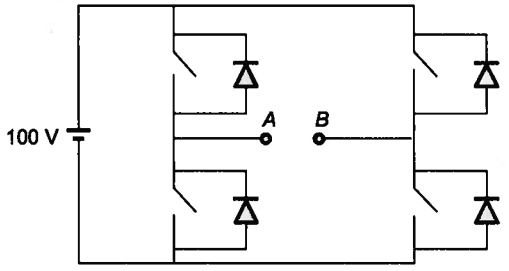
3 Inverters

Multiple Choice Questions

Q.1 A single phase full bridge VSI is operating in 180° square operation. The phase angle between the pole voltages is 45°. The RMS value of the output voltage between two poles is

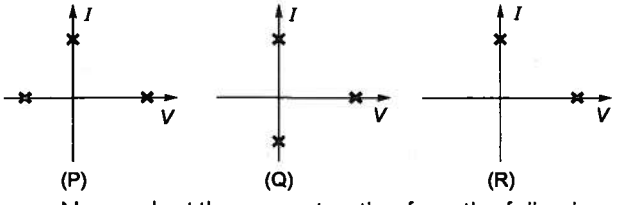


(a) 100 V (b) $100\frac{\pi}{4}$ V

(c) 200 V (d) 50 V

Q.2 The operating points of three power electronic switches on VI plane is shown below Consider the following statements regarding the switches *P*, *Q*, *R*.

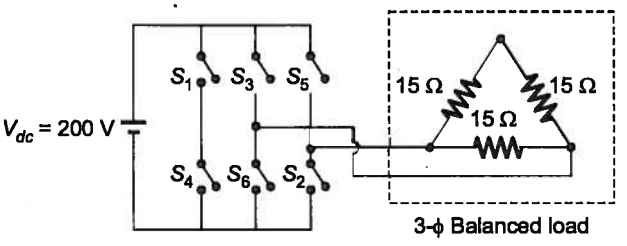
1. *P* is most suitable for VSI
2. *P* is most suitable for CSI
3. *Q* is the most suitable for VSI
4. *Q* is most suitable for CSI
5. *P*, *Q* and *R* can be used in either VSI or CSI



Now, select the correct option from the following.

(a) Only 2 and 3 are correct
(b) only 1 & 4 are correct
(c) 2, 3 and 5 are correct
(d) All are correct

Q.3 In the 3-ϕ inverter circuit shown, the load is balanced and gating scheme is 120° conduction mode. All the switches are ideal. If the dc source voltage is 200 V, the power consumed by 3-ϕ load is



(a) 5.33 kW (b) 3 kW

(c) 4 kW (d) 1.33 kW

Q.4 A single-phase voltages source inverter is controlled in a single pulse-width modulated mode with a pulse width of 150° in each half cycle. Total harmonic distortion is defined as

$$\text{THD} = \frac{\sqrt{V_{rms}^2 - V_1^2}}{V_1} \times 100$$

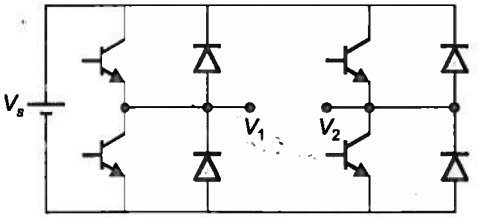
where V_1 is the rms value of the fundamental component of the output voltage. The THD of output ac voltage waveform is

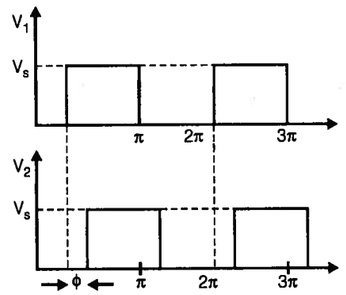
(a) 65.65% (b) 48.42%

(c) 31.83% (d) 30.49%

[GATE-2007]

Q.5





The rms value of the pole to pole voltage V_{12} —

(a) $\frac{V_s.\phi}{\pi\sqrt{2}}$ (b) $V_s\sqrt{\frac{\phi}{\pi}}$

(c) $V_s\sqrt{\frac{\phi}{2\pi}}$ (d) $\frac{V_s}{\pi}$

[GATE-2002]

