Fabrication and Database Management of Cubesat

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ABSTRACT

As the trends in technology change day to day life, there is always a need for high-end technologies to be developed for bigger inventions to unveil for mankind survival. The idea of CubeSats from 1999 has enormously decreased the cost of developing satellites and launching them into space with great involvement of several space experiment applications. A Cubesat is a type of miniaturized satellite of sounding rocket payload used to teach space technology. Cubesat is made up of multiples of 10cm\*10cm\*10cm cubic units and have a mass of less than 1.4 kilograms. It is similar to the technology used in satellites. The Antennas is mounted externally, but the diameter can't increase until the Cubesat has left the launch vehicle. Cubesat enable low-cost applications in coordinated sensing and low-bandwidth communications. Cubesat missions are usually aimed for people to gain hands on experience of a mission planning and execution. The various environmental parameter data collected by the Cubesat is centrally stored in the XAMMP database management system and acts as a small ground station server.

Keywords— Cubesat, Sensors, Space, XAMPP Server, Space Outreach.

# INTRODUCTION

Satellites are designed to undergo several scientific experiments to improve life and living better. When this comes to launching the heavy satellites into space, the payload satellite plays a crucial role as it determines the type of launch vehicle to be used. Launching these heavy satellites in powerful launch vehicle used to be a huge discussion in terms of cost and their capabilities. Later, these are completely lowered using small satellites which often termed as CubeSats.

The CubeSats are also introduced to promote knowledge in the university students for developing satellites. The idea of miniaturizing the entire satellite into CubeSat undergoes standard scientific research and equipment under time-to-time supervision of respective expertise. The standard instruments such as solar panels for generating electricity with a power backup, communication modules for having a connection with ground stations on earth, the electrical power systems will regulate the flow of power in the CubeSat, the OBC is the brain for CubeSat to function as it gives the whole commands to what to focus on, there are different payloads used for different applications and it holds the superior place among all other instruments and mechanical structure body where all these are placed inside will be designed using aluminum alloys to support space weather conditions. Fabrication of CubeSat is mainly intended to enlighten the students in space technology to give real-time practical experience while working on Small satellites and experience the challenges faced while doing so. The immediate encouragement in privatization of the space sector in India has allowed several space agencies to develop CubeSats on several applications and launch them indigenously.

# Ease of Use

*A. Design*

The required original material for fabricating a CubeSat plays an important role in how long the satellite stays in the orbit and its reliability. Commercial equipment is built with deep research and verification process in lot involve huge finance. To minimize this cost, the whole CubeSat structure, materials, electronics, communication module and Intelligence is being designed, the on-board computer, solar panels and payload are an important part of CubeSat, materials, electronic kits were procured from suppliers and customize them according to the needs. The CubeSat structure is 3U standard and has 10 × 10 × 34 cm size. To this hull structure, every electronics and telecommunication systems are installed.

Designing consists of the architectural design and the detail design. Architectural design involves identifying the software components, hardware components, developing, decomposing them in processing modules & conceptual data structure, and specifying interconnection between the components. Detail design is concerned with the details of how to package the processing modules and how to implement the processing algorithms, data structures and interconnection among the modules and the data structures. The phase of the implementation is related to the assembling and installation of the software on the client side. The various procedures are involved for the implementing a software which include giving documentation of the software to the software to the client which consist of basic as well as technical part. It also includes checking of various hardware resources available with Technology and making sure the software is running properly on this machine.

## B. System Architecture

A system architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. A system architecture can consist of system components and the sub-systems developed, that will work together to implement the overall system. There have been efforts to formalize languages to describe system architecture, collectively these are called architecture description languages (ADLs).

