(1). Design a state-variable feedback controller to yield a 20.8% overshoot and a settling time of 4 seconds for a plant as follow:

\[ G(s) = \frac{(s + 4)}{(s + 1)(s + 2)(s + 5)} \quad (20\%) \]

(2). The plant system shown as follow:

\[ G(s) = \frac{K}{(s + 2)(s + 4)(s + 5)} \]

A> Plot the Bode plots use approximated method? (10%)
B> Determine the range of \( K \) within which the unity feedback system is stable? (10%)
C> If \( K=200 \) in the system, fine the gain margin and the phase margin? (10%)

(3). Sketch the root locus \((K>0)\) of a unity feedback system that has a forward transfer function as follow:

\[ G(s) = \frac{K(s + 2)}{(s^2 - 4s + 13)} \quad (20\%) \]

(4). Convert the state and output equations as follow to a transfer function.

\[
\dot{x} = \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \\
y = \begin{bmatrix} 1 & 1 \end{bmatrix} x
\]

(15%)

(5). Determine whether the system is controllable or is observable?

\[
\dot{x} = Ax + Bu = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \\
y = Cx = \begin{bmatrix} 1 & 1 \end{bmatrix} x
\]

(15%)