**Academic Year 2023-2024**

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

**Problem 1 [3.5 points]**

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| Consider the following mechatronic circuit consisting of an RL series electrical network containing an inductance L [H], a DC power supply Vcc [V], and a non-linear potentiometer. The inductance has a ferromagnetic core that allows it to support a mass [kg] placed at a distance (the positive axis of the distance is considered to be upwards) and regulate its position by varying The equations governing the dynamics of the system are as follows (where is the constant (number) e, approximately 2.7182). | **Note**: . |

1. Is it possible to obtain an internal description of order 2 in state space from the previous models? Explain your answer. **[0.25 points]**
2. From the first equation provided by the non-linear model of the electrical part that relates the input voltage to the current flowing through the circuit (and therefore passing through the resistor and the coil), linearise that model around the operating point (with a constant voltage source ) and calculate the transfer function that relates the input voltage to the current. Once obtained, apply the following numerical data: [V], [H]. Indicate whether the system is stable or unstable in open loop. **[0.5 points]**
3. Considering the result of the previous exercise (same operating point and same parameters parámetros , , etc.), linearise this model around the operating point (with a constant voltage source and calculate the transfer function that relates the input voltage to the position. Once obtained, apply the following numerical data (those of the electrical circuit remain those of section 1): [m/s2], [kg]. Indicate whether the system is stable, unstable, or critically stable in open loop. What is the value of the resonance frequency and the resonance peak? **[0.75 points]**
4. Draw a Simulink diagram that allows you to simulate and compare the non-linear and linear systems, causing a step change in from 0 to 0.1 [V] at . **[0.5 points]**
5. Analytically calculate the time response of the linearised system to that step and write the expression for . **[0.5 points]**
6. Obtain a linear internal representation in state variables where the variables have physical meaning, as well as the controllable canonical form. **[0.5 points]**
7. If and the system starts to evolve from an initial condition [m], calculate the expression that provides the evolution of the linearised system from that initial condition. **[0.5 points]**

**Problem 2 [1 point]**

Draw the Bode diagram (use the semi-logarithmic sheet on the following page) and the Nyquist diagram of the system represented by the following transfer function, indicating the characteristic low-frequency, high-frequency, and some intermediate-frequency points on both the magnitude and phase axes and on the frequency axes.

**Problem 3 [0.5 points]**

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

**Interfaz de usuario gráfica, Gráfico

El contenido generado por IA puede ser incorrecto.**

Imagen que contiene biombo, edificio, jaula

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