I. System Architecture

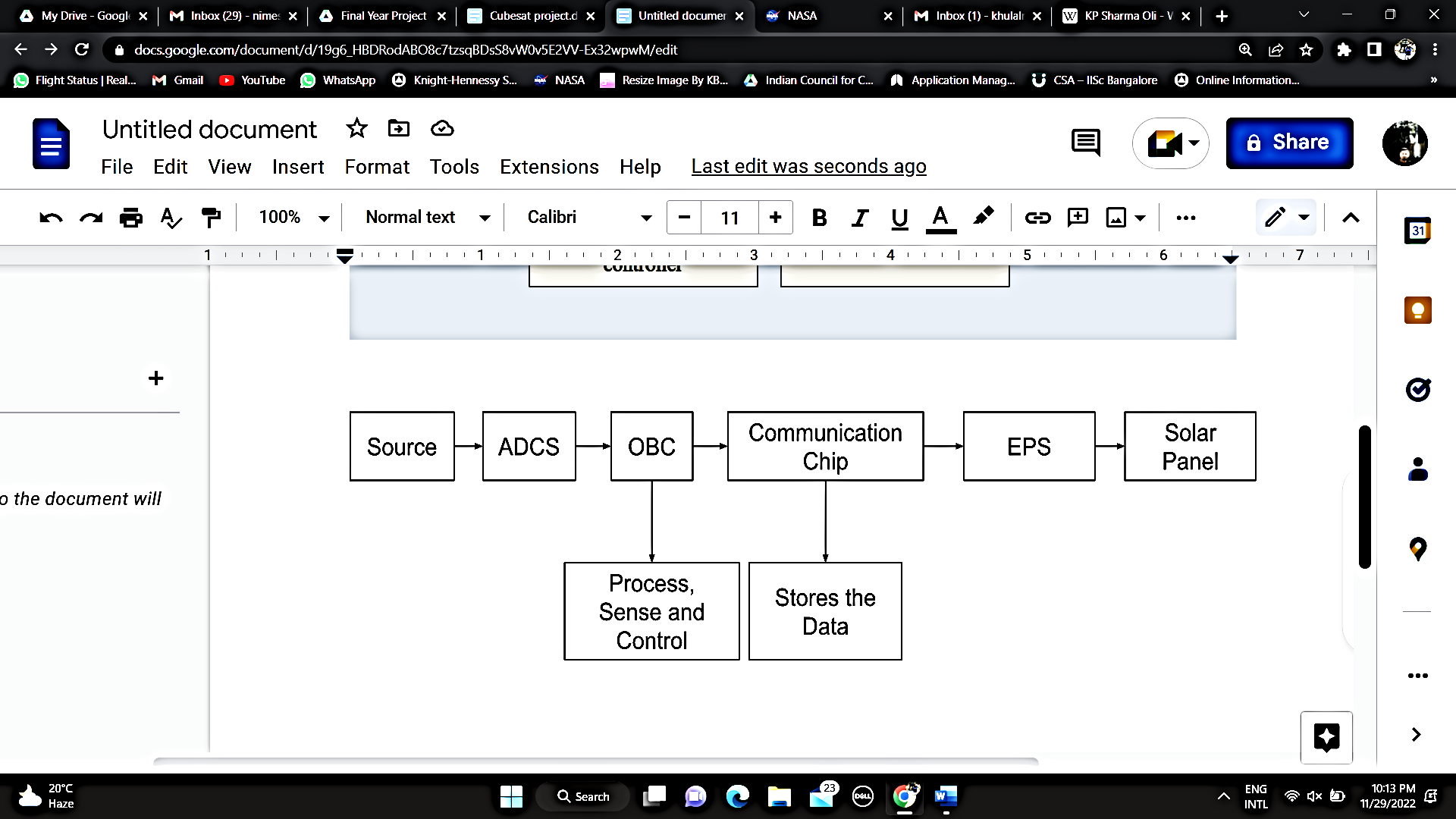


Fig: System Architecture of Cube Satellite

II. Block Diagram

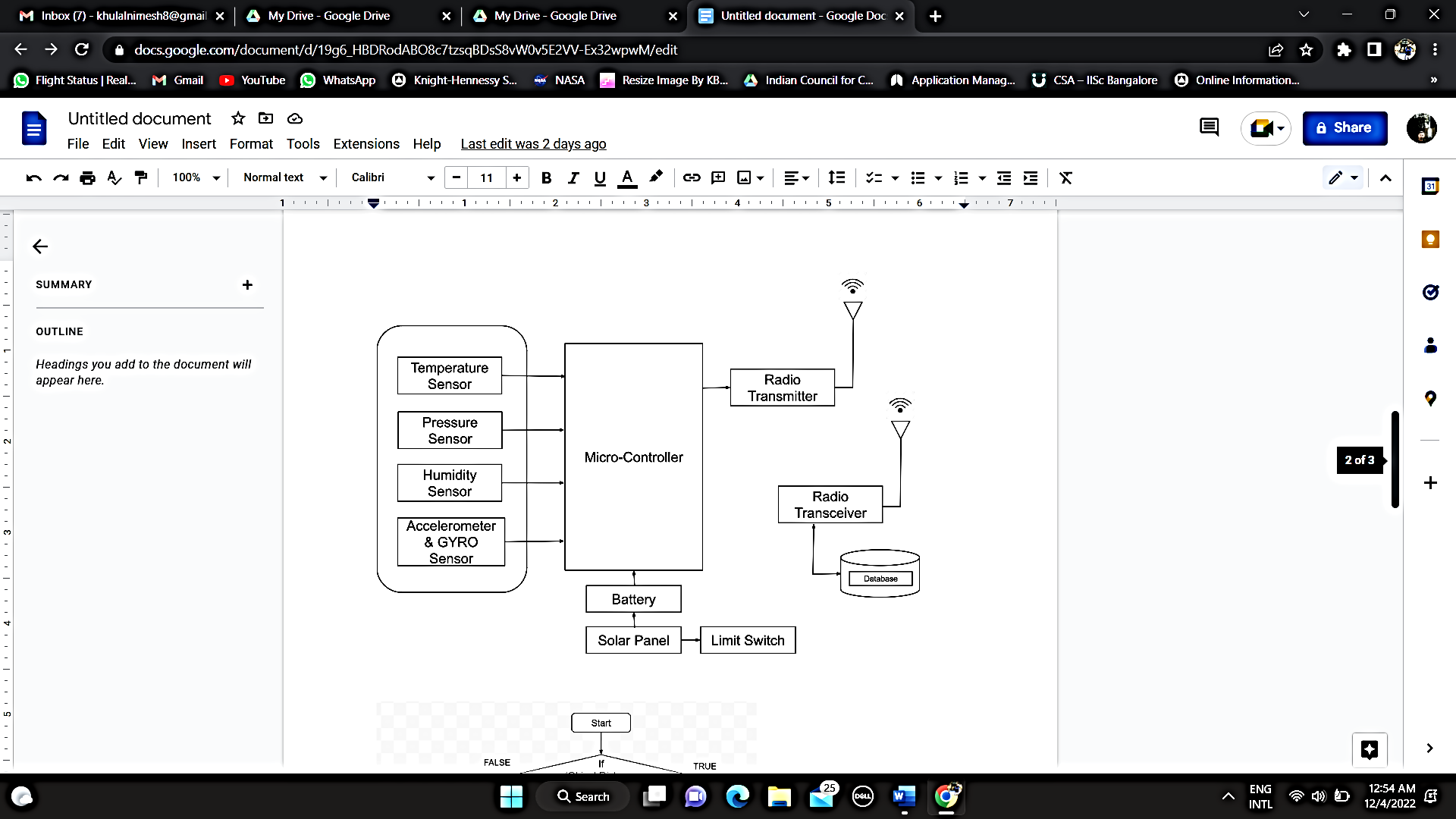


Fig: Block Diagram of Cube Satellite

The block diagram shows the connection of different sensors with microcontroller and output devices. The input unit consists of various sensors which are connected to the microcontroller and the collected data from the sensors is forwards to the local database server by using telemetry process.

III. Operating Temperature of Cube Satellite Subsystems

| S.No. | Cube Satellite Subsystem | | |
| --- | --- | --- | --- |
| Subsystem | T°min (°C) | T°max (°C) |
| 1. | BMP180 | -40°C | 80°C |
| 2. | MPU6050 | -40°C | 85°C |
| 3. | DHT22 | -40°C | 125°C |
| 4. | On-Board Computer | -40°C | 90°C |
| 5. | 5V Batteries | 0°C | 90°C |
| 6. | Radio Transceiver | -40°C | 90°C |
| 7. | Electronic Power Systems | -40°C | 90°C |

Fig: Operating Minimum and Maximum temperatures of cube satellite subsystems

## **A. Prototype**

Fig: Prototype of Cube Satellite Model

## **B. Results and Discussions**

The functional tests of satellite verified the behavior and overall performance of the satellite. The functional test tested the power distributions, communication, and telemetry process.

