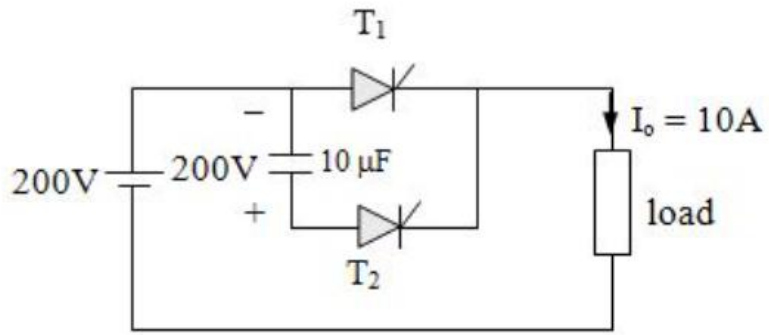
GATE 2026 TEST SERIES

Power Electronics

Test 1

1.



For a constant load current of 10 A, after 200 µsec, T_2 is turned ON. The total time for which load receives energy is

A) 400 µsec

B) 600 µsec

C) 200 sec

D) 800 µsec

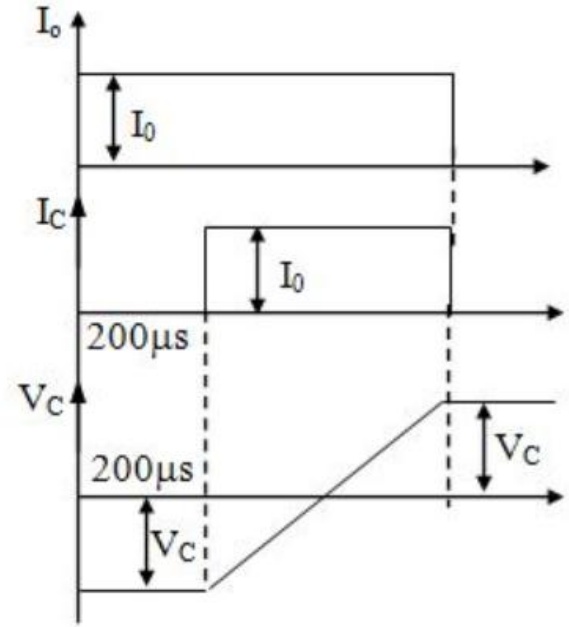
Correct Answer: **B** *Not Attempted :* Marks : 1 / 0.33 (-Ve)

$$I = C\frac{dV_c}{dt}$$

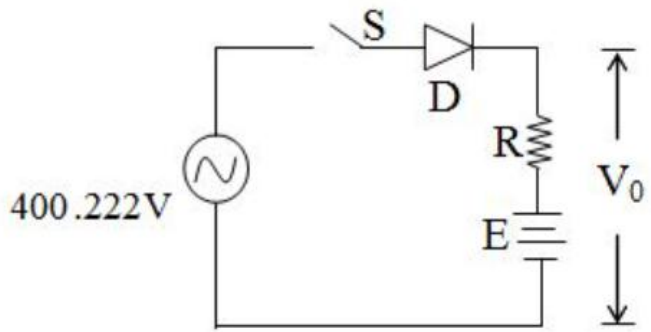
$$10 = 10\ \mu F \times \frac{400}{T}$$

$T = 400\ \mu sec$

Total time $200 + 400 = 600\ \mu$ sec



2. For source rms voltage of 400.222V , 50 Hz and for R = 8Ω, E = 220V, the PIV of the diode is _____ Volts



A) 786 V

B) 566 V

C) 876 V

D) 766 V

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

$$PIV = V_m + E$$

$$= \left|\sqrt{2} \times 400.222\right| + 220 = 566 + 220 = 786V$$

3. Which of the following statements are correct?

A) The voltage developed across the OFF switches of the half bridge converter is the maximum dc link voltage.

B) In the full bridge converter, the voltage across the primary of the transformer is the dc link voltage.

C) The voltage developed across the OFF switches of the full bridge converter is half the maximum dc link voltage.

D) Thyristor commutates when reverse biased and negative current flows through the gate

Correct Answer: **A,B** *Not Attempted :* Marks : 2 / 0 (-Ve)

The voltage developed across the OFF switches of the full bridge converter is twice the maximum DC link voltage.

