GATE 2026 TEST SERIES

Power Electronics

Test 2

1. A single-phase bridge inverter delivers power to a series connected RLC load with R=2Ω, ωL = 8Ω. For this inverter-load combination, load commutation is possible in case the magnitude of 1/ωC in ohms is

A) 10

B) 8

C) 6

D) Can't say

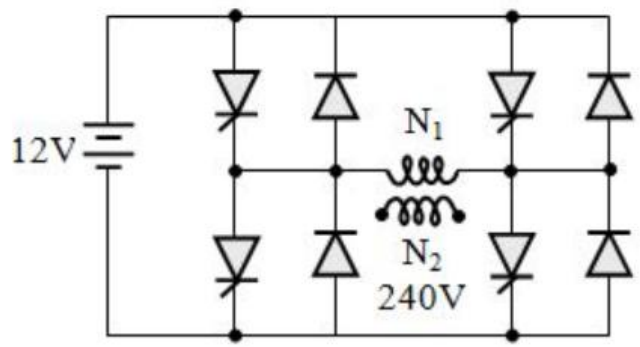
Correct Answer: **A** *Not Attempted :* Marks : 1 / 0.33 (-Ve)

Load commutation will occur when RLC load is underdamped

i.e., $X_L < X_C$

$\Rightarrow X_C > 8$

2. A single-phase bridge inverter shown in figure, has an ideal transformer with primary turns equal to 10. For obtaining a fundamental frequency output voltage of 240V, the number of secondary turns in transformer should approximately be equal to _____.



Correct Answer: **222** Answer Range: **(222 , 222)** *Not Attempted :* Marks : 2 / 0 (-Ve)

$$V_0 = \sum_{n=1,3,\ldots}^{\infty} \frac{4V_s}{n\pi} \sin(n\omega_0 t)$$

$$V_{01,p} = \frac{2\sqrt{2}V_s}{\pi}$$

$$V_{01,s} = 240V$$

$$\frac{V_{01,P}}{V_{01,S}} = \frac{N_P}{N_S} = \frac{10}{N_s} \Rightarrow N_s = 10 \times \frac{240}{\left(\frac{2\sqrt{2} \times 12}{\pi}\right)} = \frac{100\pi}{\sqrt{2}} \approx 222$$

3. In single-pulse modulation used in PMW inverters, V_s is the input d.c. For eliminating third harmonic, the rms value of fundamental component of output voltage and pulse width respectively are

A) $\frac{2\sqrt{2}}{\pi}V_s, 120°$

B) $\frac{\sqrt{6}}{\pi}V_s, 60°$

C) $\frac{2\sqrt{2}}{\pi}V_s, 60°$

D) $\frac{\sqrt{6}}{\pi}V_s, 120°$

$\text{Sin}(nd) = 0, n = 3$

$\Rightarrow nd = 180°$

$\Rightarrow d = 60°$

Pulse width, $W = 2d = 120°$

RMS, $V_{01} = \frac{2\sqrt{2}V_s}{\pi}\sin 60° = \frac{\sqrt{6}}{\pi}V_s$

Correct Answer: **D** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

4. A single-phase half-bridge inverter, connected to 230V dc source, feeds a resistive load of 10Ω. The input power factor is

A) 0.5

B) 0.90

C) 0.57

D) 0.41

Correct Answer: **A** *Not Attempted :* Marks : 1 / 0.33 (-Ve)

$$\text{input power factor} = \frac{P_{in}}{S} = \frac{P_{out}}{S}$$

$$= \frac{V_{0\,rms}^2/R}{V_{s(rms)} I_{s(rms)}} = \frac{V_{0r}^2/R}{V_{sr} \times I_{0r}}$$

$$= \frac{V_{0r}^2/R}{V_{sr} \times \frac{V_{0r}}{R}} = \frac{V_{0r}}{V_{sr}} = \frac{115}{230} = \frac{1}{2} = 0.5$$

5. A 3-phase VSI supplies a purely capacitive 3-phase load. Upon Fourier analysis, the output voltage waveform is found to have an n-th order harmonic of magnitude α_n times that of the fundamental component ($\alpha_n < 1$). The load current would then have an n-th order harmonic of magnitude is

A) Zero

B) α_n times the fundamental frequency component

C) $n\alpha_n$ times the fundamental frequency component

D) α_n/n times the fundamental frequency component

Correct Answer: **C** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

$$V_0(t) = \sum_{n=1,3,5,\ldots} V_n \sin(n\omega t)$$

$$i_L(t) = C\frac{dV_0(t)}{dt} = \sum_{n=1,3,5} n\omega C V_n \cos(n\omega t)$$

$\Rightarrow$ n-th order current harmonic,

$$i_{Ln} = n\omega C V_n$$

$\Rightarrow$ Fundamental component,

$$i_{L1} = \omega C V_1$$

$$V_n = \alpha_n V_1$$

$$\Rightarrow \quad i_{Ln} = n\alpha_n i_{L1}$$

6. For a dc-dc buck converter with supply voltage V_S, switch chopping frequency f, output voltage V_0, output power P_0, the critical inductance L_C for filter circuit is

