Implementation assignment 1 rubric

	Learning objective	Notes					Score
			9 to 10	5 to 8	4 to 1	0	
Model	**1.1** Construct and analyze state space models for non-linear and linear, continuous and discrete dynamic systems from broadly-based domains such as motion control, information systems and biological systems.	The group develops and documents a non-linear model that describes the dynamics of the gyro-actuated pendulum. The model should be formulated using a Lagrangian and should have as the input, the angular speed of the gimball axis. The four states shall be: (1) the angular rotation about the vertical axis; (2) the angular speed of rotation about the vertical axis; (3) the pendulum angle; and (4) angular speed of the pendulum. The model will accounts for friction losses and other factors. Assumptions will be clearly stated.	The model is well formulated and documented. The reader is able to understand the model from documentation provided which will include clear figures showing information of relevance including identifying rigid bodies and degrees of freedom. These link in obvious ways to the parameters that are defined in supplied Matlab files giving dimensions and inertias.	A model has been developed and it appears to be substantively correct but is marred by documentation which may lack clarity or errors in the formulaton.	Some evidence of modelling marred by fundamental errors or limited progress. The supporting documents fail to convince the reader that the model is correct	No attempt at modelling and/or no supporting documents provided	/10
			9 to 10	5 to 8	4 to 1	0	
Simulate and validate	**1.2** Employ simulation tools (i.e. Matlab and Simulink) to predict and analyze the dynamic behavior of system.	These simulations should encompass the temporal progression of the non-linear system dynamics starting from established initial conditions and specific inputs. The assessment will entail contrasting the simulation outcomes derived from the model's dynamics against experimentally gathered data, while elucidating the underlying causes for any observed disparities. By comparing simulations and experiments, substantial evidence will be presented, demonstrating that the models accurately replicate the system's behavior across diverse conditions. These comparative analyses will be documented in supplementary materials, with a curated subset highlighted during the presentation	The supporting documentation convinces the marker that the non-linear model captures the dynamic behaviour of the system. Simulations cover a diverse range of initial conditions and responses. Deviations of the model response from the experimental response are explained. The curated responses presented in the presentation are appropriate and representative. Explainations of discrepencies are provided. All plots are clearly represented with labels clearly marked.	The supporting documentation shows evidence that the model captures the non-linear behaviour of the system in some circumstances that are clearly described. Possible reasons for discrepancies are given and these are plausible. The curated responses presented in the presentation are appropriate and representative of actual performance. All plots are clearly represented with labels clearly marked.	The supporting documentation shows evidence of attempts to validate the model, but the do not convince that the model has captured the essential dynamic behaviour. Presentation of plots may confuse the marker.	No evidence of the employment of simulation tools to predict and analyze the behavior of the system	/10
			5	3 to 4	1 or 2	0	
Swing up	**1.3** Qualitatively analyze linear and non-linear dynamic systems through phase portraits, equilibrium points, limit cycles, stability, and Lyapunov methods.	This learning objective centers on formulating a controller through Lyapunov methods to swing up the pendulum. The justification for adopting the Lyapunov control law is elucidated within the presentation, substantiating the decision-making process. The presentation documents the selection of the control law.	The team showcases a controller that effectively raises the pendulum from a downward position, drawing inspiration from concepts discussed in lectures and insights gleaned from research papers. The pendulum achieves a graceful upward swing within a reasonable timeframe. During the presentation, the team not only substantiates their selection of this particular controller but also adeptly defends their decision.	The team presents a controller that raises the pendulum from a downward position, employing concepts discussed in lectures and referencing research papers available on the course website. However, the pendulum's motion lacks smoothness and finesse. When questioned, the team struggles to provide adequate justifications for their design decisions and, in some instances, the time taken for the pendulum's erection exceeds the desired duration.	The group demonstrate a controller that moves the pendulum from its equilibrium however its execution is far from convincing and it never fully erects. Descriptions of the controller by the team show limited evidence of understanding of how ideas introduced in the course might be used to achieve erection.	During the demonstration the group and the marker look at the pendulum but nothing really happens. No one in the group is able to say why. There may be an awkward silence.	/5
			5	4 to 3	2 to 1	0	
Linearise	**1.6** Compose and study linearizations of non-linear systems by Jacobian linearization and small value approximations for simple and complex systems.	The group linearises the dynamic equations about the upright position and validates that they are correct based on comparison with provided matlab script results. The linearisation is documented in the supporting documentation and summarised in the presentation.	The accompanying documentation and presentation offer a comparison between the linearization of the dynamic model of the system around its upright position and the results generated from provided Matlab scripts. The analysis establishes that these two approaches exhibit a satisfactory level of similarity, or any discrepancies that arise are adequately explicable.	The presentation and accompanying materials, which encompass Matlab scripts and Simulink models, demonstrate the team's concerted effort in attempting to formulate linearized equations of motion around the upright position. However, these equations do not align with the provided linearization. The marker deduces that minor, unidentified errors are responsible for this discrepancy. Consequently, the team opts to advance with the furnished linearized dynamic model instead of their own attempted linearization.	The team can show that they attempted to linearise the dynamics but something has gone wrong and the results do not align with reality. Consequently, the team opts to advance with the furnished linearized dynamic model instead of their own attempted linearization.	The team fails to provide any evidence that they conducted a linearisation in their supporting documentation. Consequently, the team opts to advance with the furnished linearized dynamic model instead of their own attempted linearization.	/5