The result is plotted into the graphs. The development of cube satellite functioning well and as execution data is send to the server within minimum amounts of time.

## **C. Testing**

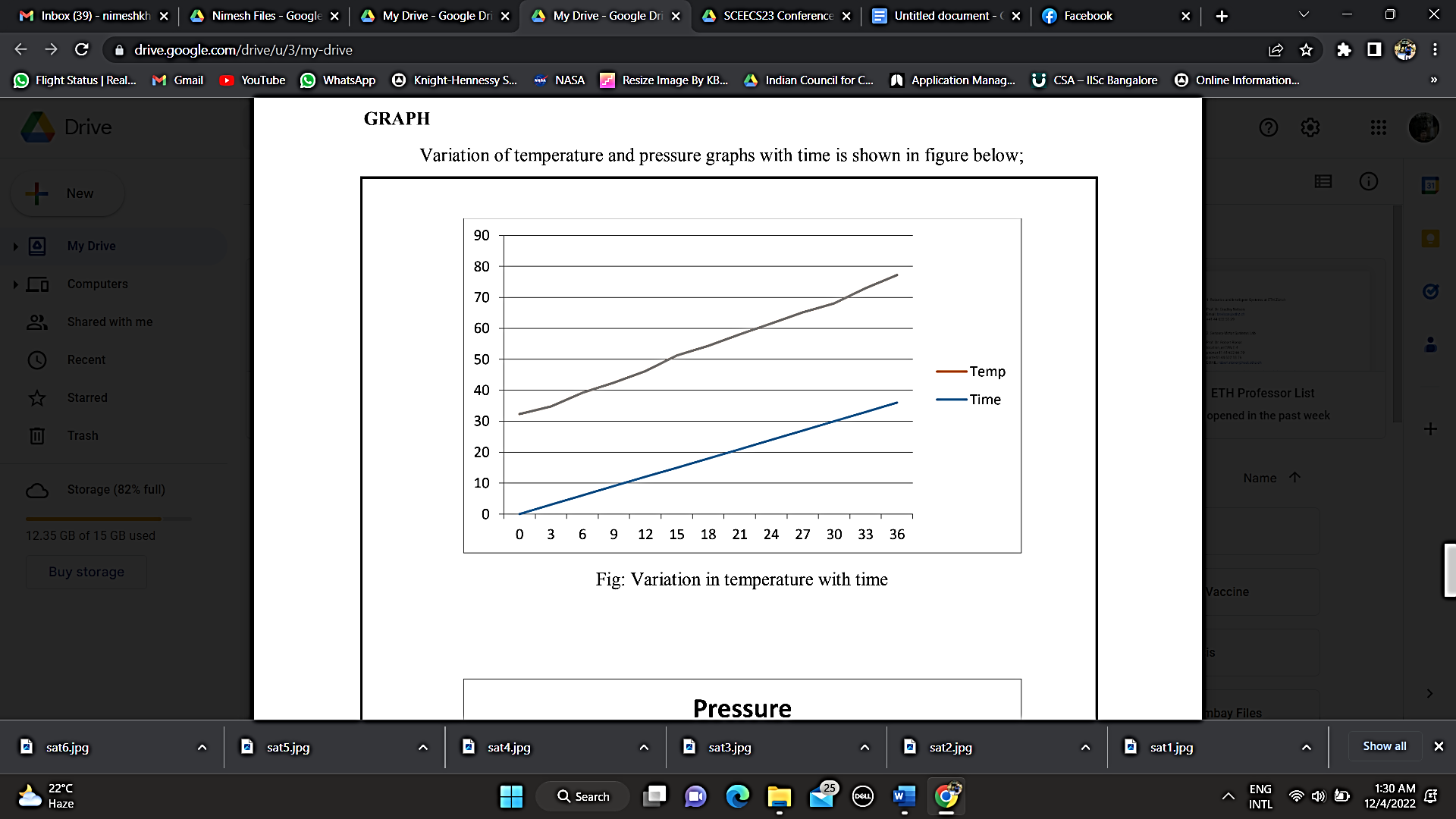


Fig: Variation in temperature (°C) with time (Sec)

The diagram shows the variation of temperature with respect to time. A time-temperature graph has temperature on the vertical y-axis and time along the horizontal x-axis. Temperature will be in degree Celsius (C) or Kelvin (K) and time in Second (Sec).

