1. P8.5-3 (note: \( y[k] - y[k-1] \). \( T_f[k] \) is also a valid approximation of an integrator)

2. P8.5-4a

3. P9.1-1 (solve by hand, first three terms \( y[0], y[1], y[2] \))

4. P9.1-2 (solve by hand, first three terms \( y[0], y[1], y[2] \))

5. For the difference equations given, determine their order and if they are linear, time-invariant, and causal. Note \( y[k] \) is the output and \( f[k] \) the input.
   a. \( y[k + 1] = y[k]f[k - 1] \)
   b. \( y[k + 2] - 5y[k + 1] + 7y[k] + 1 = 4f[k + 1] - 2f[k] \)
   c. \( y[k] + 2^k y[k - 1] + 3y[k - 3] = 1.5^{k-1} f[k + 1] + f[k] \)
   d. \( 3.3y[k + 1] + y[k] - 1.2y[k - 1] = 2f[k + 1] + 2.1f[k] + 2.2f[k - 1] \)

6. Consider the RL circuit shown.

   ![RL Circuit Diagram]

   a. Compute the output voltage \( y(t) \) (express in analytical form) for all \( t \geq 0 \) when \( y(0^-) = 0 \) and \( i(t) = u(t) - u(t-1) \) where \( u(t) \) is the unit step function.
   b. Using Euler’s approximation of derivatives with \( T \) arbitrary and input \( i(t) \) arbitrary, derive a difference equation model for the RL circuit.
   c. Use your answer to part b with \( T = 0.1sec \), \( i(t) = u(t) - u(t-1) \) (that needs to be discretized), and matlab to recursively solve for and plot the approximation of \( y(t) \) for \( 0sec \) \( \# \) \( 5sec \). Plot the exact solution from part a on the same graph and compare the results.

7. Consider the differential equation
   \[
   \frac{d^2y(t)}{dt^2} + 3\frac{dy(t)}{dt} + 2y(t) = 0, \quad y(0^-) = 1, \quad \dot{y}(0^-) = 0.
   \]
   a. Compute \( y(t) \) and express in analytical form, then plot \( y(t) \) for \( 0sec \) \( \# \) \( 10sec \).
   b. Using Euler’s approximation to the derivative with \( T \) arbitrary, derive a difference equation model from the differential equation.
   c. Recursively solve your difference equation in part b using \( T = 0.4 \) and then \( T = 0.1 \) for \( 0sec \) \( \# \) \( 10sec \) and plot your results. Compare these numerical solutions to the exact solution plotted in part a. Which time interval \( T \) gives a better approximation? Why?

8. Consider the differential equation model of a high-speed vehicle on a horizontal surface
   \[
   12\frac{dv(t)}{dt} + 0.9v(t) + 0.6v^2(t) = f(t)
   \]
   where \( v(t) \) is the vehicle velocity and \( f(t) \) is the drive/brake force.
   a. Solve for \( v(t) \) as an analytical expression.
   b. Using Euler’s approximation to the derivative with \( T \) arbitrary, derive a difference equation model from the differential equation.
   c. Using the answer in part b with \( T = 0.2sec \), compute and plot the approximation to \( v(t) \) using recursion for \( 0sec \) \( \# \) \( 20sec \).
   d. Using the answer in part b with \( T = 2.0sec \), compute and plot the approximation to \( v(t) \) using recursion for \( 0sec \) \( \# \) \( 20sec \).
   e. Are you more confident in your approximation from part c or d? Why?