Q.6 A 3 phase VSI, supplies a purely inductive 3-ϕ 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

(a) Zero

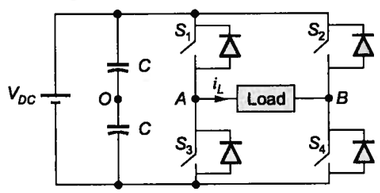
(b) α_n times the fundamental frequency component

(c) $n\alpha_n$ times the fundamental frequency component

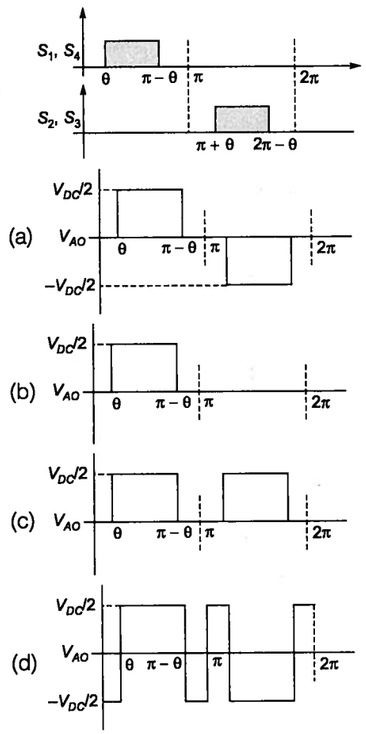
(d) $\frac{\alpha_n}{n}$ times the fundamental frequency component

[GATE-2000]

Q.7 A single-phase voltage source inverter shown in figure is feeding power to a load. The triggering pulses of the devices are also shown in the figure.

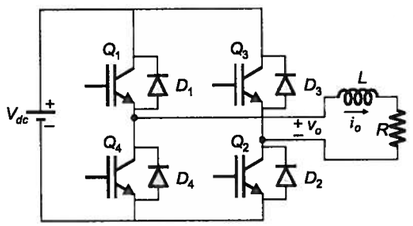


If the load current is sinusoidal and is zero at 0, π, 2π..., the node voltage V_{AO} has the waveform.



[GATE-2014]

Q.8 The Voltage Source Inverter (VSI) shown in the figure below is switched to provide a 50 Hz, square-wave ac output voltage (v_o) across an *R-L* load. Reference polarity of v_o and reference direction of the output current i_o are indicated in the figure. It is given that $R = 3\ \Omega$, $L = 9.55$ mH.



In the interval when $v_o < 0$ and $i_o > 0$ the pair of devices which conducts the load current is

(a) Q_1, Q_2 (b) Q_3, Q_4

(c) D_1, D_2 (d) D_3, D_4

[GATE-2013]

Q.9 The output voltage of a 3-phase voltage source inverter contains 5th and 7th harmonics. Assume the output is balanced.

If $V_a = V_{1m}\sin(\omega t) + V_{5m}\sin(5\omega t) + V_{7m}\sin(7\omega t)$ Volt, then V_b can be expressed as

(a) $V_b = V_{1m}\sin\left(\omega t - \frac{2\pi}{3}\right) + V_{5m}\sin(5\omega t) + V_{7m}\sin(7\omega t)$ Volt

(b) $V_b = V_{1m}\sin\left(\omega t - \frac{2\pi}{3}\right) + V_{5m}\sin\left(5\omega t + \frac{2\pi}{3}\right) + V_{7m}\sin\left(7\omega t - \frac{2\pi}{3}\right)$ Volt

(c) $V_b = V_{1m}\sin\left(\omega t - \frac{2\pi}{3}\right) + V_{5m}\sin\left(5\omega t - \frac{2\pi}{3}\right) + V_{7m}\sin\left(7\omega t + \frac{2\pi}{3}\right)$ Volt

(d) None of the above

Q.10 A voltage source inverter will have better performance if its

(a) load inductance is small and source inductance is large

(b) both load and source inductances are small

(c) both load and source inductances are large

(d) load inductance is large and source inductance is small

Q.11 Use of reverse conducting thyristor in place of antiparallel combination of thyristor and feedback diode in an inverter

