

KiboCUBE Academy: Live Sessions Questions & Answers

Date	Question	Answer
7 November 2023	What is the best resource to study small satellite systems in detail? Are there support mechanisms for primary and secondary education for small satellite development? Are there any recommended materials or methods?	CanSats and CubeSats can be used as training for many different levels of students. A CanSat is useful to educate younger generations, even for elementary school and middle school education, not using difficult technologies like electronic systems. For example, the mission of the CanSat could be to make the flight duration be a certain length (such as several seconds), or stay standing at the landing, etc. High school students can include electronic system design into CanSats. Both CanSats and CubeSats are useful to obtain problem-solving skills. UNISEC provides training courses for CanSat development. (http://cltp.info/). The on-demand pre-recorded lectures of KiboCUBE Academy also cover different topics related to small satellite development.
	Is there any computer simulation environment or software to test my satellite digitally before doing real physical tests? What is the best software to learn spacecraft design and simulations?	For example, S2E (Space Simulation Environment) is provided by the University of Tokyo as an open source tool for space simulation: https://www.space.t.u-tokyo.ac.jp/s2e-documents/
	Could the design of the satellite take into account the paradigm of space circular economy, focusing on recycling or cleaning after the satellite's operation? Planning in advance, for instance, by adding a magnetic material to reveal when the satellite becomes unusable, enabling the possibility of cleaning it up?	If the satellite is being deployed into low earth orbit of less than 500km altitude, like in the case of the deployment from the ISS, usually the satellite will only survive for a maximum one and half year and re-enter the atmosphere due to the gravitational pull from Earth. To make sure the satellite demises, the material and design of the satellite should be taken into account. Satellites can also use thrusters to drop the trajectory, if this can be designed into the satellite.
	How do you operate 2 On Board Computers (OBCs) in one satellite?	It is possible to operate as many OBCs as possible in a satellite. It depends on the size and power consumption of the OBCs and complexity of the system.



	<p>Which subsystem do you recommend focusing the most on to reduce the "Early Loss" common failures?</p>	<p>The receiver system is important and should be made redundant. Another very important system is the power control system and main OBC. A "reset (power off-on)" mechanism should be incorporated so that the satellite can survive even after the satellite power cuts off.</p>
	<p>Regarding cold welding phenomena, how much does it affect the deployable antenna design?</p>	<p>Cold welding is a phenomena when materials, such as aluminum, stick together on orbit, which results in malfunction for motors or hinges. If the surface of aluminum is covered by materials such as Teflon or is anodized, cold welding will not occur. For the deployable antenna, stainless steel is frequently used. The antenna is secured with a nylon wire in the satellite and is deployed by burning out the nylon wire with a nichrome line after it has been released into space. Since the time in space is not so long before the deployment, cold welding has not been an issue with this material.</p>
	<p>What is the optimal battery voltage level required for each satellite operation mode (sun acquisition, mission standby, mission)?</p>	<p>Standard battery voltage is determined by the number of batteries that are connected in series and the voltage of one battery cell. For previous missions, 4.5-5V, 12V and 28-30V have been used, but it highly depends on the mission of satellite. Voltage does not need to be changed for different modes.</p>
	<p>Is it possible to use command centric architecture (C2A) in microsatellites to reconfigure satellite functions by software?</p>	<p>Uploading information and rewriting programs using software is the most versatile method for changing the behavior of satellites. However, uploading the software takes a considerable amount of operation time (to check the integrity and transfer from submemory to main memory, etc.) and is sometimes a little risky since if there is an error in the information, it may lead to disrupting the entire system. C2A based reconfiguration of satellite behaviours is easy and safe, however it cannot fully change the behavior of the satellite.</p>



