**Academic Year 2021-2022**

**Exam 1 – Overall assessment - Maximum duration: 3 hours**

**Problem 1 [5 points]**

Consider a dynamic system described by:

where and are the states of the Dynamic system, is the system output, is the manipulable input and is a disturbance. Assuming that the operating point around which the system must be linearised is given by e

1. Obtain a linear internal description. **[1 point]**
2. Calculate the transfer functions that relate the incremental output to the incremental input and the incremental output to the incremental disturbance **[1 point]**
3. Draw a diagram in Simulink that allows you to compare the output of the non-linear system with its approximation in the form of a transfer function. **[0.5 points]**
4. Starting from an initial condition of non-zero deviation variables () and supposing that , calculate the response of the linearised system when a unit impulse is introduced into the system at . Obtain the analytical expression and draw the approximate evolution for values for y . **[1.25 points]**
5. Draw the Bode diagram (on the template provided) and the Nyquist diagram of the linearised system from the transfer function calculated in section 2. **[1.25 points]**

**Problem 2 [5 points]**

For the time-invariant linear minimum phase system described by the following Bode diagram. Gráfico, Gráfico de líneas

El contenido generado por IA puede ser incorrecto.

1. Calculate the transfer function of the system whose frequency response is given by the figure above. **[0.5 points]**.
2. Analyse the root locus when controlled with a proportional controller whose gain varies between 0 and . Indicate the value of that provides a dominant closed-loop time constant of 2 seconds, and the value of K that provides a closed-loop time constant of 4 seconds. [**0.5 points**]
3. Also using a proportional controller, analyse the stability of the closed-loop system as a function of using Nyquist's stability criterion, specifying the transformation of the contours in the s-plane and in the plane. [**0.75 points**]
4. Analyse the stability of the closed-loop system using the Routh-Hurwitz criterion. [**0.25 points**]
5. Design a controller that is as simple as possible and provides a phase margin of 135º. We recommend using the figure above. What will be the steady-state error at step, ramp, and parabolic inputs of the system controlled with this controller? Can you change the gain margin of the system by reducing the gain of the controller? **[1 point]**
6. Design a controller that is as simple as possible and meets the following specifications:

* Disturbance rejection: the control scheme must ensure that, when faced with a disturbance at the plant input in the form of a unit step, the system output returns to its previous value before the step and the dominant poles have a relative damping coefficient I Indicate the expected 2% settling time ().
* Reference tracking: the control scheme must achieve a closed-loop response to a step reference with zero error in steady state and a dominant first-order dynamic with a time constant of 1 second. **[1 point]**

1. For a system with the following internal description, design a linear state vector feedback control system that achieves zero error at step input in the reference and such that the desired polynomial is Draw the control diagram. If you run out of time, leave the calculations indicated. Indicate how you would implement a state estimator. **[1 point]**

**Imagen que contiene biombo, edificio, jaula, reloj

Descripción generada automáticamente**