VIT

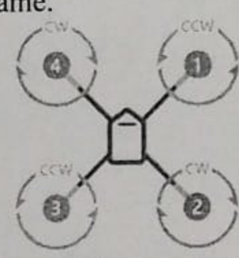
Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

Continuous Assessment Test II–March 2025

Programme	: **B.Tech CSE with Specialization in AIR**	Semester	: **WINTER SEMESTER 2024-25**
Course Title	: **Autonomous Drones**	Code	: **BCSE428L**
		Class Nbr(s)	: **CH2024250501969 CH2024250502380 CH2024250501964**
Faculty (s)	: **Dr. D.Sathian Dr. V. Muthumanikandan Dr. M. Prasad**	Slot	: **A1**
Time	: **90 Minutes**	Max. Marks	: **50**

Answer all the questions

S. No		Question	Marks
1.		A quadcopter is flying in stable conditions when it suddenly experiences a yaw disturbance due to wind. The drone has the following specifications: • Frame Specifications: The quadcopter has a total frame weight of 2 kg, and its onboard battery and payload together weigh 1.5 kg. • Motor Specifications: Each of the four motors can generate a thrust-to-weight ratio of 8:1 at full throttle. • Wheelbase = 700 mm • Aerodynamic torque coefficient: C_{aero}=0.12 Nm/(rad/s) • Wind-induced external torque: $\tau_{external}$=2 Nm • Yaw angular velocity at the moment: ω_{yaw}=3 rad/s • Set total yaw torque to zero for stability Determine the required motor thrust imbalance (ΔT) to counteract the yaw disturbance and maintain stability. (Mass calculation – 2m, maximum thrust – 5m, thrust imbalance – 5m, steps – 3m)	**[15]**
2.		A quadcopter as shown with x-configuration has a mass of 2 kg and an arm length of 0.3 m. The moment of inertia values are: Ixx = 0.04 kg·m², Iyy = 0.04 kg·m², and Izz = 0.08 kg·m². The four motors generate thrust forces T1, T2, T3, and T4, with the thrust vector aligned perpendicular to the quadcopter's frame.  (a) Compute the net torques about the roll (x), pitch (y), and yaw (z) axes if the motor thrusts are: T1 = 6N, T2 = 5N, T3 = 7N, T4 = 5N. (3) (b) Calculate the linear acceleration (roll, pitch and yaw) and identify in what direction the drone is moving. (4) (c) Calculate the angular accelerations (roll, pitch, and yaw) using the given moments of inertia. (8)	**[15]**
3.	a	Suppose you are developing a flight controller for a quadcopter in Simulink. You first test the controller using MIL, then transition to SIL, and finally to HIL. What modifications or	**[10]**

		additional considerations are required at each stage to ensure consistency in performance?	
	b	Consider a quadcopter control system that includes a PID controller for altitude hold. If a bug is found in the controller during HIL testing, but not in MIL or SIL, what could be the possible reasons? How would you debug the issue?	
4.	a	Design a UAV payload system for a Martian drone where gravity is only 38% of Earth's. Given that a drone on Earth hovers at 50% throttle with a 2 kg payload, determine how much payload it could theoretically carry on Mars using the same motors and configuration. (5)	
	b	A disaster relief drone needs to deliver emergency supplies to areas with high wind resistance. If wind conditions increase the required hover thrust by 15%, how would the payload formula change? If the drone originally hovered at 65% throttle while carrying a 6 kg payload, determine the new hover throttle percentage and discuss whether the current configuration is viable. (5)	**[10]**
		Total Marks	**[50]**

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