	<p>What were the most critical problems you had when achieving the main functions at the Hodoyoshi system level?</p>	<p>The most critical problem was that the sun sensor was affected by the Earth's albedo and recognized it as sun light. The satellite almost died because it was not able to generate electric power. By using a magnetic torquer, in a week, the satellite was able to manually control the attitude.</p>
	<p>Was the Hodoyoshi mission developed with Agile methodology? Is it possible to use this methodology for the development of microsattelites? What would be the main challenges?</p>	<p>The Hodoyoshi mission did not intend to follow the Agile development style, as the missions could be defined in detail from the beginning. But through the development process, the agile methodology was adopted to add more in-orbit experiments. Such possibility of agile development is one very important feature of micro/nano-sattelites, but in order to do so, the total satellite system should be simple and easy to understand so that there is freedom to add-on to the design when it is possible.</p>
21 July 2023	<p>Do the CubeSats released from the ISS not become a threat of collision with the ISS? What power source do CubeSats use for the orbit maneuver to escape the ISS orbit?</p>	<p>The CubeSats released from the ISS will not become threats to the ISS as the release trajectory is very well designed so that the distance between the ISS and CubeSats will never become very small. Many CubeSats do not have a thruster and the direction of deployment is decided to prevent collision with ISS.</p>
	<p>Do satellites orbiting the SSO orbit experience both eclipse and daylight?</p>	<p>Yes, the SSO orbit is with a typical 98-degree inclination. It will experience eclipse and daylight alternatively, whose ratio depends on the sun-shining angle with respect to the orbital plane. If the above angle is 0 degree, then there is no eclipse, and if it is 90 degree, eclipse will be about 45-48% of the total time.</p>
	<p>When do we need to implement orbit control systems? What are its functions?</p>	<p>Thrusters are used to deorbit or correct the orbit to keep mission operation. However, for CubeSats, there is usually not enough space for the propellant, necessary for deorbiting.</p>
	<p>What is the most common mode of failure of 1U CubeSats that we should be careful of?</p>	<p>The most common failure is communication errors. The causes may be the failure of the receiver electronics, failure of the antenna deployment of CubeSat. Besides that,</p>



		there are other typical causes like power subsystem failure, attitude control failure etc. Most difficult environment effect is radiation, so you should find out such components or parts tolerant against radiation.
	Do clouds pose any interference during data transmission between ground stations and CubeSats, and vice versa? What potential solutions can be implemented to address it?	Using radio waves in frequency bands such as the Ka band may affect communication due to rain attenuation. As a countermeasure, prepare a backup ground station in different sites , and use the backup station if communication is not possible with the main ground station because of rain. For other frequency such as UHF, VHF, S-band, X-band, you don't have to care about such interference.
	How was the Freedom satellite tracked without communication and power subsystem?	Satellites that do not have a communication system have a method of tracking orbit by mounting a reflector and applying a laser from the ground.
	Do CubeSats have enough power for Magnetic Attitude control?	Yes, small magnetorquers are common on CubeSats. It does not require much power. But the problem is that the control torque is very small and attitude maneuver requires very long time.
	For batteries for CubeSats, which type do you recommend: lithium Ion or nickel metal hydrate? Which one has better flight heritage?	Both batteries are used for CubeSats. Lithium Ion batteries have a higher energy density than nickel metal hydride batteries, so they can be made smaller.
	Which has the worst impact on battery life, the cold or the hot temperatures in space?	Batteries generally perform poorly at low temperatures. It is necessary to use the battery within a certain temperature range, as deterioration will be accelerated even on the high temperature side. The charge discharge cycles are giving damage to batteries, and if the depth of discharge(DOD) is large (such as more than 30 %), they damages battery more quickly
	Are there any CubeSats available in space now that have operational HF transmitters?	HF bands are not suitable for satellite communications because they reflect off the ionosphere.
	To check noise inside the satellite which instrument do you usually use?	Electromagnetic compatibility (EMC) tests are the most common way to check the noise inside the satellite, which is usually done before launch. The testing facility consists of a shield room for isolating the test objects from



		<p>external noise sources, antenna system to receive electromagnetic signal from the electronic equipment and to emit electromagnetic signal and a receiver. https://shiken.jaxa.jp/en/facility9_e.html</p>
	<p>Does the Ground Station have to adjust the receiver frequency to accommodate the Doppler Shift of communication frequency?</p>	<p>To account for frequency variations due to the Doppler shift, ground stations must accommodate frequency tolerances. Or automatic tracking of frequency generated by doppler shift is also possible, and some ground communication transceivers have such functions.</p>
	<p>What are the typical minimums and maximums of the temperature in LEO and the maximum rate of change of temperature?</p>	<p>The temperature of the surface of an object flying in an orbit around the earth varies depending on the degree of absorption of sunlight (infrared rays) by the material used and the degree of heat radiation from the surface. The temperature drops to minus 150 degrees in the shaded area and plus 120 degrees in the area exposed to the sun. By appropriately choosing the surface material, the inside temperature is usually kept at 0-50 degree.</p>
	<p>It is still possible to design reliable, critical subsystems (power, comms) of a CubeSat that is relatively robust against radiation effects without using rad-hars/space-qualified electronic components?</p>	<p>In order to develop radiation-resistant equipment without using space-approved electronic components, it is necessary to verify radiation resistance using radiation tests, which increases the hurdles of development, but still it is possible. If this system is subject to Single Event Effect (SEE) such as latch-up or upset, then you can make your system more robust against them by implementing reset(power off-on) function, voting function or electric fuse, which can cut the circuit quickly if excel current flows.</p>
	<p>In urgent data transmission situations, like uploading a program to the satellite, is it possible to switch to another ground station with a stronger signal to ensure the successful and timely delivery of the data?</p>	<p>It is possible to change the ground station, if the new ground station has the license to communicate with the satellite. But since the transmission power has an upper limit, it is not possible to emit stronger radio waves than that. Even if the transmission power is increased, it does not</p>



