Sketch the circuit diagram of (i) and considering the above parameters plot the necessary waveforms. (4 Marks) (OR) (b) i. A three-phase full converter charges a battery from a three-phase supply of 230 V, 50 Hz. The battery emf is 200 V and its internal resistance is 0.5 Ω. On account of inductance connected in series with the battery, charging current is constant at 20 A. Compute the firing angle delay and the supply power factor. (8 Marks) ii. In case it is desired that power flows from DC source to AC load in part (i), find the firing angle delay for the same current. (4 Marks)	12	3	2
30.	(a) i. Design a buck converter for an application with the following specifications: Input voltage of 12 V, Output voltage of 5 V. The peak to peak output ripple voltage is limited to 20 mV and peak to peak ripple current of inductor is limited to 0.8 A. The converter is operated with a switching frequency of 25 kHz. (8 Marks) ii. Sketch the circuit diagram of (i) and considering the above parameters plot the necessary waveforms. (4 Marks) (OR) (b) i. The buck-boost converter is employed in an application with the following specifications: Input voltage of 12 V, duty cycle of 0.6, switching frequency of 25 kHz, filter inductance and capacitance are 250 μH and 220 μF respectively, With an average load current of 1.5 A, evaluate (a) average output voltage, (b) peak to peak ripple voltage and current, (c) load resistance and output power. (8 Marks) ii. Sketch the circuit diagram of (i) and considering the above parameters plot the necessary waveforms. (4 Marks)	12	5	3
31.	(a) Explain the principle of working of a three-phase bridge voltage source inverter with circuit diagram and voltage waveforms for 120° mode of operation. Also, represent the rms value of phase and line voltages. (OR) (b) Explain the following techniques to control the output voltage of single phase inverter with mathematical representations and waveforms: i. Single-pulse modulation technique ii. Multiple-pulse modulation technique	12	4	4

32. (a) i. A single phase AC voltage controller exhibiting integral cycle control has an input voltage of 240 V, 50 Hz and a load resistance of  $5\ \Omega$ . For 8 cycles on and 2 cycles off, determine (a) RMS output voltage, (b) power delivered to load, and (c) input power factor (8 Marks)  
ii. Sketch the circuit diagram of (i) and considering the above parameters plot the necessary waveforms. (4 Marks)

(OR)

- (b) i. A single phase full wave AC voltage controller feeds a load of  $R=8\ \Omega$  with an input voltage of 200V, 50 Hz. The maintained firing angle for thyristor is  $60^\circ$ . Evaluate, (a) RMS value of output Voltage, (ii) The load power and input power factor. (8 Marks)  
ii. Sketch the circuit diagram of (i) and considering the above parameters, plot the necessary waveforms. (4 Marks)

\* \* \* \* \*

12 3 5