**Academic Year 2022-2023**

**Exam 1 – Part I - Maximum duration: 3 hours**

**Problem 1 [4 points]**

A dynamic system is described by the following system of differential equations:

where, as usual, is the input, is the output and and are the states. The operating point around which the system must be linearised is

1. Obtain a linear internal representation in state variables. **[0.5 points]**
2. Obtain the transfer function of the linearised system and analyse its stability and the location of the poles as a function of the parameter . **[1 point]**
3. For the parameter value that provides two equal real poles not equal to zero, calculate and approximately plot the free response of the system if it starts with an initial value of the states . **[0.75 points]**
4. For the parameter value that provides two equal real poles not equal to zero (as in the previous section), draw qualitatively (without calculating the inverse transform) the system's response to a unit step. **[0.25 points]**
5. Draw a Simulink diagram that allows you to simulate and compare the non-linear and linear systems (both in internal description and transfer function) for the simulation scenario described above. Include the values of the input blocks, constants, and integrators. **[0.25 points]**
6. Draw the Bode diagram (on the attached sheet) and Nyquist diagram of the system with the value of parameter that provides two equal real poles not equal to zero (same conditions as in section 3). Indicate the value of the Bode phase curve if parameter changes sign. **[1 point]**
7. If a sinusoidal input , s introduced, indicate approximately the time response that will be obtained in steady state using the previous section (without calculating inverse transforms). **[0.25 points]**

**Problem 2 [1 point]**

Approximately calculate the transfer function of a minimum phase system whose Bode diagram is shown in the following figure.

**Gráfico

El contenido generado por IA puede ser incorrecto.**

Imagen que contiene biombo, edificio, jaula

Descripción generada automáticamente