		necessarily mean that communication is possible.
	Where can one find the orbit parameters of operational CubeSats?	NORAD provides the orbit parameter of satellites as TLE (Two-Line Elements). Find the TLE information here: http://www.celestrak.com/NORAD/elements/
4 Nov 2021	When building a CubeSat from scratch, 1) How long does it take to develop a concept? 2) How do you select your components (especially electronic components so that they can withstand radiation and ionization effects)? 3) Are the materials/components to build a CubeSat easily obtainable?	Go to YouTube: https://youtu.be/poNbktVGd7o?t=3810
	What is the difference between the Command and Data Handling System (C&DH) and OBC (on-board computer)?	Go to YouTube: https://youtu.be/poNbktVGd7o?t=4089
	How do you configure the power budget? What are the suggested margins?	Go to YouTube: https://youtu.be/poNbktVGd7o?t=4145
	What is the general lifespan of a CubeSat?	The life span of a CubeSat is mainly affected by the orbit lifetime, meaning that how long the CubeSat can stay in orbit before it re-enters the Earth atmosphere. If the initial orbit altitude is about 400-500km, the orbit lifetime can vary from about a year to several years depending on the solar activity, which influences the density of the atmosphere, and hence the atmospheric drag acting on the CubeSat. Another factors include electric and electronic systems degradation within space environment, such as radiation, temperature change, charge and discharge cycles, and atomic oxygen, etc. University of Tokyo's world first CubeSat XI-IV has been working in



	<p>What is the minimum rate for a beacon to transmit and for how long?</p>	<p>space for more than 20 years since 2003.</p> <p>A CubeSat is not necessarily equipped with beacon transmitters. And there is no clear definition of the rate and duration of beacon signals. Each satellite developer shall conduct communication link budget design to define the specification of the beacon communication.</p> <p>Please also refer following On-demand Pre-Recorded Lecture of KiboCUBE Academy Season 2: Lecture #9 Subsystem Lecture for CubeSat: Communication System (https://www.unoosa.org/oosa/en/our-work/access2space4all/SatDevTrack_Webinars.html#Tag1)</p>
	<p>Do CubeSats have a safe mode and redundancies?</p>	<p>It is common that a CubeSat is designed in the way that it has several different operational modes, such as safe mode, communication mode, observation mode, experiment mode, etc. The safe mode can be regarded as a stand-by mode as well. These are up to project definitions.</p> <p>Implementation of redundancies in any level is depending on the project decision. Due to the limitation of the satellite resources, such as mass, envelop, power, etc., it is often very difficult to implement redundancies in CubeSats. But please consider “functional redundancy” instead. For example, you can use X-band communication line to downlink house keeping data instead of S-band, in case S-band line (S-band is usually used for house keeping data downlink) fails..</p>
	<p>Will computers on-board CubeSats need security systems such as anti-virus or some other form of Cybersecurity?</p>	<p>It is not common that a CubeSat or even a general satellite is equipped with anti-virus software. Another important consideration is encryption of uplink command. If the uplink command is hacked and someone sends “seemingly proper” uplink command, then the satellite control will be made by such persons. Therefore the uplink command should have some</p>