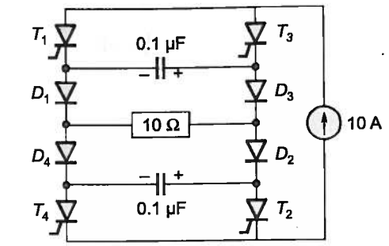
(a) effectively minimizes the peak commutating current

(b) decreases the operating frequency of operation

(c) minimizes the effects of load inductances on the commutation performance

(d) causes deterioration in the commutation performance

Q.12 The current source Inverter shown in figure is operated by alternately turning on thyristor pairs (T_1, T_2) and (T_3, T_4). If the load is purely resistive, the theoretical maximum output frequency obtainable will be

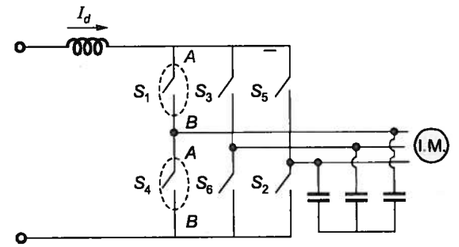


(a) 125 kHz (b) 250 kHz

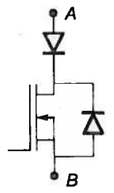
(c) 500 kHz (d) 50 kHz

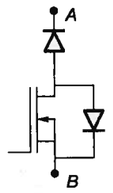
[GATE-2009]

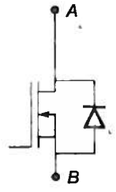
Q.13 A three-phase current source inverter used for the speed control of an induction motor is to be realized using MOSFET switches as shown below. Switches S_1 to S_6 are identical switches.

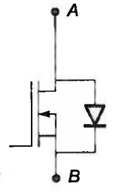


The proper configuration for realizing switches S_1 to S_6 is

(a) 

(b) 

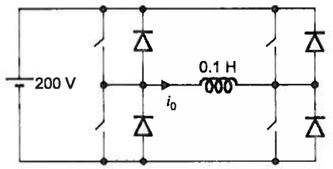
(c) 

(d) 

[GATE-2011]

Numerical Data Type Questions

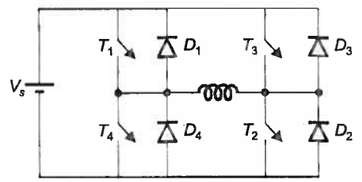
Q.14 A single phase voltage source inverter is feeding a purely inductive load as shown in the figure



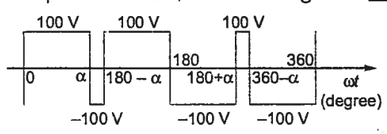
The inverter is operated at 50 Hz in 180° square wave mode. Assume that the load current does not have any dc component. The peak value of the inductor current i_0 will be _____ A.

[GATE-2008]

Q.15 A single-phase full bridge VSI feeds a purely inductive load as shown in the figure. The inverter is operated in square wave mode with a frequency of 50 Hz. If the average load curent is 0, the time duration of conduction of each feedback diode in a cycle is _____ ms.

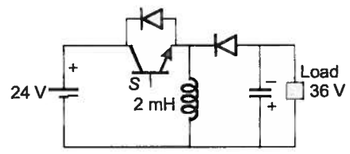


Q.16 The figure shows one period of the output voltage of an inverter. α should be chosen such that $60° < \alpha < 90°$. If rms value of the fundamental component is 50 V, then α in degree is _____.



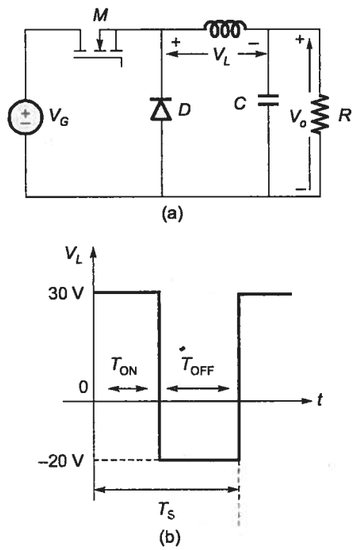
[GATE-2014]

Q.17 A buck-boost DC-DC converter, shown in the figure below, is used to convert 24 V battery voltage to 36 V DC voltage to feed a load of 72 W. It is operated at 20 kHz with an inductor of 2 mH and output capacitor of 1000 µF. All devices are considered to be ideal. The peak voltage across the solid-state switch (S), in volt, is _____.



