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| Preliminary Design Report  PDR For Model Rocketry by InSpace |
| |  |  |  | | --- | --- | --- | | Nandish Panchal | [Date] | [Course title] | |

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# Team Composition and management

Team Pinaka is a multi-disciplinary team consisting students of various Departments of Lovely Professional University. Following is the list of persons involved:

|  |  |  |
| --- | --- | --- |
| Name | Discipline | Role |
| Pranav MP | Aerospace Engineering | Aerodynamics |
| Vijay Mishra | Aerospace Engineering | Design |
| Shalu Yadav | Aerospace Engineering | Aerodynamics |
| Prajwal | Aerospace Engineering | Motor and Propellant |
| Ishu | Aerospace Engineering | Motor and Propellant |
| Bhanu Mahesh | Robotics Engineering | Avionics and Electronics |
| V Manish | Robotics Engineering | Avionics and Electronics |
| Nandish Panchal | Mechanical Engineering | Manufacturing |

# Mission Overview

## Mission Objective

### Design Requirements

* Length: The rocket should not exceed **180 cm** from base to the highest point in launch configuration.
* Rocket body materials can include **Aluminium**, **Cardboard**, **PVC**, or **other material** with the body mass (including motor) under **15 kg** (Aluminium), **10 kg** (Cardboard), and **11.5 kg** (PVC). Motor mass is around **3 kg**.
* The rocket must be a **single-stage** powered by **commercially made model rocket motors** and should not exceed **2800 N-seconds** of total impulse.
* Ensure all parts (except recovery wadding) descend tethered together using **parachute recovery**.
* The rocket should carry a **CAN-sized satellite (CANSAT)** with a mass of **1.0 kg ± 0.05 kg**.

### Avionics Requirements

* All electronics must be enclosed and shielded from the environment, except for sensors. A structural enclosure is required to protect electronic components.
* Electronic circuit boards must be hard mounted using standoffs and screws. High-performance adhesives can also be used for mounting purposes.
* The rocket’s ignition must be carried out remotely. An external power switch with an indicator light or sound must be provided.
* The battery should support up to **30 minutes** of waiting time on the launch pad, in addition to the flight operations.
* Alkaline, Ni-Cad, Ni-MH, or Lithium-ion batteries are allowed. However, **Lithium Polymer** batteries are **prohibited**. Lithium cells should have a metal package similar to 18650 cells.
* There must be an easily accessible battery compartment, allowing batteries to be installed or removed in under a minute without requiring total rocket disassembly.
* Spring contacts should not be used for making electrical connections to batteries, as shock forces could cause momentary power disconnects.
* The rocket communications must use **XBEE / Zigbee** radio series (1/2/pro) or a similar system.
* The radios must have their **NETID/PANID** set to the team number.
* The radios should operate in a mode that does not interfere with other communication systems.
* The flight software must maintain and telemeter an indicator of its **state**. Example states are:
  + 0: BOOT
  + 1: TEST\_MODE
  + 2: LAUNCH\_PAD
  + 3: ASCENT
  + 4: PAYLOAD\_SEP
  + 5: DESCENT
  + 6: AEROBREAK\_RELEASE
  + 7: IMPACT
* In the event of a **processor reset** during the mission, the flight software should determine the correct state and resume operations accordingly.

## Mission Profile

## System Overview

### Rocket Configuration

### Major components

### Engineering drawings

### Launch and descent strategy

### Post-launch recovery

### Data retrieving and Analysis

# Subsystem Details

## Payload Subsystem

## Housekeeping Subsystem

### Mechanical Subsystem

### Communication and Data Handling Subsystem

### Electrical Power Subsystem

### Sensor Systems

# Flight Software Algorithm Description

# Ground station

# Rocket Integration and Testing

## Mechanical Systems

## Electronic Systems

# Operations Plan & Quality Control

# Technical Specifications

## Structural Design

Describe the materials and construction methods for the rocket body, fins, and nose cone.

## Avionics and Control Systems

Explain the onboard electronics, including any sensors, controllers, and communication systems.