		encryptions so that other persons cannot send proper uplink commands easily.
	How large was the solar sail for the 1U CubeSat "FREEDOM" developed by Tohoku University?	The sail was 1.5 m x 1.5 m large. More on FREEDOM: - Orbit Verification Results of the De-Orbit Mechanism Demonstration CubeSat FREEDOM - Structural Design of De-orbit Mechanism Demonstration CubeSat FREEDOM
	What is the estimated budget for making a functional 1U CubeSat?	It is very difficult to answer this question. It can range from several 10K USD to several 100K USD depending on the satellite mission, components being used, testing facilities used, cost of human resources etc.
	How do we decide which mission constraints are more important than the other, if all of them cannot be fulfilled?	Go to YouTube: https://youtu.be/poNbktVGd7o?t=8086
	What is your recommended Computer Network Architecture?	Go to YouTube: https://youtu.be/poNbktVGd7o?t=8136
	Is there specific observation camera used for each specific design of CubeSat or it's just standard for all CubeSats?	There is no standard observation camera system for CubeSats. Terrestrial-use cameras can often be used in space after appropriate environmental testing, such as vibration test, thermal vacuum test, etc.
	Why is hub configuration for power Distribution more efficient in bigger systems?	Go to YouTube: https://youtu.be/poNbktVGd7o?t=6025 Electrical power distribution can be more efficient if the supply voltage is higher.
18 Nov 2021	Can a CubeSat be launched into deep space?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=1673
	Can CubeSats be launched above 400km?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=1692
	What is the average mission life-time of a CubeSat launched from the ISS?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=1791
	Are there any active active debris removal (ADR) missions right now?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=1877
	What is the specific cost of developing a CubeSat?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=1918



	What is the maximum mission life-time of a 6U or larger CubeSat?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=2025
	Given that the CubeSats launched from the Kibo module stays in a similar orbit from the ISS, can this pose a threat of a collision with other satellites or the ISS itself?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=2150
	If a CubeSat's orbit is about the same as the ISS, how likely is it to recover them by, for example, robotic arms on the ISS to then be re-purposed for possible subsequent missions?	CubeSats are required to be designed in the way that the altitude decays faster than that of the ISS for safety reason. Also, spacecrafts which intentionally approaches the ISS requires specific safety designs. Therefore, it is not realistic that a CubeSat can be re-captured by the ISS.
	Which software do you use for Link budget analysis?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=5730
	Is the software deployed on-board is open source? Can it be customized as per the mission objectives?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=5780
	Is it possible that we can upload commands at any point of time using intra communication between 2 satellites?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=5850
	Will the South Atlantic Anomaly (SAA) evolving radiation environments causing the Single Event Effects (SEE) / defects in the future hinder satellites missions on LEO and GEO in the SAA region?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=5946
	How many ground stations does a country need to have optical communication with the satellite?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=6089
	What are the guidelines or conditions for a clean room?	Go to YouTube: https://youtu.be/qeSIWP1NFp4?t=6378
2 Dec 2021	Which frequency band do you use for this BIRDS Global Ground Station Network?	Go to YouTube: https://youtu.be/OYbtmhNocjg?t=3070
	What physical/simulation flat-sat or test bed do you recommend?	Go to YouTube: https://youtu.be/OYbtmhNocjg?t=3120
	For the first 1-3 CubeSats as tech demonstrators/prototypes, would you recommend a shared ride or deploying from the ISS?	Go to YouTube: https://youtu.be/OYbtmhNocjg?t=3186



	<p>Among the BIRDS1 results; Why was there no uplink success at that time? How did you operate those satellites without uplink?</p>	<p>Go to YouTube: https://youtu.be/OYbtmhNocjg?t=3363</p>
	<p>Some satellites failed to uplink and downlink implying failure of the mission. How can we convince decision makers to provide budget again after such failure?</p>	<p>Go to YouTube: https://youtu.be/OYbtmhNocjg?t=3408</p>
	<p>How do you join the BIRDS project?</p>	<p>Go to YouTube: https://youtu.be/OYbtmhNocjg?t=3500</p>
	<p>Is the antenna tracking software self-developed or was it bought in a single package with the hardware equipment?</p>	<p>Go to YouTube: https://youtu.be/OYbtmhNocjg?t=5047</p>
	<p>Which level is the clean room that is used?</p>	<p>Go to YouTube: https://youtu.be/OYbtmhNocjg?t=5179</p>
	<p>How did you reach the conclusion to do shield only for the battery and not the rest of the components of the nanosatellite?</p>	<p>Go to YouTube: https://youtu.be/OYbtmhNocjg?t=5283</p>
	<p>For the BIRDS project, may COTS components of the participant country be used?</p>	<p>Go to YouTube: https://youtu.be/OYbtmhNocjg?t=5374</p>