A) $\frac{V_0(V_s - V_0)}{2fP_0}$

B) $\frac{V_0(V_s - V_0)}{fP_0}$

C) $\frac{V_0^2(V_s - V_0)}{2fV_sP_0}$

D) $\frac{V_0^2(V_s - V_0)}{fV_sP_0}$

Correct Answer: **C** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

For critical case, $I_{min} = 0$

$$I_0 = \frac{I_{max}}{2}$$

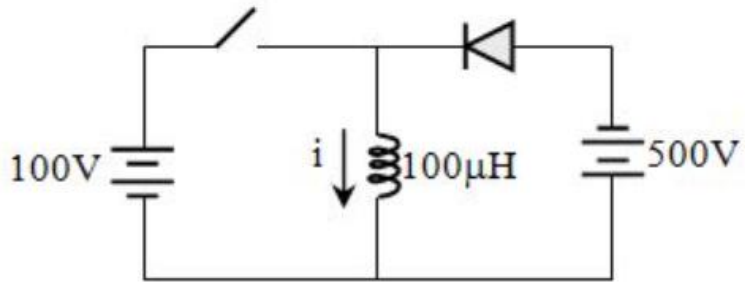
$$T_{on}: \Delta V_L = V_S - V_0 = \frac{L_C \Delta I_L}{T_{on}} = L_C \frac{I_{max}}{DT}$$

$$L_C = \frac{(DT)(V_s - V_0)}{I_{max}}$$

$$= \frac{D(V_s - V_0)}{2I_0 f} = \frac{DV_s(V_s - V_0)}{\frac{2P_0}{V_0} fV_s}$$

$$L_C = \frac{V_0^2(V_s - V_0)}{2fV_sP_0}$$

7. The given converter circuit is operated at boundary of continuous and discontinuous conduction, the switching frequency is f = 10 kHz. The value of T_{on}/T_{off} is _____.

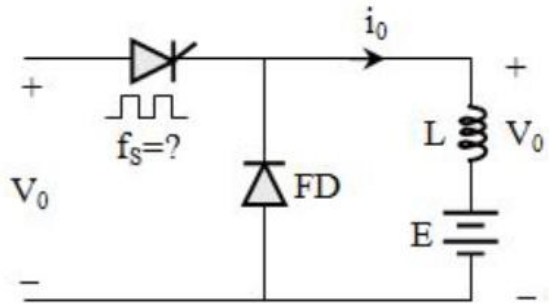


Correct Answer: **5** Answer Range: **(5 , 5)** *Not Attempted :* Marks : 1 / 0 (-Ve)

$$\frac{V_0}{V_s} = \frac{D}{1-D} \Rightarrow \frac{500}{100} = \frac{D}{1-D} \Rightarrow D = \frac{5}{6}$$

$$\frac{T_{on}}{T_{on} + T_{off}} = \frac{5}{6} \Rightarrow \frac{T_{on}}{T_{off}} = 5$$

8. An RLE load is operating in a chopper circuit from a 60 V supply. For the load R = 0 Ω, L = 60 mH, E = 12 V and duty cycle D = 0.2. The chopping frequency to limit amplitude of load current excursion to 1 A is



A) 400 Hz

B) 320 Hz

C) 240 Hz

D) 160 Hz

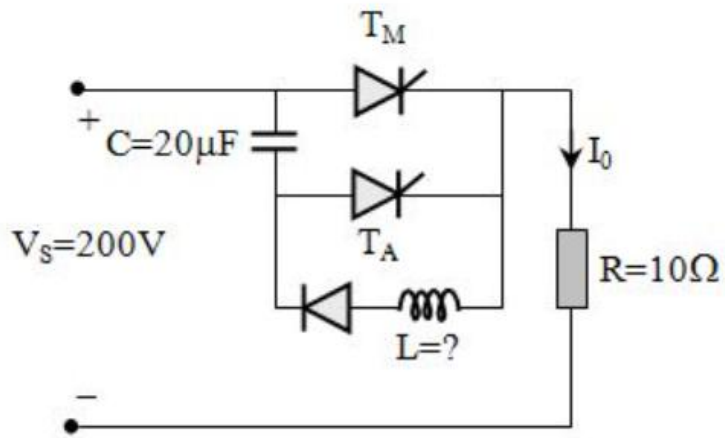
Correct Answer: **D** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

$$I_{max} - I_{min} = \frac{V_s - E}{fL} D = \frac{E(1-D)}{fL}$$

$$\Delta I = \frac{V_s - E}{fL} D$$

$$f = \frac{V_s - E}{L\Delta I} D = \frac{60-12}{60\times10^{-3}\times1} \times 0.2 = 160 \text{ Hz}$$

9. A voltage commutated chopper is shown. The minimum value of inductor L in case maximum permissible current through the main SCR is 2.5 times load current, is _____ mH.