4. For the same voltage output, which one of the following has larger peak Inverse voltage of the thyristor?

A) Single phase full wave centre tapped circuit

B) Single phase full wave bridge circuit

C) Three phase full wave bridge circuit

D) Three phase full wave centre tapped circuit

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

For bridge rectifiers PIV $\rightarrow V_m$

For centre tapped rectifiers PIV$\rightarrow 2V_m$

5. The reverse recovery time of a power diode is 5 μs and the rate of fall of current is about 20 A/μsec. the value of peak reverse current (I_{RR}) is _____ A.

Correct Answer: **100** Answer Range: **(100 , 100)** *Not Attempted :* Marks : 2 / 0 (-Ve)

Given, $t_{rr} = 5\ \mu sec,\ \frac{di}{dt} = 20\ A/\mu sec$

$$I_{RR} = \sqrt{2Q_R \frac{di}{dt}}$$

Where, $Q_R = \frac{1}{2} \times \frac{di}{dt} \times t_{rr}^2$

$$= \frac{1}{2} \times (20) \times 10^6 \times 25 \times 10^{-12}$$

$$= 250\ \mu C$$

$$\therefore I_{RR} = \sqrt{2 \times 250 \times 10^{-6} \times 20 \times 10^6}$$

$$= 100\ A$$

6. A 6-phase bridge converter feeds a purely resistive load. The delay angle α is measured from the point of natural commutation. The effective control of voltage can be obtained when α lies in the range

A) $0 \leq \alpha \leq 105°$

B) $0 \leq \alpha \leq 120°$

C) $0 \leq \alpha \leq 150°$

D) $0 \leq \alpha \leq 180°$

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

12-pulse bridge converter is same as 6- phase bridge converter.

7. An SCR bridge of 2-SCR and 2-diodes supplies load to a highly inductive load, such that output current is constant at 10 A. If firing angle is 45°, then the average current through thyristor for symmetric and asymmetric connection respectively are

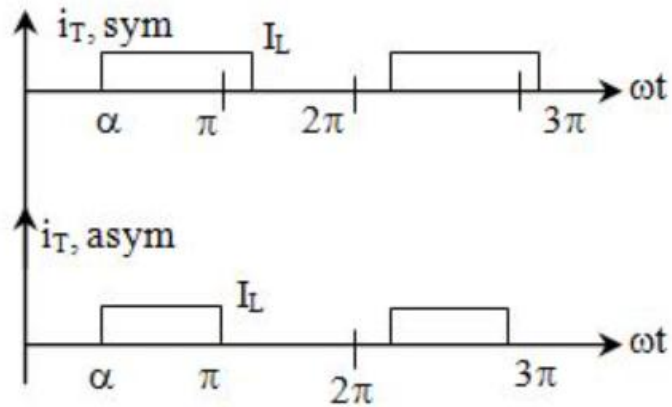
A) 5 A and 5 A

B) 5 A and 3.75 A

C) 3.75 A and 5 A

D) 3.75 A and 3.75 A

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



$$I_{T,\,sym} = \frac{I_L}{2} = 5\ A$$

$$I_{T,\,asym} = \frac{I_L(\pi - \alpha)}{2\pi} = 3.75\ A$$

8. A 3-phase fully controlled bridge converter is fed from a 3-phase 400 V, 50 Hz mains. For a firing angle of 60°, output current is level at 25 A, and output voltage is 250 V, for this converter the angle of overlap in degrees is _____. (Give answer up to one decimal place)

A) 4.8

B) 5.6

C) 8.7

D) 7.6

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

For 3-ϕ full converter with source inductance,

$$\cos(\alpha+\mu) = \cos\alpha - \frac{2\omega L_S}{V_{m\ell}} I_0$$

$\therefore L_S$ = Source inductance

To get L_S:

$$V_0 = \frac{3V_{ml}}{\pi}\cos\alpha - \frac{3\omega L_s}{\pi} I_0$$

$$\frac{3\omega L_S}{\pi} I_0 = \frac{3V_{m\ell}}{\pi}\cos\alpha - V_0$$

$\therefore L_S = 2.68$ mH

$$\cos(60°+\mu) = \cos 60° - \frac{2\times 314\times 2.68\times 10^{-3}}{400\times\sqrt{2}}\times 25$$

$$\cos(60° + \mu) = 0.4256$$

$$\mu = 4.81°$$

9. A 3-phase M-3 converter is operated from a 3-phase, 230 V, 50 Hz supply with load R = 10 Ω. The value of firing angle of average output voltage is 50% of maximum possible output voltage, is_____.

