Given the single-input single-output LTU discrete system described by

$$x(k+1) = \begin{bmatrix} -0.64 & 0.9 & 0.58 \\ -0.32 & 0.2 & 3.04 \\ -0.32 & 0.2 & 1.04 \end{bmatrix} x(k) + \begin{bmatrix} 2 \\ 1 \\ 1 \end{bmatrix} u(k) \quad , \quad y(k) = \begin{bmatrix} 2 & 0.2 & -2.2 \end{bmatrix} \text{x(k)}$$

Where the sampling period is 0.1 sec.

a) Find the transformation matrix P and its invers that transform this system to the standard controllable form and hence deduce the open loop pulse transfer function.
b) Determine the state feedback gain matrix K such that u(k) = r(k) – K x(k) so as to locate the closed loop poles of this system to z_1= 0.3 and $z_{2,3}$ = 0.4 $\pm$ 0.5 i
c) Find the closed loop pulse transfer function and the response of the closed loop system to a unit step input while adding a scalar gain after the input r(k) to ensure that the steady state value of the output is equal to one due a unit step input. Calculate the rise time, max percentage overshoot, mini= percentage overshoot as well as the settling time. Try to use the Matlab functions as much as you can in your steps.

You are required to repeat parts b) and c) corresponding to five closed loop poles of your choice, in the first two choices choose three real closed loop poles while the remaining three cases choose one real pole and two complex conjugate poles. Make sure that all closed loop poles are inside the unit circle for stability. Further, draw the step responses of the five closed loop cases on a single graph using Matlab with different colors. Summarize the step responses parameters in a table that show rise time, max percentage overshot, min percentage overshoot and settling time and comment on your results.