DESIGN AND MANUFACTURE 2 – MECHANISM DESIGN

1 INTRODUCTION

You will be working in pairs to design a mechanism that will open and close a roof for a convertible car as shown in Figure 1. This is an open-ended feasibility exercise with a high level of uncertainty. There are many ways that one could solve the problem. Your report should detail the:

- design process you have gone through;
- assumptions made and their implications; and,
- justification for your design decisions.

Figure 1: Mini Convertible Roof Mechanism

To start, you will need to come up with a Product Design Specification (PDS) for the design of the mechanism. You will then come up with an initial set of concepts for a deployment mechanism and use the PDS to compare the concepts using the controlled convergence strategy. A decision should be made by week 20 as to which one you will be carrying forward for further iterations and preliminary design work. The PDS along with a diagram of your chosen concept will form a stage-gate submission at the end of **week 20 (Friday 17th March, 2017)**.

After selecting your design, you will develop a dynamics model in Simulink that models the deployment and retraction of your mechanism. A description of the model should be presented within your report, which describes what calculations the simulink model is performing during each iteration. You should also describe how the motor & gearbox and has been modelled. The assumptions within the model should also be clearly articulated along with the likely impact they will have on the results that you will generate. Using this model, you will then trial a

variety of motor, gearbox ratios and damping values to achieve a convertible roof with a smooth operation.

The gearbox ratio will then be used to form the initial requirement for your gearbox design. You will then evaluate the suitability of a multi-stage spur and helical gearbox. These will consist of gears of your choosing in order to generate the required ratio. **Please note**, your PDS should also cover requirements for your motor and gearbox.

The final aspect that you will cover is the creation of a general assembly of the gearbox arrangement. You are not required to select all the components in the gearbox although you could provide estimates for the shaft diameters and bearings given your experience from the previous exercise. The CAD model should have representative models of these components in order to demonstrate the arrangement.

2 PROBLEM DETAILS

Figure 2 provides a drawing of the car that you will be designing for. The mechanism can be connected to the car within the boundary marked (a) and the mechanism has to extend to reach the windscreen (b). You do not have to worry about storing the mechanism when closed as it will sit atop the main chassis as demonstrated in Figures 1 & 2. You should aim to collapse within the area (a) and extend to meet the windscreen within the region (b). You are not required to meet these values **exactly** but aim to get as close as possible.

To get you started, here are **some** example requirements that you should consider when forming your PDS. We do expect these points to be expanded upon and made quantifiable where possible.

- To have a reasonable deployment time
- To minimise the space consumed when fully packed down.
- To maximise interior space when fully deployed.
- To be safe for operation near passengers.
- To minimise the energy required for deployment and retraction.

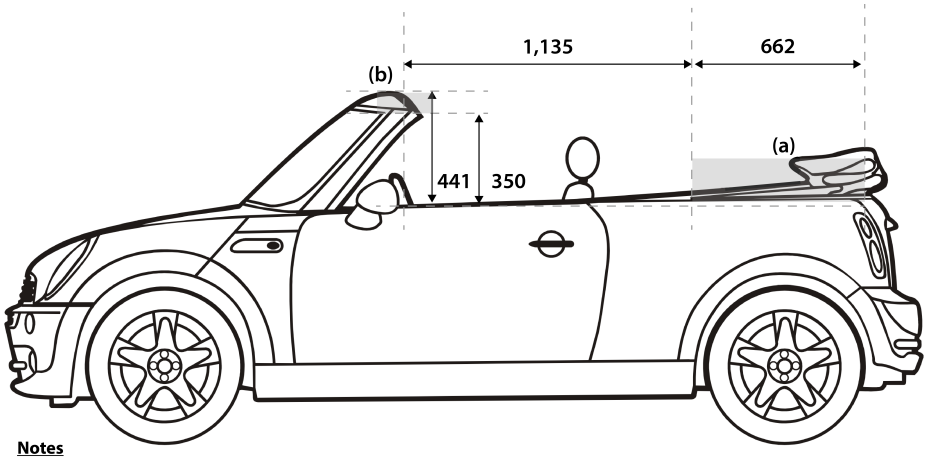

Figure 2: Key dimensions for deployment mechanism

3 SUBMISSION

The exercise will be assessed through a stage-gate submission of your initial PDS and chosen concept at the mid-exercise stage-gate on blackboard (5%, Friday 17th March 2017) and a final design report that should also be submitted on blackboard as well as a hard copy submitted to the School Office by 3:30pm on 5th May 2017. A LaTeX template is provided for the report. The report should be no longer than 15 pages (excluding A3 submissions & reference list) and include the following (page guide and mark assignment in brackets):

