NASA MINDS

Minority University Research and Education Project (MUREP) Innovative New Designs for Space

2020-2021

Rules and Rubrics Handbook

NASA, Kennedy Space Center
Rev: 1

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I. Introduction

What is NASA MINDS?

> ***"NASA is called to land American astronauts, including the first woman and the next man, on the Moon by 2024. We're committed to achieving this bold goal. Through the Artemis program, we will go to the Moon in a way we have never gone before – with innovative new partnerships, technologies and systems to explore more of the lunar surface than ever before. Then we will use what we learn on the Moon to take the next giant leap – sending astronauts to Mars."***
>
> **-NASA Administrator Jim Bridenstine**

NASA MINDS is a multi-semester undergraduate level activity that supports our Artemis mission and Human Exploration and Operations Mission Directorate. Students' skills, creativity and innovation are challenged as they are asked to design and build technologies needed for NASA's Artemis mission, with the support of their faculty. A vast array of technologies are needed, in areas such as propulsion, dust mitigation, solar arrays, swarming robotics, and many more. All Minority Serving Institutions (MSIs) are eligible to have a faculty-led student team. Student teams will submit a proposal with a design concept meeting all baseline requirements. Teams selected by NASA will receive $1,500.00 to be used in the build of their design. Teams must have a faculty advisor, and the faculty will receive a $1,000.00 stipend upon successful completion of all requirements. Selected team projects will be reviewed by NASA judges; teams are eligible for recognition awards of up to $5,000.00. Winning teams will receive a complimentary trip to NASA Kennedy Space Center for a recognition ceremony, behind the scenes tours with KSC Subject Matter Experts and enjoy a full day at the KSC Visitor Complex.

NASA MINDS is not a competition but rather a hands-on design and build collegiate learning experience. The most unique feature of NASA MINDS is found in its broad-based approach. While competitions focus on a specific technology all teams must work on, teams in NASA MINDS will select a technology of their own choosing that is relevant to NASA's Artemis mission. This will allow students to focus on technologies which interest and inspire them the most. The only constraint is that the technology and the goals of the team's project must support a need for the technologies required for Artemis.

How does NASA MINDS support Artemis?

Artemis presents the potential to inspire the next generation of technicians, researchers, engineers, and scientists. Most importantly, involving college and university students in the specific technologies that are both relevant to and needed by Artemis provides pathways for these students to enter the NASA and aerospace workforce. In addition, NASA MINDS believes that the work undertaken by students has the potential to uncover unique ideas, accelerate innovation, and aid in technological breakthroughs.

Background

NASA has led the charge in space exploration for more than six decades, and through the Artemis program we will pave the way to the Moon and on to Mars. The Artemis program is the next step in human exploration. It will enable us to land the first woman and next man on the Moon by 2024 and establish sustainable exploration with our commercial and international partners by 2028. Artemis will secure America's preeminence in space exploration and establish a strategic presence at the Moon. A lunar investment is also an investment in our future: it will create new jobs, help improve life here on Earth, and inspire a new generation and encourage careers in Science, Technology, Engineering and Math (STEM). Furthermore, Artemis is a part of NASA's broader Moon to Mars exploration approach, through which we will quickly and sustainably explore the Moon and enable humanity's next giant leap, human exploration of Mars. On the Lunar surface we will demonstrate technologies, expand commercial opportunities needed for deeper space exploration, and test methods to obtain water from ice and other natural resources to further our journey.

MUREP Overview

The NASA Minority University Research and Education Project (MUREP), administered through NASA's Office of STEM Engagement (OSTEM), provides financial assistance via competitive awards to MSIs. These opportunities are available to Historically Black Colleges and Universities, Hispanic Serving Institutions, Asian-American and Native American Pacific Islander Serving Institutions, Alaska Native and Native Hawaiian-Serving Institutions, Tribal Colleges and Universities, Native American-Serving Nontribal Institutions, and Predominately Black Institutions. In turn, these schools actively recruit and retain underrepresented and underserved students, including women and persons with disabilities, into STEM fields.

MUREP Objectives

- Expand and advance NASA's scientific and technological base through collaborative efforts with MSIs.
- Enhance the research, academic and technology capabilities of MSIs through multiyear grants.
- Assist faculty and students in research and provide authentic STEM engagement related to NASA missions.
- Provide NASA-specific knowledge and skills to learners who have historically been underrepresented and underserved in STEM.
- Assist NASA in meeting the goal of a diverse workforce through student participation in internships and fellowships at NASA centers and Jet Propulsion Laboratory (JPL).

