Q1: (30 marks)

a) If the characteristic equation is $\mathbf{1}+\frac{K(0.06z+0.05)}{z^2-1.5z+0.5}=\mathbf{0}$. Determine the range of ***K*** satisfy the system must be stable.

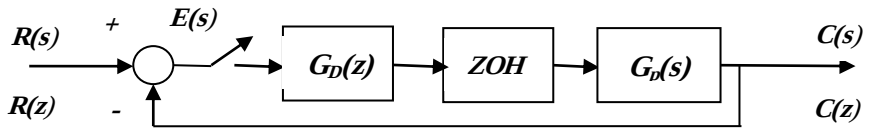
b) Consider the discrete-time control system:

$$\begin{bmatrix}x_1(k+1)\\x_2(k+1)\\x_3(k+1)\end{bmatrix}=\begin{bmatrix}0 & 1 & 0\\0 & 0 & 1\\-0.1 & -0.6 & 0\end{bmatrix}\begin{bmatrix}x_1(k)\\x_2(k)\\x_3(k)\end{bmatrix}+\begin{bmatrix}1\\1\\1\end{bmatrix}u(k),\quad and\ y(k)=\begin{bmatrix}1 & 0 & 0\end{bmatrix}\begin{bmatrix}x_1(k)\\x_2(k)\\x_3(k)\end{bmatrix}$$

1. Check the system is controllable and observable.
2. By using the pole placement design method, determine the gain matrix ***k*** such that the error signal will exhibit a dead beat response ($z_1= z_2= z_3=0$) to an arbitrary initial state.
3. Design a full–order observer such that the error signal will exhibit a dead beat response to an arbitrary initial error.

Q2: (20 marks)

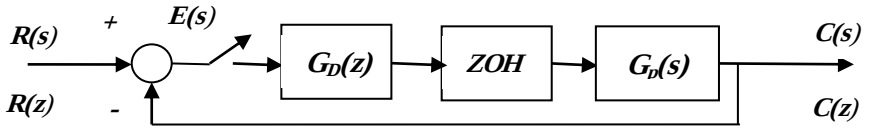
Consider the discrete-time control shown below:



If the $G(z)=\frac{3(z+0.34)}{(z-1)(z-0.0182)}$, by using the root-locus method design a suitable digital controller $G_D(z)$ so that the system dominant closed loop poles will have a damping ratio $\zeta = 0.7$, the number of samples per cycle is **10** and the steady-state error to ramp input is 2.5% (Assume the $T = 0.1$ sec).

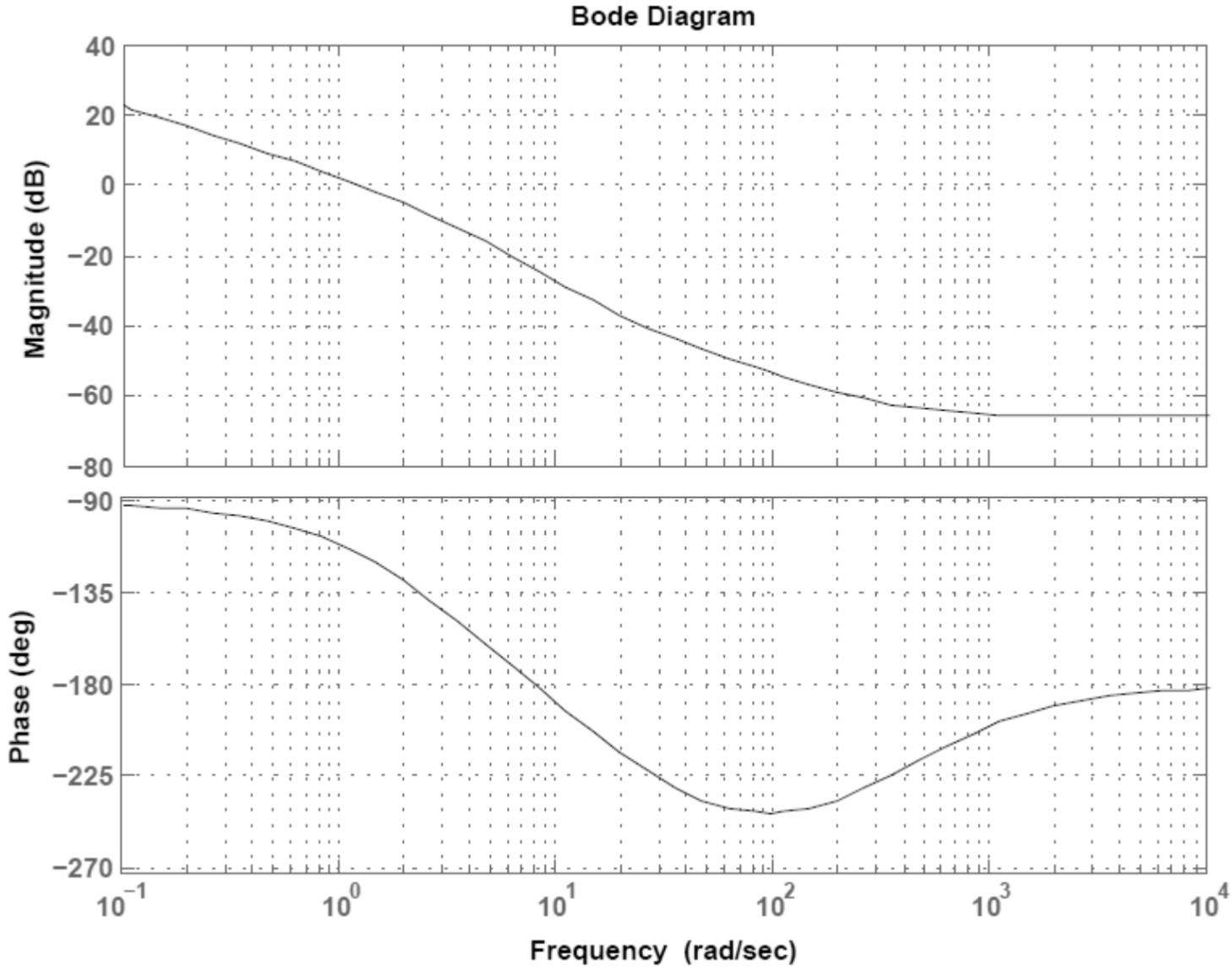
Q3: (20 marks)

Consider the discrete-time control shown below and if $\boldsymbol{G(z) = \frac{0.00454(z+0.004)}{z^2-1.741z+0.7408}}$:



a) Design a suitable digital controller by using the bode diagram to meet the following specifications. (k_v **= 4**, **gain margin ≥ 15 dB**, **phase margin = 70^0**, and the sampling period ***T = 0.1 sec***).

b) Design a digital controller $G_D(z)$ for this system so as to achieve a deadbeat response for unit step input (assuming the ***T = 0.1 sec***).



GOOD LUCK

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