Imperial College London

DE2.3 Electronics 2 for Design Engineers

Tutorial 5

Selected Questions from Problem sheets 1 & 2 (continued)

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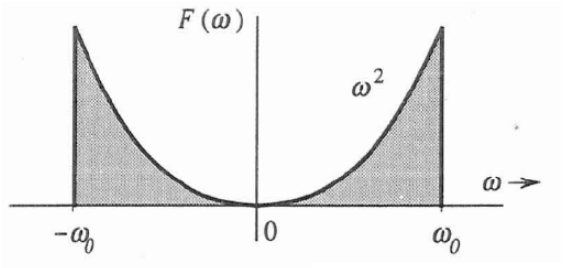
Sheet 2 Q2 a)

2.* Derive the inverse Fourier transform of the spectra shown in Fig. Q2 (a)



a) $f(t) = \frac{1}{2\pi}\int_{-\omega_0}^{\omega_0} \omega^2 e^{j\omega t}\, d\omega$

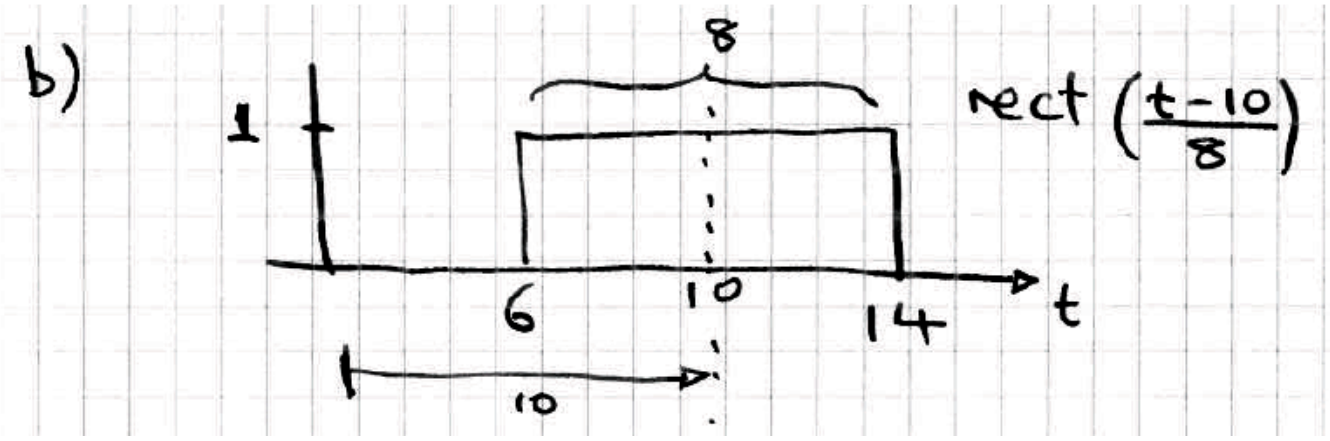
Don't forget we integrate wrt ω, NOT t.

$$= \frac{1}{2\pi}\,\frac{e^{j\omega t}}{(jt)^3}\left[-\omega^2 t^2 - 2j\omega t + 2\right]\Big|_{-\omega_0}^{\omega_0}$$

$$= \frac{(\omega_0^2 t^2 - 2)\sin\omega_0 t + 2\omega_0 t\cos\omega_0 t}{\pi t^3}$$