[GATE-2016]

Q.18 A buck converter, as shown in Figure (a) below, is working in steady state. The output voltage and the inductor current can be assumed to be ripple free. Figure (b) shows the inductor voltage V_L during a complete switching interval. Assuming all devices are ideal, the duty cycle of the buck converter is _____.



[GATE-2016]

Conventional Questions

Q.19 A single-phase full bridge inverter delivers power to RLC load with $R = 3\ \Omega$ and $X_L = 12\ \Omega$. The bridge operates with a periodicity of 0.2 ms. Calculate the value of C so that load commutation is achieved for the thyristors. Turnoff time for thyristors is 12 µs. Factor of safety is 2. Assume the load current to contain only fundamental component.

Q.20 A star connected load of 15 Ω per phase is fed from 420 V d.c. source through a 3-phase bridge inverter. For both (a) 180° and (b) 120°.

Determine:

(*i*) rms value of load current

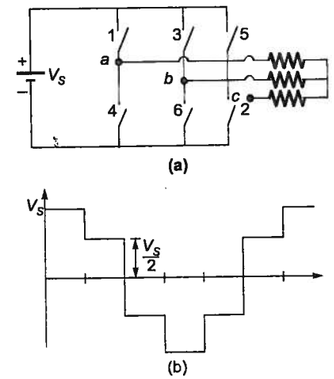
(*ii*) rms value of thyristor current

(*iii*) load power

Also find above parameters for Δ connected load $R = 15\ \Omega$.

Try Yourself

T1. Figure (a) shows a 3-ϕ inverter fed by a constant voltage source V_s and connected to a balanced resistive load at the output. Each switching device may conduct for 120° or for 180°. The waveform shown in figure (b) is,



(a) line voltage with 120° firing

(b) load phase voltage with 120° firing

(c) line voltage with 180° firing

(d) load phase voltage with 180° firing

[Ans: (a)]

T2. A single phase full bridge inverter is fed from a dc source such that fundamental component of output voltage is 230 V. The rms value of thyristor current if the load is $R = 2\ \Omega$, $X_L = 8\ \Omega$ and $X_C = 6\ \Omega$ is _____ A.

[Ans: (54.82)]

T3. A single-phase full bridge inverter has RLC load of $R = 4\ \Omega$, $L = 35$ mH and $C = 155$ µF. The dc input voltage is 230 V and output frequency is 50 Hz. The 3rd harmonic component in load current is

(a) 1.6 A (b) 2.24 A

(c) 1.98 A (d) 2.61 A

[Ans: (d)]

T4. For a single-phase full-bridge inverter, $V_s = 230$ V dc, $T = 1$ ms. The load consists of RLC in series with $R = 1\ \Omega$, $\omega L = 6\ \Omega$ and $\frac{1}{\omega C} = 7\ \Omega$.

(a) Sketch the waveforms for load voltage V_0, fundamental component of load current i_{01}, source, current i_s and voltage across thyristor 1. Indicate the devices under conduction during different intervals of one cycle.

(b) Find the power delivered to load due to fundamental component.

(c) Check whether forced commutation is required or not. Take thyristor turn-off time as 100 µs.

[Ans: (b) 21.443 kW]

T5. A single-phase full bridge inverter, employing transistors, is fed from 220 V DC and output frequency is 50 Hz. Load is RLC with $R = 6\ \Omega$, $L = 30$ mH and $C = 180$ µF.

(a) Calculate THD of the output voltage and its distortion factor.

(b) Obtain an expression for load current in Fourier series. also compute

(c) THD of the load current and its distortion factor

(d) Load power and average DC source current.

Considering only the fundamental component of load current, calculate :

(e) conduction time of each transistor and diode and

(f) peak and rms current of each transistor.

[Ans: (a) 48.34%, 0.9, (c) 15.55%, 0.988, (d) 2314.4 W, 10.52 A, (e) 7 ms, 3 ms, (f) 27.44 A, 12.66 A]