In an a.c. circuit, the instantaneous e.m.f. and current are given by

$e = 100 \sin 30t$

$i = 20 \sin\left(30t - \frac{\pi}{4}\right)$

In one cycle of a.c., the average power consumed by the circuit and the wattless current are, respectively:

(1) 50, 10

(2) $\frac{1000}{\sqrt{2}}, 10$

(3) $\frac{50}{\sqrt{2}}, 0$

(4) 50, 0

Based on JEE Main 2018 - 123IITJEE

$P_{AV} = V_{rms} I_{rms} \cos\phi$

$\therefore P_{AV} = \frac{20}{\sqrt{2}} \times \frac{100}{\sqrt{2}} \cos\left(-\frac{\pi}{4}\right) = \frac{1000}{\sqrt{2}}$

Hence, the only option possible is option (2). Further verification can be done as follows:

Let, $e = e_0 \sin(\omega t)$ and $i = i_0 \sin(\omega t + \phi)$

$i = i_0 (\sin\omega t \cos\phi + \cos\omega t \sin\phi)$

Or, $i = (i_0 \cos\phi) \sin\omega t + (i_0 \sin\phi) \cos\omega t$

When product of e and i is integrated over a cycle to find the average power, the $i_0 \sin\phi$ part of the current gives zero result as the integral of $\sin\omega t . \cos\omega t$ over a cycle is zero. The rms current corresponding to $i_0 \sin\phi$ is the wattless current.

So, wattless current =

$\left|I_{rms} \sin\phi\right| = \left|\frac{20}{\sqrt{2}} \sin\left(-\frac{\pi}{4}\right)\right| = 10$

Ans: Option (2).