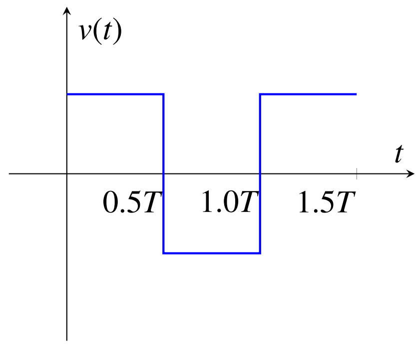
Gate-2022-EE-58

EE22BTECH11008 - Annapureddy Siva Meenakshi*

Q: Consider an ideal full-bridge single-phase DC-AC inverter with a DC bus voltage magnitude of $1000V$. The inverter output voltage $v(t)$ shown below is obtained when diagonal switches of the inverter are switched with 50% duty cycle. The inverter feeds a load with a sinusoidal current given by $i(t) = 10\sin(\omega t - \frac{\pi}{3})$ A, where $\omega = \frac{2\pi}{T}$. The active power, in watts, delivered to the load is __.[Gate2022-EE-58]



Solution:

Variable	Description	Value
V_s	input DC voltage	$1000V$
$i(t)$	output current	$\sin(\omega t - \frac{\pi}{3})$
$v(t)$	Output voltage	given
ω	Frequency	$\frac{2\pi}{T}$
v_0^{rms}	RMS output voltage at the fundamental frequency	none
i_{rms}	RMS output current at the fundamental frequency	none
$v_0(t)$	output voltage at the fundamental frequency	none
ϕ	phase difference between $v_0(t)$ and $i(t)$	none
i_0	amplitude of output current	1
P	active power delivered	none

TABLE 0: Input parameters

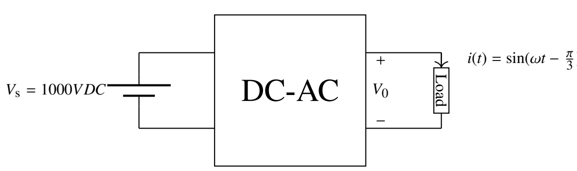


Fig. 0: circuit diagram of the system

The Fourier series expansion of the given voltage $v(t)$ is,

$$
\begin{aligned}
v(t) &= \sum_{n=1,3,5,\ldots}^{\infty} \frac{4V_{\text{dc}}}{n\pi}\sin(n\omega t) && (1)\\
v_0(t) &= \frac{4V_{\text{dc}}}{\pi}\sin(\omega t) && (2)\\
\therefore \quad \phi &= \frac{\pi}{3} && (3)\\
v_0^{\text{rms}} &= \frac{4V_{\text{dc}}}{\pi\sqrt{2}} && (4)\\
&= \frac{4000}{\pi\sqrt{2}} && (5)\\
i_{\text{rms}} &= \frac{i_0}{\sqrt{2}} = \frac{1}{\sqrt{2}} && (6)
\end{aligned}
$$

Active power delivered to load in Watts is given by,

$$
\begin{aligned}
P &= v_0^{\text{rms}} \times i_{\text{rms}} \times \cos\phi && (7)\\
&= \frac{4000}{\pi\sqrt{2}} \times \frac{1}{\sqrt{2}} \times \cos\frac{\pi}{3} && (8)\\
&\approx 3183 && (9)
\end{aligned}
$$

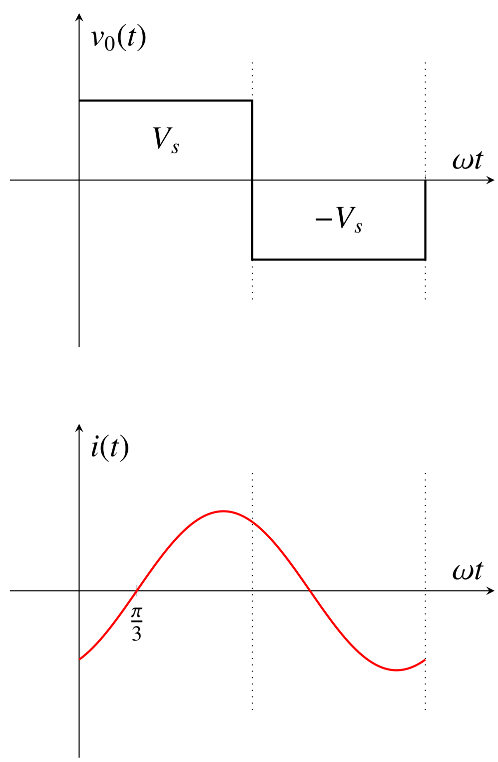


Fig. 0: output voltage and current of the system