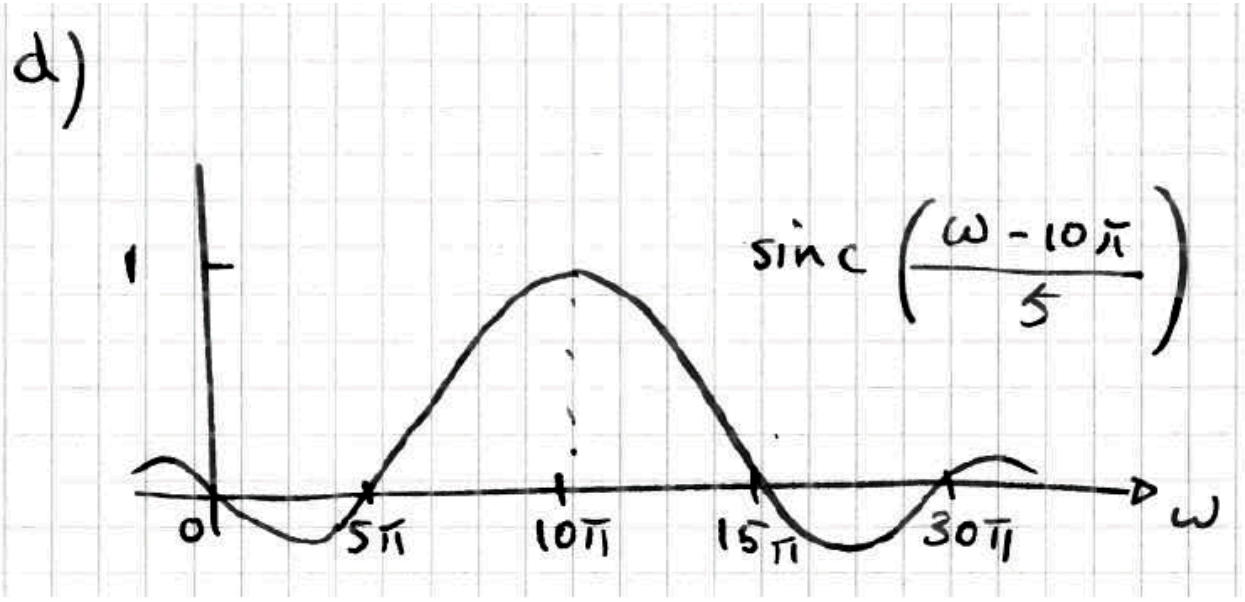
Sheet 2 Q3 b)

3.* Sketch the following functions: b) $rect(\frac{t-10}{8})$



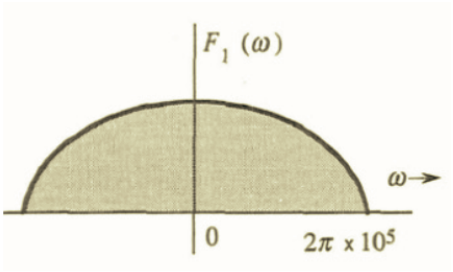
Sheet 2 Q3 d)

3.* Sketch the following functions: d) $\text{sinc}(\frac{\omega-10\pi}{5})$.

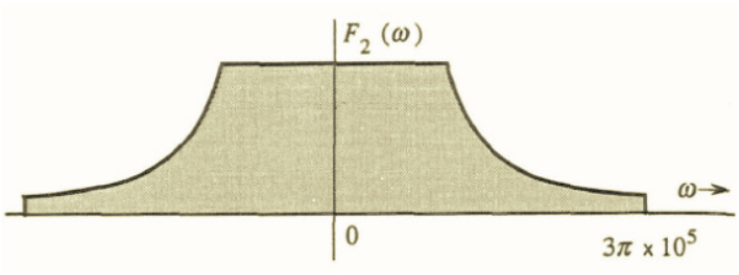


Sheet 2 Q4

4.** Fig. Q4 (a) and (b) shows Fourier spectra of signals $f_1(t)$ and $f_2(t)$. Determine the Nyquist sampling rates in each case.



(a)



(b)

a) Bandwidth of $f_1(t)$ is 100kHz.
Nyquist Sampling frequency ≥ 200kHz.

b) Bandwidth of $f_2(t)$ is 150kHz.
Nyquist Sampling frequency ≥ 300kHz.

Sheet 2 Q5

5.*** For a signal *f(t)* that is time-limited to 10 ms and has an essential bandwidth of 10 kHz, determine N_0, the number of signal samples necessary to compute its DFT with a frequency resolution f_0 of 50 Hz.

Given that bandwidth of f(t) is 10kHz,
Sampling frequency $F_s \geq 2 \times 10kHz$
$\geq 20,000$.

If we have frequency resolution of $f_0 = 50Hz$,
the time window T_w required to provide
the DFT is $T_w = \frac{1}{50Hz} = 20ms$.

$\therefore N_0 \geq \frac{1/F_s}{T_w} \geq 400$.

Since N_0 must be a power of 2,
choose $N_0 = 512$. //

Now if we have 512 samples at $T_s = 50\mu s$
we need a signal of duration
$512 \times 50\mu s = 25.6ms$.

Since we only have a signal duration
of 10ms, we need to zero padding
over 15.6 ms //