1. Title page (Title of the exercise, names & student numbers)
2. Introduction (1 page)
3. Product Design Specification (1 page, 10%)
4. Concept Design & Selection (2 pages, 10%)
5. Deployment Modelling (3 pages, 20%)
6. Motor, Gear Ratio & Damping Selection (3 pages, 15%)
7. Gearbox Design (3 pages, 20%)
8. Solution Specification (1 page)
9. Conclusion & References (1 page)
10. Separate A3 pages (10%)
    (a) Simulink Model; and,
    (b) Gearbox Assembly.

Additional Notes
10% for the quality of report writing.
The reference list may go beyond the 15 page limit.

4 SUPPORT & TIME-LINE

As with the first exercise, supporting lectures are given on Tuesday afternoons and there is an expectation that you will work on the exercise ahead of the Tuesday morning sessions where there will staff available to provide formative feedback and support. Table 1 provides a summary of the time-line for the exercise.

Table 1: Exercise Time-line

Academic Week	Date	Time	Type	Content
13	Monday 23rd January 2017	15:00-16:00	Lecture	Introduction to the Overall Course & Constrained Design Task Introduction
13	Tuesday 24th January 2017	9:00-13:00	Tutorial	Form groups, Exercise Familiarisation & Product Design Requirements
13	Tuesday 24th January 2017	14:00-15:00	Lecture	Reactions, Bending and Macaulay Notation
14	Tuesday 31st January 2017	9:00-13:00	Tutorial	Reactions and Bending Moments
14	Tuesday 31st January 2017	14:00-15:00	Lecture	Bearing Selection
15	Tuesday 7th February 2017	9:00-13:00	Tutorial	Bearing Selection
15	Tuesday 7th February 2017	14:00-15:00	Lecture	Sprocket and Safety Factors
15	**Friday 10th February 2017**		**Submission**	**Shear Force & Bending Moment Diagrams (Blackboard)**
16	Tuesday 14th February 2017	9:00-13:00	Tutorial	Sprocket and Chain Selection
16	Tuesday 14th February 2017	14:00-15:00	Lecture	Fixings and Submission Details
17	Tuesday 21st February 2017	9:00-13:00	Tutorial	Fixings
17	Tuesday 21st February 2017	14:00-15:00	Lecture	Introduction to the Feasibility Design Task
18	**Reading Week**			
19	**Monday 6th March 2017**		**Submission**	**Constrained Design Report Submission (Office and Blackboard)**
19	Tuesday 7th March 2017	9:00-13:00	Tutorial	Form pairs, Exercise Familiarisation & Product Design Specification
19	Tuesday 7th March 2017	14:00-15:00	Lecture	Product Design Specification, Concept Design & Selection
20	Tuesday 14th March 2017	9:00-13:00	Tutorial	Concept Design & Selection
20	Tuesday 14th March 2017	14:00-15:00	Lecture	Modelling the Deployment of the Mechanism 1
20	**Friday 17th March 2017**		**Submission**	**PDS & Linkage Model of Selected Concept (Blackboard)**
21	Tuesday 21st March 2017	9:00-13:00	Tutorial	Deployment Modelling
21	Tuesday 21st March 2017	14:00-15:00	Lecture	Modelling the Deployment of the Mechanism 2
22	Tuesday 28th March 2017	9:00-13:00	Tutorial	Deployment Modelling and Motor & Gear Ratio Selection
22	Tuesday 28th March 2017	14:00-15:00	Lecture	Gearbox Design
	Easter			
23	Tuesday 25th April 2017	9:00-13:00	Tutorial	Gearbox Design
23	Tuesday 25th April 2017	14:00-15:00	Lecture	General Assemblies & Submission Details
24	Tuesday 2nd May 2017	9:00-13:00	Tutorial	Report Writing and Submission
24	Tuesday 2nd May 2017	14:00-15:00	Lecture	Free
24	**Friday 5th May 2017**	**14:00-15:00**	**Submission**	**Feasibility Design Report Submission**