Task 3B : Theme & Rulebook Questionnaire

Team ID	Your Team ID
College	Your College Name
Team Leader	Name Team Leader
e-mail	Team Leader e-mail ID
Date	February 19, 2020

Question No.	Max. Marks	Marks Scored
Q1	5	
Q2	10	
Q3	5	
Q4	5	
Q5	10	
Q6	5	
Q7	10	
Q8	15	
Q9	5	
Q10	5	
Q11	10	
Q12	5	
Q13	10	
Total	100	

Q1. Briefly describe your experience in building the Lunar Scout bike.
A1.

Q2. In task 1, you were introduced to LQR controller design for a simple pendulum and asked to do mathematical modelling and LQR controller design for Rotary Inverted Pendulum. In that, you were asked to derive the equations, linearize around the equilibrium point and find the A & B matrix using the Jacobian function.

In this question, you have to choose the states for your Lunar Scout bike that you are going to design. Model the system using Euler-Lagrangian Mechanics that you learned in task 1. Linearize the system using jacobians around the equilibrium points representing your physical system. Use mathematical expressions for derivations and proper diagrams where necessary.
A2.

Q3. Which is the most optimal controller between PID and LQR. Justify your answer.
A3.

Q4. What is the significance of finding Controllability and Observability of a system in state space approach?
A4.

Q5. Briefly explain your opinion on having the centre of mass of the bike low or high. Use diagrams/calculations/examples to support your argument.
A5.

Q6. In what cases will the run time be considered as the maximum time (Tmax = 300 seconds) according to the scoring formula and theme rules?
A6.

Q7. Explain what you have understood from the Theme play in your own words.

A7.

Q8. What will be the SCORE in the following situation:

Given Run Configuration:

Start Location : S1

Colony Sites: 1, 2, 3, 5

Obstacle: O1, O3

In the given run there are four Colony Sites(**CS**). The bike started its journey from S1. It halted near the first CS, which has the north pole of the magnet facing the track. It indicated green LED and buzzer, then started its traversal.

- Now it has reached the second CS which has no magnet in it. It doesn't indicate any of the light and started its traversal .
- The bike crossed one obstacle and then indicated the first CS again with red led and buzzer with proper halt, then it continued forward.
- Now it reaches its final CS which is having a south pole facing towards the track and indicating green LED and buzzer beep while passing by the CS, but without halting near the CS.
- Bike then goes to the S2 position, stops and beeps the buzzer for 5 seconds. By this time 150 seconds have passed, from the start time. The bike did not have any MI/PP/HP during the run.

A8.

Q9. What is Parallel and Perpendicular axis theorem? Is it required for mathematical modelling? Justify your answer with respect to the lunar scout bike.

A9.

Q10. How will you check whether the system is stable or not in a state-space approach?

A10.

Q11. What will be happening in the following situation:

The bike wrongly indicated the LED colour for a colony site while in halt. When starting to move it crosses the dotted line and hits the colony sites and falls. So Manual intervention has taken place. How many penalties will be imposed and what are they?

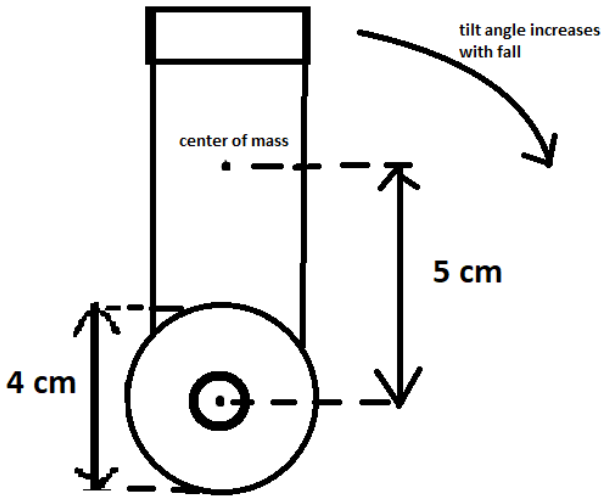
A11.

Q12. How many different type sensors does a 6-axis Inertial Measurement Unit(IMU) have? Explain what physical quantities they measure exactly?

A12.

Q13. Consider a wheeled inverted pendulum having a vertical body balanced using a DC geared motor. The center of mass of the body is at 5 cm height from the axle of the wheel and motor shaft. The diameter of the wheel is 4 cm.

- What is the torque required from the DC geared motor(max RPM = 300), to be able to balance this body of total mass 1.5 kg(consider wheel & motor massless), with max correctable angular tilt as +/- 5 degrees.
  (Mention steps for your calculation)



A13.