Students and faculty supported by MUREP are able to engage in NASA-related research and mission-specific technology development. In addition, MUREP addresses the national challenge of attracting and retaining underrepresented and underserved university students in STEM. For more information about MUREP opportunities, please visit: www.nasa.gov/stem/murep.

NASA Core Values

NASA's core values are Safety, Integrity, Teamwork, Excellence and Inclusion.

On Thursday, July 23, 2020, NASA Administrator Jim Bridenstine announced the addition of the fifth NASA core value: Inclusion. As stated by Mr. Bridenstine, "Incorporating *Inclusion* as a NASA core value is an important step to ensuring this principle remains a long-term focus for our agency and becomes ingrained in the NASA family DNA. Together, we can continue to accomplish great things for all of humanity."

***Inclusion**: NASA is committed to a culture of diversity, inclusion, and equity, where all employees feel welcome, respected, and engaged. To achieve the greatest mission success, NASA embraces hiring, developing, and growing a diverse and inclusive workforce in a positive and safe work environment where individuals can be authentic. This value will enable NASA to attract the best talent, grow the capabilities of the entire workforce, and empower everyone to fully contribute.* For more information, please see https://www.nasa.gov/careers/employee-resources.

Why NASA MINDS?

The President's Council of Advisors on Science and Technology, established by Executive Order 13226, has previously called for a 33% increase in the number of STEM bachelor's degrees completed per year and recommended adoption of empirically validated teaching practices as critical to achieving that goal. The robust body of educational research conducted in STEM fields documents that active learning helps to improve student learning outcomes. A comprehensive meta-analysis by S. Freeman et al. ("Active Learning Increases Student Performance in Science, Engineering, and Mathematics," PNAS 111, 8410-8415 (2014)) showed not only increased grades but also decreased failure rates in courses in which the professors employed active learning strategies in addition to more traditional lectures. An excellent example of active learning is a capstone project.

A capstone project is generally a two-semester process in which students pursue independent research on a question or problem of their choice, and with the guidance of a faculty advisor produce a substantial paper that reflects a deep understanding of the topic. This may seem daunting, especially for underclassmen, however, it is an opportunity to push the boundaries of their potential as they strive for this higher goal.

As stated in https://www.edglossary.org/capstone-project/, "Capstone projects are generally designed to encourage students to think critically, solve challenging problems, and develop skills such as oral communication, public speaking, research skills, media literacy, teamwork, planning, self-sufficiency, or goal setting—i.e., skills that will help prepare them for college, modern careers, and adult life. In most cases, the projects are also interdisciplinary, in the sense that they require students to apply skills or investigate issues across many different subject areas or domains of knowledge. Capstone projects also tend to encourage students to connect their projects to community issues or problems, and to integrate outside-of-school learning experiences, including activities such as interviews, scientific observations, or internships."

NASA MINDS, through the implementation of a capstone project format, provides a platform for senior students and underclassmen to stretch their minds and capabilities, within a safe environment that allows for failure. Failure is expected throughout life but having the ability to learn from failure is considered a key path to growth. Learning from failure leads to humility, adaptation, and resiliency; unfortunately, most students are taught to fear failure from a young age. (https://nytimesineducation.com/spotlight/facing-failure-and-breeding-success)

As opposed to a senior design project, which is by design at the end of a student's bachelor degree, NASA MINDS allows for the participation of underclassmen as well as senior students. In this manner, underclassmen have the opportunity for this active learning multiple times, instead of just once. This also enables the opportunity to include community college students. Working on a NASA MINDS project will enable students to learn through a hands-on experiential activity, seeking out research ideas independently, and working through the technical problems and solutions to create innovative new designs. These designs will be reviewed by NASA, providing students the opportunity for direct feedback from these NASA subject matter experts. This provides an invaluable experience that will strengthen the students resumes as they seek internships and then a career.

II. Eligibility

Who is eligible?

NASA collaborates with space agencies around the globe on many programs including the International Space Station (ISS), Earth observation missions and those headed to the Moon or Mars and other off-world destinations. Building and nurturing an eligible, diverse and inclusive workforce is imperative to the future success of NASA and our Nation.

Eligible teams are comprised of students from schools classified as MSIs by the Department of the Interior (see www.doi.gov/pmb/eeo/doi-minority-serving-institutions-program). A reference list of MSIs can be found at this link. It is the responsibility of the institution to request designation as an MSI by petitioning the Department of Education. NASA does not determine MSI designation.

