

National University of Singapore
Department of Electrical & Computer Engineering

EE2023 Signals and Systems Assignment 2

1. Show that the signal $x(t) = 3 \cos(15t + \pi/6) + \sin(20t)$ is periodic. Find its fundamental frequency. *Ans : 5 rad/s*

2. Find and sketch the Fourier transform of the following time domain signals :

(i) $x(t) = Ae^{-\beta t} \cos(\omega_0 t) u(t) \quad \text{Re}(\beta) > 0$

Ans : $X(f) = \frac{A}{2} \left[\frac{1}{\beta + j2\pi(f + f_0)} + \frac{1}{\beta + j2\pi(f - f_0)} \right]$

(ii) $x(t) = A \sin(\omega_1 t) + B \cos(\omega_2 t)$

Ans : $X(f) = \frac{A}{2j} \left[\delta \left(f - \frac{\omega_1}{2\pi} \right) - \delta \left(f + \frac{\omega_1}{2\pi} \right) \right] + \frac{B}{2} \left[\delta \left(f - \frac{\omega_2}{2\pi} \right) + \delta \left(f + \frac{\omega_2}{2\pi} \right) \right]$

(iii) $x(t) = 6 \text{ sinc } (0.5t)$

Ans : $X(f) = 12 \text{ rect}(2f)$

(iv) $x(t) = 6 \text{ rect} \left(\frac{t-4}{3} \right)$

Ans : $X(f) = 18 \text{ sinc}(3f) e^{-j8\pi f}$

3. Given $e^{-|t|} \leftrightarrow \frac{1}{\pi(f^2 + 1)}$, find the Fourier transform of the following :

(i) $x(t) = \frac{d}{dt} e^{-|t|}$

Ans : $X(f) = \frac{j2f}{(f^2 + 1)}$

(ii) $x(t) = \frac{1}{2\pi(t^2 + 1)}$

Ans : $X(f) = \frac{1}{2\pi(t^2 + 1)}$

(iii) $x(t) = \frac{4 \cos(2t)}{t^2 + 1}$

Ans : $X(f) = 2\pi [e^{-|f-1/\pi|} + e^{-|f+1/\pi|}]$

4. Show that systems which transmit pulses at very high frequencies have larger bandwidth.