SE (Mechanical/Automobile) PBL – Sem. III (2018-2019)

Report on Rocket Launch Pad

Brief Requirements:

Design a launch pad to launch a given rocket (thermacol foam) a minimum of 1 m vertically in the air.

Any mechanism to be used, no explosives or chemical reactions to be used.

Results:

Students mostly used **pneumatic mechanism**, **and rubber bands/springs** as a means to store energy and impart to rocket. Heights achieved: less than 1 m to 25 m, some failed to launch, unstable.

Though some equations of Energy conservation and Kinematics were available from internet sources, **lacked proper understanding and application to the project**. **Report Writing, graphing and presentation** too needed improvement.

Conclusions:

Students were **overall satisfied**, as reflected from their feedback. **Theoretical understanding needs to be improved further**.

Detailed Problem Statement

Rocket Launch Pad

Department of Mechanical and Automobile Engineering,
Pillai College of Engineering

1 Problem Description

Student groups are tasked to design a launchpad that is capable of launching a rocket a minimum of 1m vertically in the air. The rocket will have a mass of approximately 50 gms and will be provided to the students during the demonstration. The launchpad will be a platform that will impart momentum to the rocket. It can use springs, rubber bands, flexible sheets or any pneumatic mechanism to store energy and the impart it to the rocket. The design should ensure that the rocket goes only vertically upwards. It also cannot use any explosives, chemical reactions or fireworks to launch. Students should also design some form of latching mechanism or electrical switch to launch the rocket.

The basic outcome for this project will be for students to have a deeper understanding of **Conservation of Energy**, **Kinematic Equations**, **Mechanical Design and CAD**, **Material Selection** and **Basics of Data Visualization using Software.**

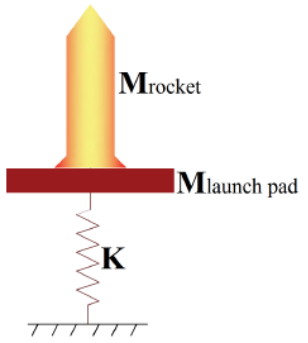

Figure 1: Illustration of an Rocket Launcher with a single spring to launch the rocket.

1.1 Outcomes

1. Students should know and apply Newtons laws of kinematics and principles of conservation of energy
2. Students should be able to design and model in CAD software
3. Students should be able to pick suitable materials for their project
4. Students should be able to use basic tools for word processing, graphing and presentation.

2 Problem Stages

The device will be developed in multiple stages. Students will be tasked to do the following

1. Model the device and derive equations for the following (30 marks).

   (a) Assume that we use a spring powered launchpad with effective spring stiffness K. Using energy balance derive a relationship between **the deflection of the spring (x) and the initial velocity (u)**. Assume you know the mass of the launch pad ($M_{launchpad}$) and mass of the rocket (M_{rocket}). Also assume that all the energy of the spring is transferred to the rocket.

   (b) Find an expression for the time required for the rocket to reach its maximum height.

   (c) Using Newtons kinematic equations derive an expression for **maximum height (h) reached by the rocket in terms of the acceleration due to gravity (g) and the initial velocity (u)**

   (d) Assume that $K = 50000N/m$, $M_{launchpad} = 500gms$, $M_{rocket} = 20gms$, For values of the deflection x ranging from 1mm to 20mm make a graph in Excel or Python or any other programming software of the **maximum height h vs the spring deflection**. If you change the value of K what happens to this graph. Submit a software generated graph of deflection vs the max height reached by the rocket.

2. Submit a detailed assembly drawing in Solidworks of the launchpad with all its components should be submitted by . The design should be balanced and should allow for alignment of the rocket so that it goes as vertically as possible. It should also provide for a latching mechanism or a switch in the Solidworks model. In case you are using multiple springs what is the equivalent spring stiffness? (20 marks)

3. Fabrication of the launchpad. Students should select appropriate launching mechanism and make their materials selection accordingly. (20 marks)

4. The launchpad will be tested in an open field and the maximum height reached by the rocket will be recorded. The time taken for the rocket to launch and come back down will also be recorded. The launchpad should not damage the given rocket. (20 Marks)

5. Complete the Pre and the Post PBL assessment (10 marks)

Students need to furnish a detailed report (typed and printed) with all the details requested above (design, fabrication, calculations, results etc). Students should provide pictures of fabrication process as well as Solidworks drawings and calculations. Neat and labelled computer generated graphs of the theoretical equations are also expected.