A) 92.7°

B) 67.7°

C) 63.7°

D) 75.7°

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

$$V_{0,\,max} = \frac{3V_{mL}}{2\pi} = \frac{3\times 230\sqrt{2}}{2\pi} = 155.3\ V$$

$$V_0 = 0.5V_{01,\,max} \Rightarrow \alpha = 60° > 30° \text{ (Not valid)}$$

$$V_0 = \frac{3V_{mph}}{2\pi}\left[\cos\left(\frac{\pi}{6}+\alpha\right)+1\right] = 77.65$$

$$\alpha = 67.7°$$

10. Which one of the following statements regarding IGBT is NOT true?

A) IGBT is developed by combining the characteristics of MOSFET and BJT

B) On state losses of an IGBT are lesser than a MOSFET

C) IGBT is slower than BJT

D) IGBT contains a parasitic thyristor

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

IGBT is a faster device than BJT.

The decreasing order of speed of operation of devices is PMOSFET, IGBT, PBJT, SCR.

11. A 3-phase half-wave bridge rectifier, with source 230 V, 50 Hz feeds a load R = 10 Ω. If firing angle $\alpha = 15°$, the power delivered to load is _____ kW.[give upto one decimal place]

Correct Answer: **2.39** Answer Range: **(2.2 , 2.45)** *Not Attempted :* Marks : 2 / 0 (-Ve)

$$V_{0(rms)} = \left[\frac{1}{\frac{2\pi}{3}}\int_{20+\alpha}^{150+\alpha}\left(V_{mph}\sin\omega t\, d(\omega t)\right)^2\right]^{\frac{1}{2}}$$

$$= \left[\frac{3V_{mph}^2}{2\pi}\int_{30+\alpha}^{150+\alpha}\left(\frac{1-\cos 2\omega t}{2}\right)d\omega t\right]^{\frac{1}{2}}$$

$$= \left[\frac{3V_{mph}^2}{4\pi}\left(\frac{2\pi}{3}-\frac{1}{2}\left(\sin(300+2\alpha)-\sin(60+2\alpha)\right)\right)\right]^{\frac{1}{2}}$$

$$= V_{mph}\left[\frac{3}{4\pi}\left\{\frac{2\pi}{3}+\frac{\sqrt{3}}{2}\cos 2\alpha\right\}\right]^{\frac{1}{2}}$$

Given $\alpha = 15°$ degrees

$V_{0(rms)} = 15.475$ V

$$P = \frac{V_{0(rms)}^2}{R} = 2.39 \text{ kW}$$

12. A three phase fully controlled bridge converter operating from a 3 phase 220 V, 50 Hz supply is used to charge a battery bank with nominal voltage of 240 V. The battery bank has an internal resistance of 0.01 Ω and the battery bank voltage varies by ± 10% around its nominal value between fully charged and uncharged condition. By assuming the continuous conduction, find out the range of firing angle when the battery bank is charged with a constant average current of 100 A through a lossless inductor of 250 mH.

A) $\alpha_{min} = 26.88°$ and $\alpha_{max} = 43.08°$

B) $\alpha_{min} = 43.08°$ and $\alpha_{max} = 26.88°$

C) $\alpha_{min} = 38.38°$ and $\alpha_{max} = 62.56°$

D) Cannot be calculated

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

The maximum and minimum battery voltages are

$E_{max} = 1.1 \times 240 = 264\,V$ and $E_{min} = 0.9 \times 240 = 216\,V$

Now, output voltage can be determined as

$$V_{o,max} = E_{max} + RI_o = 264 + 0.01 \times 100 = 265\,V$$

$$V_{o,min} = E_{min} + RI_o = 216 + 0.01 \times 100 = 217\,V$$

But, the output voltage of three phase fully controlled converter,

$$V_o = \frac{3V_{ml}}{\pi}\cos\alpha$$

$$V_{o,max} = \frac{3V_{ml}}{\pi}\cos\alpha_{min} \Rightarrow \frac{3 \times 220\sqrt{2}}{\pi}\cos\alpha_{min} = 265 \text{ or } \alpha_{min} = 26.88°$$

$$V_{o,min} = \frac{3V_{ml}}{\pi}\cos\alpha_{max} \Rightarrow \frac{3 \times 220\sqrt{2}}{\pi}\cos\alpha_{max} = 217 \text{ or } \alpha_{max} = 43.08°$$