			5	4 to 3	2 to 1	0	
Analysis	**2.2** Analyse the properties of linear systems including reachability, observability, controllability and understand how these properties impact on the ability to design a control system.	For this assessment, this learning objective will show that students can apply the concepts of controllability and observability to the pendulum system and they know what they mean.	The presentation and or supporting material includes a correct study of the controllability and observability of the linearized system and the group demonstrates knowledge of how the these concepts apply to the control of the inverted pendulum.	The presentation and or supporting material includes a study of the controllability and observability of the linearized system but the analysis has errors however the group shows sound understanding of how the these concepts apply to the control of the inverted pendulum.	The presentation and or supporting material includes a study of the controllability and observability of the linearized system but the analysis has errors and/or the group shows a lack of understanding of how the these concepts apply to the control of the inverted pendulum.	When asked about this at the demonstration the group tells the marker "Huh, what do you mean observability and controllability?" or something similar.	/5
			20 to 16	15 to 10	10 to 4	3 to 0	
Capture and hold upright	**2.3** Stabilize linear systems using state feedback for situations where (i) the system is represented in reachable canonical form and (ii) by eigenvalue assignment.	This learning objective will be achieved by demonstrating the system will swing up and then hold the pendulum upright. This will be supported by evidence based arguments. It is expected the state feedback will be used to keep the pendulum upright. The team may choose to use either pole placement or LQR but is expected to speak to their design methodology.	The pendulum autonomously rights itself, at which point the capture controller assumes control. A demonstrably effective capture technique is evident through the use of state flow. The pendulum, once stabilized in the upright position, displays resilience against disturbances. Should notable disturbances occur, the controller adeptly returns the pendulum to its upright stance. Furthermore, the controller exhibits the capability to navigate and maintain various angles about the vertical axis while ensuring the pendulum remains upright. The design methodology for the capture controller is well explained.	The controller demonstrates a functional foundation: the pendulum achieves self-erection, allowing the stabilizing controller to assume control. Nevertheless, the overall control system lacks robustness. For instance, the method employed for erection or capture may prove to be unreliable. While the pendulum manages to stabilize in the upright position, its resilience against disturbances is questionable. The controller's reliability might falter unexpectedly, potentially leading to its failure in recuperating the pendulum to an upright stance when significantly perturbed. Additionally, the controller's inability to navigate and maintain diverse angles around the vertical axis while keeping the pendulum upright is notable. At the very least, within this scoring category, the requirement mandates the pendulum's consistent ability to remain upright.	The controller's functionality falls short during the demonstration; nonetheless, the marker holds the belief that, with an amount of further effort, it could potentially be refined to achieve its intended functionality.	The controller's failure to operate during the demonstration has left the marker unconvinced that a functional controller will emerge based on the current presentation. Despite this, there could be indications of some progress being made.	/20
			5	4 to 3	2 to 1	0	
Insights	**2.4** Employ state feedback design methods being cognizant of the tradeoffs that exist among the magnitude of the control inputs, the robustness of the systems to perturbations, and the closed loop performance of the system.	Students will be evaluated on their grasp of this learning objective by showcasing an understanding of constraints stemming from non-linear effects like saturation and measurement noise, or by presenting other pertinent insights related to the control challenge.	The team adeptly imparts insights and responds to inquiries with accurate and/or credible answers when probed about limitations and trade-offs.	The team's insights appear to be limited. When prompted, the members provide responses that exhibit a degree of comprehension regarding the limitations of the system, but this understanding weakens upon deeper investigation by the marker.	The team offers insights reflecting a partial grasp of the constraints involved in controlling the system, yet they struggle to provide precise responses to the questions posed to them.	The team remains incapable of offering insights or responding to questions, resulting in an uncomfortable silence.	/5
			9 to 10	5 to 8	4 to 1	0	
Teaming	**5.** Work as a team member in a group **5.1** Break down a control systems problem into manageable tasks and identify for each task who in the team is responsible, accountable, consulted and informed. **5.2** Work with team members to deliver an outcome resolving technical and interpersonal issues and concerns as they arise effectively.	Students will be evaluated on these learning learning objective by evidence provided by their RACI chart and updates.	The team effectively constructed their RACI chart, distributing work equitably and identifying roles. They used the chart to report progress by submitting two updates. There is evidence that the group worked effectively as a team and resolved issues in a timely way without requiring Course Coordinator intervention.	The team effectively constructed their RACI chart, distributing work and identifying roles. There may be issues of equity. They used the chart to report progress by submitting two updates on time. Issues were largely managed and reported. The timeliness of resolution may be in question.	The team produced a RACI chart but used it only in a token sense. Work is not equitably distrubuted. One or both updated may be missing. Issues were not resolved or were denied. Team dysfunction resulted in requiring the application of a peer-assessment factor.	The team did not engage with this learning objective	/10
						Total	/70