There is no relationship between time and temperature. Temperature is the intensity of heat present in an object, while time is the interval between events.

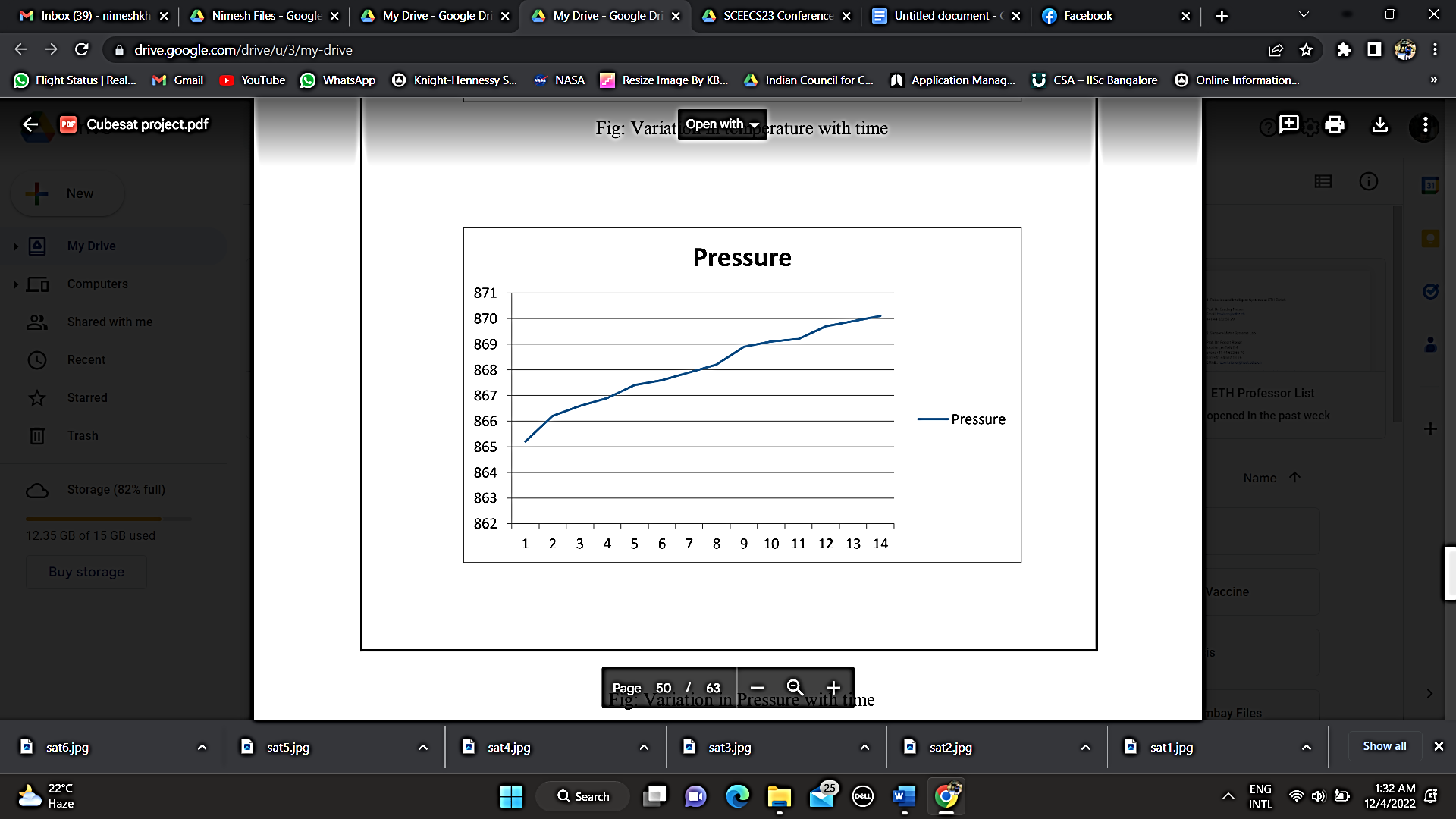


Fig: Variation in atmospheric pressure (Hg) with time (Sec)

The diagram shows the variation of atmospheric pressure with respect to time. A time-pressure graph has atmospheric pressure on the vertical y-axis and time along the horizontal x-axis. Atmospheric pressure will be in Hg and time in Second (Sec).