13. A single phase full converter feeds power to RLE load with R = 5 Ω, L = 6 mH and E = 120 V the source voltage is 230 V, 50 Hz. For continuous conduction, the firing angle is 120^0.Then the average current (in A) on the assumption of continuous conduction is _____

(Give answer up to one decimal place)

Correct Answer: **3.29** Answer Range: **(3.2 , 3.3)** *Not Attempted :* Marks : 2 / 0 (-Ve)

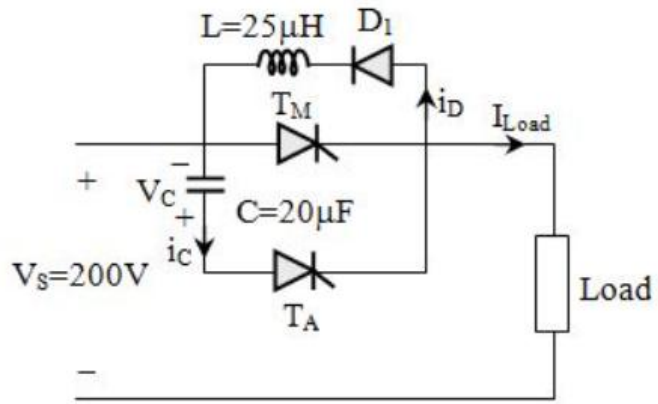
$$V_0 = \frac{2V_m}{\pi}\cos\alpha = \frac{2\times 230\sqrt{2}}{\left(\frac{22}{7}\right)}\times\left(-\frac{1}{2}\right) = -103.536\text{V}$$

The full converter is operating as line commutated inverter because $\alpha > 90°$

$$V_0 = -E + I_0R$$

$$I_0 = \frac{V_0 + E}{R} = \frac{-103.536+120}{5} = 3.29\text{A}$$

14. For the commutation circuit, the supply voltage is $V_S = 200$ V. If load current varies from 100 A to 200 A, the circuit turn-off time varies from t_{q1} to t_{q2}. The value of $t_{q1} + t_{q2}$ = _____ μs



Correct Answer: **40** Answer Range: **(40 , 41)** *Not Attempted :* Marks : 2 / 0 (-Ve)

$$V_C(t = 0) = -V_S = -200\ V$$

$$i_C(t = 0) = I_L$$

$$i_C = i_D + i_L$$

$$\nu_C = \nu_C(t = 0) + \frac{1}{C}\int i_c dt$$

$$i_C(t) = V_S\sqrt{\frac{C}{L}}\sin\left(\frac{t}{\sqrt{LC}}\right) + I_L\cos\left(\frac{t}{\sqrt{LC}}\right)$$

$$V_C(t) = I_L\sqrt{\frac{C}{L}}\sin\left(\frac{t}{\sqrt{LC}}\right) - V_S\cos\left(\frac{t}{\sqrt{LC}}\right)$$

Turn-off time

$$t_q = \sqrt{LC}\tan^{-1}\left(\frac{V_0}{I_L}\sqrt{\frac{C}{L}}\right)$$

For $I_L = 100\ A$

$t_{q1} = 23.7\ \mu s$

$I_L = 200\ A$

$t_{q2} = 16.3\ \mu s$

$t_{q1} + t_{q2} = 40\ \mu s$

15. Which of the following statements is/are correct regarding Thyristor?

A) It conducts when forward biased and positive current flows through the gate

B) It conducts when forward biased and negative current flows through the gate

C) It commutates when reverse biased and negative current flows through the gate

D) It commutate when the gate current is withdrawn

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

A thyristor conducts when its anode voltage is positive with respect to cathode voltage. It is forward biased by applying positive gate current and the conduction current is independent of gate current once it enters into the latching state.