Name: **Enrolment No:**	

UPES

End Semester Examination, May 2025

Course: Avionics System Design — **Semester: 8**

Program: B.Tech Aerospace Engineering (Avionics) — **Time : 03 hrs.**

Course Code: AVEG4007 — **Max. Marks: 100**

Instructions:

1. Please read each question carefully and then proceed to answer it.
2. Answer all questions.
3. Use figures and diagrams wherever necessary.

SECTION A

(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	In the general solution of a differential equation, which term corresponds to the system's decaying behavior? Also, explain the rationale behind using impulse functions as input signals in engineering analysis of systems.	**4**	**CO1**
Q 2	List down the reason for using a magnetometer with an accelerometer and gyroscope in an inertial measurement unit (IMU) of an aircraft?	**4**	**CO3**
Q 3	State the condition under which resonance occurs in an RLC circuit, and provide the corresponding mathematical relationship between its components.	**4**	**CO1**
Q 4	Define what is meant by a homogeneous equation and a non-homogeneous equation in the context of differential equations.	**4**	**CO1**
Q 5	Derive an expression for error signal of a closed loop, negative feedback system.	**4**	**CO2**

SECTION B

(4Qx10M= 40 Marks)

Q 6	a) State the '***final value theorem***' and explain its significance with an application.	**5+5**	**CO3**

	b) Consider two different transfer functions and demonstrate conditions under which the final value theorem is applicable and when it is not.		
Q 7	An RC low-pass filter is built using a resistor R = 0.5 kΩ and a capacitor C = 0.1 μF . (a) Calculate the cutoff frequency (fc) of the filter. (b) If a sinusoidal signal of frequency 15 kHz is applied, will it be attenuated significantly?	**5+5**	**CO2**
Q 8	Sketch Bode plot for a system where a pole of the system is at the origin. Also, explain the steps involved in plotting the gain and phase margin plots.	**10**	**CO3**
Q 9	Explain, with the help of a suitable example, why feeding a sinusoidal input into a Linear Time-Invariant (LTI) system results in a change in amplitude and phase of the output, but not in its frequency. **Or** Analyze the given open-loop transfer function $G(s)$ to compute the steady-state error for both step and parabolic input signals. Then, incorporate a PID controller, and evaluate how the steady-state error changes after implementation. Assume, K_p = 0.1, K_i = 0.5 and K_d = 0.05. $G(s) = \frac{1}{S(S-2)}$	**10**	**CO3**
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	Design a flowchart illustrating the key steps involved in conducting a Root Locus analysis for an avionics control system. Further, explain each step with appropriate mathematical expressions used during the construction of the Root Locus plot. **Or**	**20**	**CO4**

<table>
<tr><td></td><td>For the open loop transfer function $G(s)$ given below, apply the root locus steps to show the movement of poles and zeros for different values of 'K' and draw the root locus response on the graph sheet provided.

$$G(s) = \frac{K\ (S+2)}{S^2+4S+11}$$</td><td></td><td></td></tr>
<tr><td>Q 11</td><td>a) For the mass-spring-damper system shown in Fig. 1, derive the governing differential equation when a sinusoidal force is applied. Then, using the Laplace transform, solve the equation and provide the final solution in the time domain.

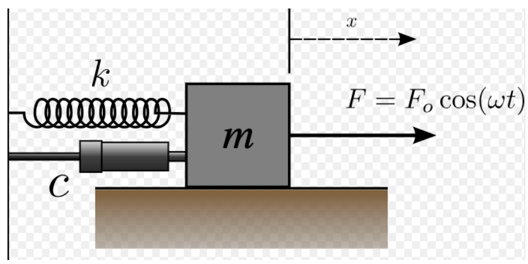

Fig 1: A mass, spring, and damper system with a sinusoidal force.

b) Develop a MATLAB or Python-based program to estimate an aircraft's orientation using accelerometer and gyroscope data independently. Use only a quaternion-based method for computing body angles from the gyroscope in the implementation.</td><td>10+10</td><td>CO4</td></tr>
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