Collaborations between eligible schools is permissible. It is highly recommended that the schools be co-located in close proximity, to allow for full participation from both schools. Collaborating schools are treated as one, unified team. Team funding and award distribution is determined by the arrangement the teams have between each other. Awards to winning collaborating teams would read as follows:

Futurama State University and Mars University

Who should be on my team?

Decades of research by organizational scientists, psychologists, sociologists, economists and demographers show that socially diverse groups (i.e., those with a diversity of age, race, ethnicity, gender and sexual orientation) are more innovative than homogeneous groups (www.scientificamerican.com/article/how-diversity-makes-us-smarter/). This diversity extends to student majors as well. Teams are encouraged to be multi-disciplinary, as this will only strengthen the ability of your team to respond to all team requirements and deliverables. You will need to select a team lead when you apply, and you will need support for report writing, as well as social media and a team video (optional).

Team Categories

For the purposes of this document and the fulfillment of NASA MINDS requirements, the definition of an underclassman is a student in college who is not a senior. To be considered a senior, the general rule is that student must have completed a minimum of 90 credit hours.

- **Senior Teams**: If you have at least one senior student on the team, your team will follow the requirements for Senior Teams.
    - The Senior Teams must comprise of at least two undergraduate students, with at least one senior student. Graduate students may serve only as a mentor.
    - Senior Teams will be required to submit a systems engineering paper. Please see the Deliverable Components section for complete details.

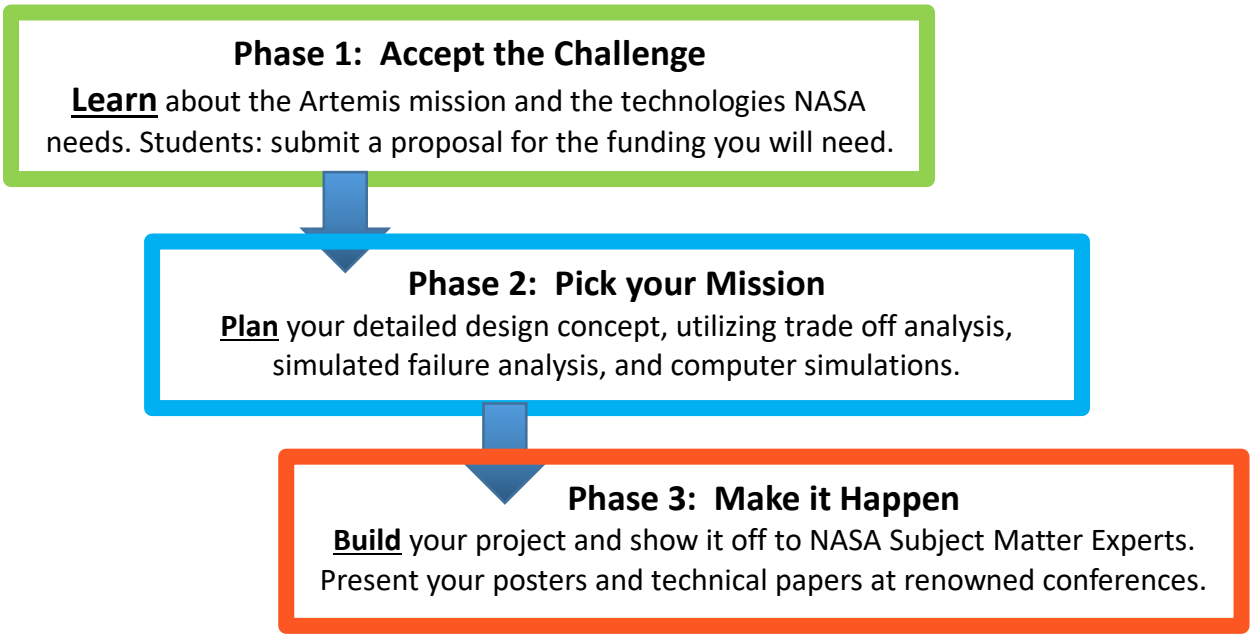
- **Underclassmen Teams**: If your team is only comprised of underclassmen (no senior students), your team will follow the rules for Underclassmen Teams.
    - Underclassmen Teams must be comprised of undergraduate students, with no senior students on the team.
    - Underclassmen Teams may be permitted to be comprised of only one student team member with a strong justification in your proposal. Graduate students may serve only as a mentor.
    - Underclassmen Teams will submit a technical paper. Please see the Deliverable Components section for complete details.