Correct Answer: **0.89** Answer Range: **(0.8 , 0.9)** *Not Attempted :* Marks : 2 / 0 (-Ve)

$$i_{TM,\,peak} = \frac{V_s}{R} + V_0\sqrt{\frac{C}{L}} \le 2.5\frac{V_s}{R}$$

$$\Rightarrow V_0\sqrt{\frac{C}{L}} \le 1.5\frac{V_s}{R}$$

$$L \ge \frac{R^2C}{1.5^2} = 888.88\ \mu H$$

$$L_{min} = 0.89\ mH$$

10. The main disadvantage of non-circulating current type dual converter is

A) Power loss is high in comparison to circulating current type.

B) Reversal of armature current not possible.

C) Slow speed response due to commutation delay

D) Only two quadrant operation is possible

Correct Answer: **C** *Not Attempted :* Marks : 1 / 0.33 (-Ve)

Power loss is higher in circulating current type converter due to circulating current present.

Reversal of armature current is possible, but it is not smooth.

All four-quadrant operation is possible

11. For a buck-boost regulator, input voltage V_s = 12V, duty ratio D = 0.25, switching frequency 25 kHz, inductance 150 μH and filter capacitance C = 220 μF. If the average load current is 1.25A, the peak switch current is

A) 2.067A

B) 2.467A

C) 1.650A

D) 2.010A

Correct Answer: **A** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

$$I_{sw,peak} = \frac{I_o}{(1-D)} + \frac{\Delta I}{2}$$

$$\Delta I = \frac{DV_s}{fL} = \frac{0.25\times 12}{25\times 10^3 \times 150\times 10^{-6}} = 0.8A$$

$$I_{sw.peak} = \frac{1.25}{(1-0.25)} + \frac{0.8}{2} = 2.067A$$

12. A dc battery is to be charged from a constant dc source of 220V. The battery is to be charged from its internal emf of 90V to 122V. The battery has internal resistance of 1Ω. If the charging current remains constant at 10A, the range of duty cycle is

A) $0.41 < D < 0.55$

B) $0.45 < D < 0.6$

C) $0.41 < D < 0.6$

D) $0.45 < D < 0.55$

Correct Answer: **B** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

$$V_0 = E_b + I_0R$$

$$DV_s = E_b + I_0R$$

$$D = \frac{E_b + I_0R}{V_s}$$

$$D_{min} = \frac{E_{b,min} + I_0R}{V_s} = \frac{90 + 10 \times 1}{220} = 0.4545$$

$$D_{max} = \frac{E_{b,max} + I_0R}{V_s} = \frac{182 + 10 \times 1}{220} = 0.6$$

13. For the circuit realization of DC –DC converters, which of the following rule(s) is/are to be followed?

A) Current sources should not be open circuited

B) Voltage sources should not be short circuited.

C) Inductor currents should not be interrupted

D) Capacitor voltages should not be shorted.

Correct Answer: **A,B,C,D** *Not Attempted :* Marks : 1 / 0 (-Ve)

All the given statements are fundamental rules of network theory and applicable to dc-dc converter circuits.

14. A DC chopper is used in regenerative braking mode of a dc series motor. The dc supply is 500 V, the duty cycle is 60%. The average value of armature current is 100 A. It is continuous and ripple free. The value of power feedback to the supply is _____ kW.

Correct Answer: **20** Answer Range: **(20 , 20)** *Not Attempted :* Marks : 2 / 0 (-Ve)

Incase of regenerative braking mode

$V_s = V_0$

$V_0 = 500$ V, $I_0 = 100$ A

For regenerative mode chopper is step-up chopper

$$V_0 = \frac{V_s}{1-D}$$

$$V_s = V_0(1 - D) = 500(1 - 0.6) = 200 \text{ V}$$

Power feedback to the supply $= V_s I_s = 200 \times 100 = 20$ kW

15. A single phase capacitor commutated CSI with Resistive load of R is 20 ohm. Commutating capacitor is 1 μF. Minimum value of operating frequency to obtain sinusoidal current at output is

A) 2.3 kHz

B) 3.3 kHz

C) 4.3 kHz

D) 5.3 kHz

Correct Answer: **D** *Not Attempted :* Marks : 2 / 0.66 (-Ve)

Minimum value of inverter operating frequency for obtaining sinusoidal output current for capacitor commutated CSI is,

$$\omega_{minimum} = \frac{2}{3RC}$$

Or, $$f_{minimum} = \frac{1}{2\pi} \times \frac{2}{3 \times 20 \times 1 \times 10^{-6}}$$

$$F_{minimum} = 5.3 \text{ kHz}$$