GATE - EC 27

EE23BTECH11215 - Penmetsa Srikar Varma

Question

Q27) Let m(t) be a strictly band-limited signal with bandwidth B and energy E. Assuming $\omega_0 = 10B$, the energy in the signal $m(t)\cos(\omega_0 t)$

(A) $\frac{E}{4}$

(B) $\frac{E}{2}$

(C) E

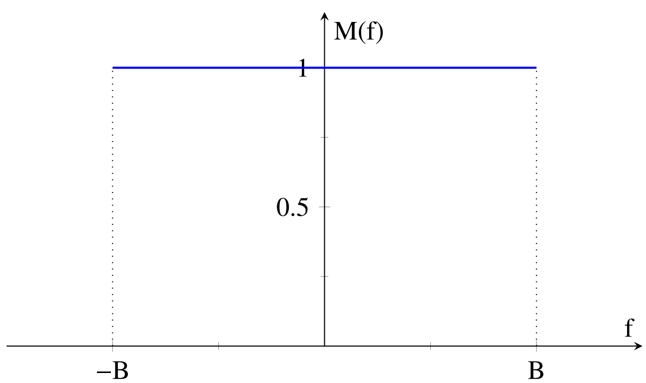
(D) 2E (GATE EC 2023)

Solution

Variables	Conditions
M(f)	Fourier transform of m(t)
y(t)	$y(t)=m(t)\cos(2\pi f_0 t)$
Y(f)	Fourier transform of y(t)

Table of Parameters

Let us assume for a case of M(f),



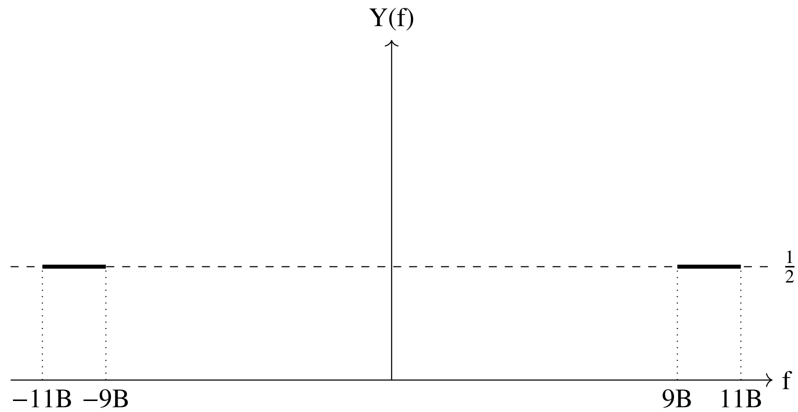
Energy (E) of the signal M(f) is given by,

$$E = \frac{1}{2\pi}\int_{-B}^{B} |M(f)|^2 \, df = \frac{B}{\pi} \tag{1}$$

Fourier transform of y(t) is given by,

$$Y(f) = M(f) * \frac{1}{2}\left(\delta(f+f_0) + \delta(f-f_0)\right) \tag{2}$$

$$Y(f) = \frac{1}{2}\left(M(f+f_0) + M(f-f_0)\right) \tag{3}$$



Energy (E_1) of the signal Y(f) is given by,

$$E_1 = \frac{1}{2\pi}\left(\int_{-11B}^{-9B} \frac{1}{4}\, df + \int_{9B}^{11B} \frac{1}{4}\, df\right) = \frac{B}{2\pi} \tag{4}$$

So, from (1) and (4),

$$E_1 = \frac{E}{2} \tag{5}$$

Hence, option B is correct