Rules for all Teams

- All students must be enrolled during the current or upcoming school semester and in good standing with their school (as certified by the faculty advisor in writing).
- The teams must include at least one faculty/staff member who is currently registered with the college or university. Funding and awards will be disbursed to the faculty.
- The number of team members on each team is at the discretion of the team. The team should have sufficient members to successfully design and build their project, as well as complete all required submissions on time. Teams are encouraged to recruit a multi-disciplinary STEM team, as well as communications, public affairs majors or other majors as deemed necessary. Teams must identify a team lead on their application.
- Students can only be members of **one** team.
- Schools may be permitted to have more than one team at NASA's discretion. Each team must have its own individual, unique project. Students can only participate on **one** team. Each team must have their own individual faculty advisor; faculty can only serve as an advisor for **one** team.

III. How do we participate?

The NASA MINDS initiative is comprised of three sequential phases.



Phase 1: Accept the Challenge

Accept the Challenge: Learn about the Artemis mission and the technologies NASA needs.

- Artemis Technology Gap – what are we missing?
- Artemis Technology Improvement – what technology could be even better?
- Artemis Ongoing Research – what are current areas of research you can work on?

During Phase 1, student teams will need to learn about the Artemis mission and the technologies NASA needs. Appendix A has a chart with acronyms used in this document and Appendix B has numerous links to information you may utilize. NASA MINDS has spec sheets with information on technologies needed that could serve as a potential topic for your project. Your team is **not** limited to only those topics. Those are provided only as starting point for your research and as a potential resource.

Student projects must support an Artemis technology need that aligns with the work of the Human Exploration and Operations Mission Directorate. Student teams will need to decide on

a project and submit a proposal that includes an overview and concept for your potential design. Teams that are approved for funding will receive $1500.00 to be utilized during the design and build of your project.

Submitting Your Proposal

Once you have done your research, and have a design concept in mind, your team will need to fill out the application to submit a proposal for a funding request. This proposal **MUST** be completed **online** in order to be eligible to receive funding. Email submissions will **NOT** be accepted. Teams will adhere to all the requirements in the online proposal and in this rule document. The application is available here. Remember to meet all due dates as indicated online. **Teams are requested to set up a team email address before applying**. This team email address will be used in the first step of creating an account, which is required in order to submit a proposal. This team email address will allow any team member with access to that email to log in and check team acceptance status and team deliverables status. Please read all details carefully and follow all instructions when applying and submitting your proposal. More information is included in Appendix C.

There are 50 team slots available for Fall 2020/Spring 2021, which may be awarded on a rolling basis. Therefore, teams are encouraged to submit their proposals well ahead of the deadline. After the 50 team slots are allocated, other teams may be waitlisted. Teams that are waitlisted must continue to meet all deadlines to remain on the waitlist. Teams deciding to withdraw must notify NASA MINDS so that others team can be offered the opportunity to be eligible for funding.

Phase 2: Pick your Mission

Plan your detailed design concept. This is a multi-semester project which will require a significant amount of planning. Your proposal will include a high level description of your project.

During Phase 2, which is the fall semester, you will develop a detailed design concept, utilizing trade off analysis, simulated failure analysis, and computer simulations. You should utilize software such as Mat Lab, Solid works, AutoCAD, etc. to refine and test your designs. Keep detailed logs of your work to ensure other team members know what has been tested during the design process. Plan your purchases and ensure you have a contingency fund.

Phase 3: Make it Happen

Build your project and show it off to NASA Subject Matter Experts. Present your posters and technical papers at renowned conferences.

During Phase 3, which is the spring semester, you will build your project. It is anticipated that you may need to make design changes along the way, as you find out what works and what doesn't work. That is expected. This is where you will find out how accurate your design concept and computer simulations are. Things don't always work the way they do in a virtual environment! Even as you begin your build, you may decide to change your design. You will want to document all of these changes as you go through this process. This will become part of your technical paper (Underclassmen Teams) or systems engineering paper (Senior Teams). Take plenty of pictures during this process! While we always want our designs to work, there may be reasons why it does not or cannot work. Be sure to document that and include that in your papers as well.

Safety

Instilling a culture of safety is a value that every individual in the NASA community must embrace as we pursue NASA's mission and vision. NASA MINDS has adopted safety as a core value and has established the framework for safety leadership in all aspects of the program. Everyone is responsible for safety during the design, build, and testing of your projects.

NASA believes that the teams that take the lead in developing safety programs and policies have a positive and lasting impact on each team member, mentors, advisors, their communities, and their present and future work places.

Teams are reminded that you must always follow the rules and regulations applicable in whatever lab or facility you are utilizing. Remember to use good workshop and engineering practices and principles as outlined in Appendix X, which includes a sample safety checklist. This is not a comprehensive list but can serve as a quick safety check of your workstations.