##### CONCLUSION

The cube satellite projects showcased the potential of small-scale satellite development, empowering individuals and educational institutions to engage in hands-on space exploration. It provided a platform for experimental learning,

Fostered creativity, and inspired future generations of space enthusiasts. The journey from conception to launch underscored the significance of teamwork, innovation, and the pursuit of scientific knowledge.

The cube satellite initiative stands as a testament to the spirit of exploration and the democratization of space. It serves as a blueprint for others interested in embarking on their own satellite projects, encouraging continued innovation and discovery in the realm of space exploration.

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##### REFERENCES

[1] Palani Murugan, “Satellite Projects by Indian Students,” IRS & SSS Programme Management and Systems Group.UR Rao Satellite Centre. ISRO, Bangalore-17, ISSN: 2278-0181, vol.9 Issue 03, pp.551-558, March 2020.

[2] Dong-Hyun Cho, Won-Sub Choi, Min-Ki Kim, Jin-Hyung Kim, Eunsup Sim and Hae-Dong Kim, “High-Resolution Image and Video CubeSat (HiREV): Development of Space Technology Test Platform Using a Low-Cost CubeSat Platform”, KARI Republic of Korea, in correspondence to Hae-Dong Kim, May 2019.

[3] Cristóbal Nieto-Peroy and M. Reza Emami, “CubeSat Mission: From Design to Operation,” pp. 1-24, August 2019.

[4] Md. Mahbubur Rahman, Divya Shankar and Shreya Santra, “Analysis of Radiation Environment and its Effect on Spacecraft in Different Orbits,” Skolkovo Institute of Science and Technology, Moscow, Russia, September 2017.

[5] Pradeep Shinde, Alvaro Quintero, Ibrahim Tansel and Sabri

Tosunoglu, “CubeSat Thermal Analysis,” Florida Atlantic University, Boca Raton, Florida, May 2017, [30th Florida Conference on Recent Advances in Robotics, May 2017]

[6] Rachid Darbali-Zamora, Eduardo I. Ortiz Rivera and Amilcar A. Rincon Charris, “Dynamic Real-Time Simulation Approach to Power Management Modelling for CubeSat Applications,” University of Puerto Rico – Mayagüez, Inter American University of Puerto Rico – Bayamon, USA, June 2019.

[7] Scott Madry, Peter Martinez and Rene Laufer, “Innovative Design, Manufacturing and Testing of Small Satellites,” ISBN 978-3-319-75094-1, Published in association with Praxis Publishing, Chichester, UK, Springer, 2017.

[8] Alejandro Garzón and Yovani A. Villanueva, “Thermal Analysis of Satellite Liberated 2: A Guide to CubeSat Temperature Prediction,” J Aerosp Technol Manag, 10: e4918. DOI: 10.5028/jatm. v10.1011, Universidad Sergio Arboleda – School of Exact Sciences and Engineering-Department of Mathematics, Bogotá, Colombia, May 2018.

[9] NASA. CubeSat 101; NP2017-10-2470-HQ; NASA, Headquarters/Media Fusion: Washington, DC, USA, 2017.

[10] L. Alminde, M. Bisgaard, D. Vinther, T. Viscor and K.Z Ostergard, “The AAU CubeSat Student Satellite Project: Architectural Overview and Lessons learned,” In Proceedings of the 16th IFAC symposium on automatic control in Aerospace, Saint Petersberg, Russia,14-18 June 2004.

[11] H. Heidt, J. Puig Suari, S. Nakasuka and R. Twiggs, “CubeSat: A new generation of picosatellite for education and industry low-cost space experimentation, In proceedings with AIAA/USU Conference on Small Satellites, Logan, UT, USA, 11-26 September 2000. [Cross Ref]

[12] National Research Council 2010, “Defending Planet Earth: Near-Earth-Objects Surveys and Hazard Mitigation Strategies,” Washington, DC: The National Academic press, ISBN: 978-0-309-14968-6, DOI: https://doi.org/10.17226/12