IIT Bombay
Systems and Control Engineering
Intelligent Feedback and Control

SC 645 | ***Assignment 5*** | **Date:** 10.04.2024 | Maximum Marks: 10

Instructions:

- Submit the answers to this assignment on or before the **deadline** at 12:30 p.m. on 10.04.2024.
- All the results and the associated observations/analysis must be compiled in a single pdf file. This pdf and the associated code must also be submitted in a single zip folder on moodle on the relevant submission link.
  Label this folder in the form: FirstName_RollNumber_AS05.
- Please preserve the code and the report till the end of this semester.
- Assumptions made, if any, must be clearly stated and must be justified.
- After the end of each question, the numbers to the right, in square brackets, indicate marks allotted to it.

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1. Consider the state-space realization of the system as follows, **(3 + 5 + 2)**

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}1 & 1 & 0\\ 0 & 2 & 0\\ 0 & 1 & 3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}1 & 1\\ -1 & 1\\ 0 & 0\end{bmatrix}\begin{bmatrix}u_1\\ u_2\end{bmatrix} \quad ; \quad \begin{bmatrix}y_1\\ y_2\end{bmatrix} = \begin{bmatrix}1 & 0 & 0\\ 0 & 0 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

   - Design a **feedback decoupler** to decouple the outputs of the given system. The decoupled system should have the following input-output structure,

$$\begin{bmatrix}y_1\\ y_2\end{bmatrix} = [D(s)]_{2\times 2}\begin{bmatrix}v_1\\ v_2\end{bmatrix}$$

     Here, $D(s)$ must be a diagonal matrix (All the off-diagonal entries must be zero). The inputs to the decoupled system are $\begin{bmatrix}v_1\\ v_2\end{bmatrix}$.
   - Design appropriate feedback control inputs to stabilize the outputs at arbitrarily set reference points. Provide a **block diagram** of the decoupled system, and **provide detailed mathematical reasoning** of how the control designs were carried out to achieve the following. **(1 + 1.5 + 2.5)**
     - The settling time of output y_1 to its given reference should be 2 seconds.
     - The output y_2 must be stabilized at its reference without oscillations (there must not be any sign change in the error during the transient phase).
   - Demonstrate the feedback controller's performance via MATLAB simulations to exhibit the prescribed specifications. **(Outputs vs Time, Inputs vs Time).**

[10]

End of Assignment