### **a)** **Communication and Data Handling Subsystem**

The Communication and Data Handling Subsystem should mention clearly the TxRx antenna design & details, link margin, Boot time, Processor type, data interfaces, memory slots, Real- time clock, antenna material, XBEE / any other radio selection, transmission control, backup in case of transmission loss, data format, etc in adherence to Section [**5.5**](https://word-edit.officeapps.live.com/we/wordeditorframe.aspx?ui=en-US&rs=en-US&hid=UgcZ%2BCOc3kaQyWINYzcsUA.0.14.0&wopisrc=https%3A%2F%2Fwopi.onedrive.com%2Fwopi%2Ffiles%2FF039C0C49C604BF3!8674&wdo=2&wde=docx&sc=host%3D%26qt%3DDefault&wdp=3&uih=onedrivecom&jsapi=1&jsapiver=v2&corrid=e8959afa-f771-4480-9de3-e93ce28f78d5&usid=e8959afa-f771-4480-9de3-e93ce28f78d5&newsession=1&sftc=1&uihit=editaspx&muv=1&cac=1&sams=1&mtf=1&sfp=1&sdp=1&hch=1&hwfh=1&dchat=1&wdorigin=Other&instantedit=1&wopicomplete=1&wdredirectionreason=Unified_SingleFlush#_bookmark12)**.** [**Ground Station**](https://word-edit.officeapps.live.com/we/wordeditorframe.aspx?ui=en-US&rs=en-US&hid=UgcZ%2BCOc3kaQyWINYzcsUA.0.14.0&wopisrc=https%3A%2F%2Fwopi.onedrive.com%2Fwopi%2Ffiles%2FF039C0C49C604BF3!8674&wdo=2&wde=docx&sc=host%3D%26qt%3DDefault&wdp=3&uih=onedrivecom&jsapi=1&jsapiver=v2&corrid=e8959afa-f771-4480-9de3-e93ce28f78d5&usid=e8959afa-f771-4480-9de3-e93ce28f78d5&newsession=1&sftc=1&uihit=editaspx&muv=1&cac=1&sams=1&mtf=1&sfp=1&sdp=1&hch=1&hwfh=1&dchat=1&wdorigin=Other&instantedit=1&wopicomplete=1&wdredirectionreason=Unified_SingleFlush#_bookmark12)**.**

### **b)** **Electrical Power Subsystem**

The Electrical Power Subsystem should include schematic showing power connections that includes all power sources, resistor arrangements and all major components. The Payload should have an external switch.

### **Note: Use of Lithium Polymer batteries has been prohibited.**

All types of connections and mounting need to be shown clearly. Describe the power trade-off and selection. The kind of connection done (parallel or series) needs to be explained in detail.

The Power budget should include:

* Energy Balance
* Power consumption of each component/subsystem
* The total power consumed

### **c)** **Sensor Systems**

The Sensor Systems details should include a summary of all the sensors selected and the purpose for which these sensors are being used. Detailed information like interfaces, resolution, weight, cost, reason for selection of each of the following sensors shall also be included in the documentation.

* GNSS Sensor
* Altimetry
* Pressure
* Temperature
* Accelerometer sensor (Orientation/Acceleration data) – to take in to account the duration of flight, and sensitivity to be accordingly decided.
* Power Status
* Any other sensor

The team is required to clearly mention any trade-off while sensors selection power requirements and other supporting documents.

## **Flight Software Algorithm Description**

This section should include the details of functional requirements and mathematical formulations used in development of the flight software. The algorithm should be described in the form of a flow chart. The software change log should be maintained using standard software packages. This should also describe basic software architecture, programming language used, development environment and summary of the software tasks.

The following details should be included in the document viz.

* + Software sequencing timing diagram
  + Sampling rate or processor cycle time used for execution of various tasks
  + Telemetry and Telecommand details
  + Data storage and Handling
  + Software reset loop
  + Simulation mode strategy
  + Test methodology
  + Proto version testing details

## Recovery System

Describe how the rocket will safely return to the ground (e.g., parachute, streamer).

# Analysis and Justification

## Aerodynamics

Include basic calculations or simulations showing stability and drag.

## Structural Analysis

Ensure the rocket can withstand the forces during launch, flight, and recovery.

## Propulsion Analysis:

Verify that the engine/motor meets the mission requirements.

# Safety and Risk Assessment

## Personnel Safety

Identify potential design, fabrication, or operational risks.

|  |  |  |
| --- | --- | --- |
| Rank | Likelihoo**d** | Severity |
| 1 | Very Low | Negligible |
| 2 | Low | Minor |
| 3 | Average | Moderate |
| 4 | High | Major |
| 5 | Very High | Catastrophic |

## Failure Modes and Effect Analysis and their mitigation strategies

Discuss how you plan to minimize or eliminate these risks.

# Timeline and Budget

## Project Timeline

Provide a schedule for design, fabrication, testing, and launch.

## Budget Estimation

Include an estimate of the costs involved in the project, including materials, tools, and testing.

# Conclusion

## Summary

Recap the main points and reiterate how your design meets the mission objectives.

**Next Steps**

Outline what you plan to do after the preliminary design phase, such as further testing or final design adjustments.

# References

Cite any resources, standards, or guidelines you’ve used in developing your design.