1. [10 pts.] If $x[n]$ has DTFT $X(\omega) = \frac{2e^{-j\omega}}{1 - \frac{1}{2}e^{-j\omega}}$, find $x[n]$ for all $n$. Show your work!

2. A causal LTI system has transfer function $H(s) = \frac{s^2 + 1}{(s + 1)(s^2 - s - 6)}$.
   
   (a) [10 pts.] Sketch the pole-zero plot and indicate the region of convergence (ROC).
   
   (b) [5 pts.] Is the system stable? Give a reason for your answer!

3. [10 pts.] Find $y(t)$ if it is a causal signal satisfying
   
   $$\ddot{y}(t) + 7\dot{y}(t) + 12y(t) = 0; \quad y(0) = 11, \quad \dot{y}(0) = -13.$$ 

4. [15 pts.] Let $x_1(t)$ and $x_2(t)$ be a pair of bandlimited continuous-time waveforms whose Fourier transforms are shown below.

   ![Fourier Transform Diagrams]

   In order to reconstruct $y(t) = x_1(t)x_2(t)$ from samples $y(nT)$, what is the largest possible value of $T$ according to the sampling theorem? Justify your answer!

5. [11 pts.] Consider the discrete-time LTI system defined by $y[n] = \sum_{k=0}^{\infty} \frac{x[n-k]}{\ln((2+k)^2)}$.
   
   Is this system stable? Justify your answer! Hint: $\ln \theta < \theta$ for $\theta > 0$.

6. [12 pts.] Let $x(t) = \int_{-1}^{1} \omega^2 \sin(\omega t) d\omega$. Evaluate $\int_{-\infty}^{\infty} |x(t)|^2 dt$. Show your work!

7. [12 pts.] The unit step $u(t)$ is applied to an LTI system, and the observed system output is $y(t) = \frac{1}{3}u(t) - \frac{1}{3}e^{-3t}u(t)$. Find the impulse response of the system, $h(t)$, for all $t$.
    
    Simplify your answer as much as possible!

8. [15 pts.] Consider the continuous-time LTI system defined by $y(t) = \int_{-\infty}^{\infty} \frac{\sin(t-\tau)}{t-\tau} x(\tau) d\tau$.
    
    Find $y(t)$ for all $t$ if $x(\tau) = \frac{\sin(\tau/2)}{\tau}$. 