ASSESSMENT SHEETS FOR STAGES 1 & 2:

Mahatma Education Society's
Pillai College of Engineering, New Panvel

PROJECT BASED LEARNING

TOPIC: ROCKET LAUNCH PAD

STAGE-1 ASSESSMENT SHEET

Class: SE Mech–A **Academic Year:** 2018-2019 **Date:** 08 September 2018 Venue: P-401

Group No.

Group Members:	**Roll No.**	Name **of the Student**	**Sign.**
1.			
2.			
3.			
4.			

1. Design ideas generated (Y/N): _____
2. If Yes, number of design ideas generated: _____
3. Whether calculations performed for time to reach maximum height by rocket, and maximum height attained by rocket? (Y / N): _____
4. Mechanism/s used to store energy (Rubber bands / springs / flexible sheets / pneumatic / hydraulic etc.):
   _____
   _____
5. Whether Latching Mechanism or some form of Electrical Switch designed, to launch the rocket (Y/N):_____
6. Whether materials' selection made at this stage for different parts? (Y/N):_____
7. Whether the idea is being designed so as to meet the expected specifications (envelope volume of launcher = 50 x 50 x 50 cm^3, and mass = 3 grams)? (Y/N):_____
8. Whether CAD model of the most suitable design idea prepared, along with Orthographic Views showing dimensions? (Y/N):_____. If Yes, software used for modeling: _____
9. Whether a report on the preliminary work prepared, and submitted? (Y/N):_____
10. Suggestions / Improvements (if any):
    _____
    _____
    _____
11. Overall Rating of Stage-1 PBL Performance:
    - ☐ 1 – Very poor, needs a lot of improvement
    - ☐ 2 – Below average
    - ☐ 3 – Average
    - ☐ 4 – Good
    - ☐ 5 – Best
12. Judges' Signatures:

    _____ _____ _____ _____

MES's **Pillai College of Engineering**, New Panvel
PROJECT BASED LEARNING
TOPIC: ROCKET LAUNCH PAD
STAGE-2 (FINAL) ASSESSMENT SHEET
Class: SE Automobile **Academic Year:** 2018-2019 **Date:** 06 October 2018 **Venue:** Behind J-Wing

GROUP NO._____

Group Members:	**Roll No.**	**Name of the Student**	**Sign.**
1.			
2.			
3.			
4.			

1. Whether equations are derived for modeling the device? (Y/N)_____
2. Whether calculations performed for time to reach maximum height by rocket, and maximum height attained by rocket? (Y / N): _____
3. Whether software-generated graph of the max height reached by the rocket vs deflection of spring (or pressure inside rocket chamber, etc.) prepared? (Y/N):_____If Yes, software used for plotting graph/s:_____
4. Mechanism used to store energy (Rubber bands / springs / flexible sheets / pneumatic / hydraulic etc.):
   _____
   _____
5. Whether Latching Mechanism or some form of Electrical Switch designed, to launch the rocket? (Y/N):_____
6. Materials used for primary elements:_____
7. Whether the idea is being designed so as to meet the expected specifications (envelope volume of launcher = 50 x 50 x 50 cm^3, and mass = 3 grams)? (Y/N):_____
8. Whether CAD model of the most suitable design idea prepared, along with Orthographic Views showing dimensions? (Y/N):_____. If Yes, software used for modeling: _____
9. Whether a report on the work prepared, and submitted? (Y/N):_____
10. Whether a reasonably vertical trajectory of rocket travel path attained? (Y/N):_____
11. **Maximum Rocket Height attained after launch test = _____m.**
12. **Time taken for the rocket to launch and come back down = _____s.**
13. **Build Quality** of the fabricated Launch Pad: _____
14. Quality of submitted report: (Check for Equations derived, Calculations performed, Software plots, Results etc.)_____
15. Cost of the Fabricated Project: Rs._____
16. Suggestions / Improvements (if any):
    _____
    _____
17. **Overall Rating of Stage-1 PBL Performance:**
    - ☐ 1 – Very poor, needs a lot of improvement
    - ☐ 2 – Below average
    - ☐ 3 – Average
    - ☐ 4 – Good
    - ☐ 5 – Best
18. Judges' Signatures: _____ _____