Solution to ECE Test #4 S09

Find the numerical Nyquist rate for each of the following signals.
(If a signal is not bandlimited write "Infinity" or "∞".)

(a) $x(t) = 5\cos(200\pi t) - 8\sin(300\pi t)$

$X(f) = (5/2)\left[\delta(f-100) + \delta(f+100)\right] - j4\left[\delta(f+150) - \delta(f-150)\right]$

$f_{NYQ} = 2 \times 150\text{Hz} = 300\text{Hz}$

(b) $x(t) = 20\cos(2000\pi t)\cos(20000\pi t)$

$X(f) = 10\left[\delta(f-1000) + \delta(f+1000)\right] * (1/2)\left[\delta(f-10000) + \delta(f+10000)\right]$

$X(f) = 5\left[\delta(f-11000) + \delta(f+9000) + \delta(f-9000) + \delta(f+11000)\right]$

$f_{NYQ} = 2 \times 11000\text{Hz} = 22000\text{Hz}$

(c) $x(t) = \text{sinc}(200t)\sin(5000\pi t)$

$X(f) = (1/200)\,\text{rect}(f/200) * (j/2)\left[\delta(f+2500) - \delta(f-2500)\right]$

$X(f) = (j/400)\left[\text{rect}\left(\frac{f+2500}{200}\right) - \text{rect}\left(\frac{f-2500}{200}\right)\right]$

$f_{NYQ} = 2 \times 2600\text{Hz} = 5200\text{Hz}$

(d) $x(t) = \text{tri}(200t)\sin(5000\pi t)$

Time limited. Therefore not bandlimited.

(e) $x(t) = \text{sinc}(210t) * \delta_{0.1}(t)$

$X(f) = (1/210)\,\text{rect}(f/210) \times 10\delta_{10}(f)$

$f_{NYQ} = 2 \times 100\text{Hz} = 200\text{Hz}$

Solution to ECE Test #4 S09

Find the numerical Nyquist rate for each of the following signals.
(If a signal is not bandlimited write "Infinity" or "∞".)

(a) $x(t) = 5\cos(500\pi t) - 8\sin(300\pi t)$

$X(f) = (5/2)\left[\delta(f-250) + \delta(f+250)\right] - j4\left[\delta(f+150) - \delta(f-150)\right]$

$f_{NYQ} = 2 \times 250\text{Hz} = 500\text{Hz}$

(b) $x(t) = 20\cos(8000\pi t)\cos(30000\pi t)$

$X(f) = 10\left[\delta(f-4000) + \delta(f+4000)\right] * (1/2)\left[\delta(f-15000) + \delta(f+15000)\right]$

$X(f) = 5\left[\delta(f-19000) + \delta(f+11000) + \delta(f-11000) + \delta(f+19000)\right]$

$f_{NYQ} = 2 \times 19000\text{Hz} = 38000\text{Hz}$

(c) $x(t) = \text{sinc}(250t)\sin(4000\pi t)$

$X(f) = (1/250)\,\text{rect}(f/250) * (j/2)\left[\delta(f+2000) - \delta(f-2000)\right]$

$$X(f) = (j/400)\left[\text{rect}\left(\frac{f+2000}{250}\right) - \text{rect}\left(\frac{f-2000}{250}\right)\right]$$

$f_{NYQ} = 2 \times 2125\text{Hz} = 4250\text{Hz}$

(d) $x(t) = \text{tri}(200t)\sin(5000\pi t)$

Time limited. Therefore not bandlimited.

(e) $x(t) = \text{sinc}(230t) * \delta_{0.1}(t)$

$X(f) = (1/230)\,\text{rect}(f/230) \times 10\delta_{10}(f)$

$f_{NYQ} = 2 \times 110\text{Hz} = 220\text{Hz}$

Solution to ECE Test #4 S09

Find the numerical Nyquist rate for each of the following signals.
(If a signal is not bandlimited write "Infinity" or "∞".)

(a) $x(t) = 5\cos(1500\pi t) - 8\sin(800\pi t)$

$X(f) = (5/2)\left[\delta(f-750) + \delta(f+750)\right] - j4\left[\delta(f+400) - \delta(f-400)\right]$

$f_{NYQ} = 2 \times 750\text{Hz} = 1500\text{Hz}$

(b) $x(t) = 20\cos(80\pi t)\cos(5000\pi t)$

$X(f) = 10\left[\delta(f-40) + \delta(f+40)\right] * (1/2)\left[\delta(f-2500) + \delta(f+2500)\right]$

$X(f) = 5\left[\delta(f-2540) + \delta(f+2460) + \delta(f-2460) + \delta(f+2540)\right]$

$f_{NYQ} = 2 \times 2540\text{Hz} = 5080\text{Hz}$

(c) $x(t) = \text{sinc}(36t)\sin(300\pi t)$

$X(f) = (1/36)\,\text{rect}(f/36) * (j/2)\left[\delta(f+150) - \delta(f-150)\right]$

$$X(f) = (j/400)\left[\text{rect}\left(\frac{f+150}{36}\right) - \text{rect}\left(\frac{f-150}{36}\right)\right]$$

$f_{NYQ} = 2 \times 168\text{Hz} = 336\text{Hz}$

(d) $x(t) = \text{tri}(200t)\sin(5000\pi t)$

Time limited. Therefore not bandlimited.

(e) $x(t) = \text{sinc}(290t) * \delta_{0.1}(t)$

$X(f) = (1/290)\,\text{rect}(f/290) \times 10\delta_{10}(f)$

$f_{NYQ} = 2 \times 140\text{Hz} = 280\text{Hz}$