

Signals and Systems ECE 202

Assignment 14

Document and submit your analytic results. Also generate and publish a MATLAB document, where appropriate, for the following exercises. Submit your MATLAB html folder and original MATLAB code (m files).

1. Sketch the pole-zero plot and region of convergence (if it exists) for these signals

(a) $x(t) = e^{-8t}u(t)$

(b) $x(t) = e^{3t} \cos(20\pi t)u(-t)$

(c) $x(t) = e^{2t}u(-t) - e^{-5t}u(t)$

(d) $x(t) = e^{-t}u(-t) - e^{-4t}u(t)$

(e) $x(t) = e^{-2t}u(-t) - e^t u(t)$

2. Using the integral definition

$$\mathcal{L}[g(t)] = \int_{0^-}^{\infty} g(t)e^{-st} dt$$

find the unilateral Laplace transform (and region of convergence) of the following functions

(a) $x(t) = e^t u(t)$

(b) $x(t) = e^{2t} \cos(200\pi t)u(t)$

(c) $x(t) = \text{ramp}(t)$

(d) $x(t) = te^t u(t)$

(e) $x(t) = \text{rect}(t)$

3. Using the time-shifting property, find the Laplace transform of these signals.

(a) $x(t) = u(t) - u(t - 1)$

(b) $x(t) = 3e^{-3(t-2)}u(t - 2)$

(c) $x(t) = 3e^{-3t}u(t - 2)$

(d) $x(t) = 5 \sin(\pi(t - 1))u(t - 1)$

4. Using the complex-frequency-shifting property, find and sketch the inverse Laplace transform of

$$X(s) = \frac{1}{(s + j4) + 3} + \frac{1}{(s - j4) + 3}$$

5. Using the time-scaling property, find the Laplace transforms of these signals.

(a) $x(t) = \delta(4t)$

(b) $x(t) = u(4t)$

6. Using the time-differentiation property, find the Laplace transforms for these signals.

(a) $x(t) = \frac{d}{dt}(u(t))$

(b) $x(t) = \frac{d}{dt}(e^{-10t}u(t))$

(c) $x(t) = \frac{d}{dt}(4 \sin(10\pi t)u(t))$

(d) $x(t) = \frac{d}{dt}(10 \cos(15\pi t)u(t))$

7. Using multiplication-convolution duality, find the Laplace transforms of these signals and sketch the signals versus time.

(a) $x(t) = e^{-t}u(t) * u(t)$

(b) $x(t) = e^t \sin(20\pi t)u(t) * u(t)$

(c) $x(t) = 8 \cos\left(\frac{\pi t}{2}\right) u(t) * [u(t) - u(t - 1)]$

(d) $x(t) = 8 \cos(2\pi t) u(t) * [u(t) - u(t - 1)]$

8. Using the initial and final value theorems, find the initial and final values (if possible) of the signals with the following Laplace transforms. Note the location of poles.

(a) $X(s) = \frac{10}{s+8}$

(b) $X(s) = \frac{s+3}{(s+3)^2+4}$

(c) $X(s) = \frac{s}{s^2+4}$

(d) $X(s) = \frac{10s}{s^2+10s+300}$

(e) $X(s) = \frac{8}{s(s+20)}$

(f) $X(s) = \frac{8}{s^2(s+20)}$

9. Find the bilateral Laplace transforms (and region of convergence) of these signals

(a) $x(t) = 3e^{-7t}u(t) - 12e^{4t}u(-t)$

(b) $x(t) = 50e^{-10|t|}$

10. Find the inverse Laplace transforms of these functions

(a) $X(s) = \frac{24}{s(s+8)}$

(b) $X(s) = \frac{20}{s^2+4s+3}$

(c) $X(s) = \frac{5}{s^2+6s+73}$

(d) $X(s) = \frac{10}{s(s^2+6s+73)}$

(e) $X(s) = \frac{4}{s^2(s^2+6s+73)}$

(f) $X(s) = \frac{2s}{s^2+2s+13}$

(g) $X(s) = \frac{s}{s+3}$

(h) $X(s) = \frac{s}{s^2+4s+4}$

(i) $X(s) = \frac{s^2}{s^2-4s+4}$

(j) $X(s) = \frac{10s}{s^4+4s^2+4}$