Deliverable Components

You did it! You've submitted a proposal and received funding, you planned your detailed design concept, and you're working on building your hardware. You need to show off your hard work to the NASA Subject Matter Expert judges! Your project is demonstrated in several ways, as outlined below. This is why it's important to document your process along the way. Make sure you keep track of due dates for these submissions.

Systems Engineering (SE) Paper – (required for Senior Teams)

Papers should discuss the SE methods used to design and build your project. The purpose of the SE paper is to encourage the teams to use the SE process while designing, building and testing their projects. Systems engineering is a valuable skill that you can learn and add to your resume.

Technical Paper – (required for Underclassmen Teams)

The technical papers will follow the format of a conference paper. Teams will summarize your methods, results and most important achievements or discoveries. Presenting your papers at renowned conferences is very prestigious and allows you to network with industry as well as hone your skills as a presenter.

Poster – (required for all teams)

Student teams will submit an electronic research poster, highlighting their most important or most interesting finding or implementation from their project. Posters provide a visual method to share your research or project. Poster presentations are another opportunity to attend and present at renowned conferences.

Project Overview and Concept Video – (required for all teams)

You will need to provide a link to your YouTube video documenting your design build. The video is solely to assist in the technical evaluation of the project, it will not be judged nor be eligible for awards. It does not need to be polished nor formally edited. The audio (if needed) and video need to be clear and presentable. (High ranking teams will be selected as finalists for a live, online demonstration with a NASA judge.)

Creative Team Video – (optional)

All teams are encouraged to document their NASA MINDS experience by submitting a Creative Team Video. These videos are intended to be a fun, creative way to show off your work to the world. This category, Creative Team Videos, is not required.

How do we get our team funding?

A Preliminary Design Review is a requirement for teams to be eligible for funds to build your project. This is not a points-based rubric, it is a pass/fail. Teams who satisfactorily complete all components will receive $1500, to utilize in the spring semester for the build portion of your project. This is an initial plan. As you execute your project, things will change and your project will evolve, which is okay and expected. In your Systems Engineering Paper you can discuss the changes to your plan and how your project adapted.

Maximum length of the plan is 5 pages. Any content over the 5 pages will not be reviewed.

Preliminary Design Review Criteria	
Element	**Pass/Fail**
Title/Team Info: Include title of paper, college/university name, faculty advisor's full name, team name, full names of all team member and team email.	
Formatting: Formatted professionally; organized clearly so that each required element is easy to find; correct spelling; text no smaller than size 12-point font in the main body; text no smaller than size 9-point font in graphics and tables.	
Initial Project Schedule: Provide a Gantt Chart or equivalent that shows the project's major due dates and events to include: Start Date, Completion Date, Major Review Milestones, Deliverables Dates, and Important Milestones related to budget, technical performance, and testing.	
Budget: Provide an estimate of the total project budget, inclusive of all possible costs, including any additional funding that you hope to obtain. Be as detailed as possible.	
Research: What have you learned about the Artemis mission? How does your project support NASA's Artemis mission? What changes have you made from your original proposal based on the research you have done? Why do you believe your project has the potential to be successful?	
Technical: An updated, detailed description of what you plan to build. Include the technological gap, current research, or problem this project seeks to address. A visual graphic of the prototype must be included, that provides a clear, high-level depiction of your overall final design. This may include SolidWorks or AutoCAD drawings, and additionally, flow charts, diagrams, etc.	

Eligible purchases with your $1500 team funding include:

1. Hardware
2. Software and/or software licenses (e.g. SolidWorks, MATLAB, AutoCAD, etc.)
3. Travel to technical resources (as required)

Your faculty will receive the funds and will have the responsibility for oversight of the $1500 funding. However, it is ultimately up to the team to implement and execute a proper plan in order to have a successful project.

IV. Timeline and Deliverables

All items are due by 3:00PM Eastern Time on the date listed – *teams failing to meet the deadlines will be removed from consideration. Issues with access to the system will not be accepted as a reason for delay.*

2020-2021 Academic Year Schedule		
Description	**Start**	**End**
NASA announces call for proposals	Aug 17, 2020	
NASA receives applications and proposals	Aug 17, 2020	Oct 7, 2020
NASA reviews proposals	Sept 1, 2020	Oct 9, 2020
NASA notifies institutions/teams of projects accepted (Note: Rolling proposal review planned for 2020-2021 implementation)	Sept 15, 2020	Oct 9, 2020
Teams work on project design	Sept 15, 2020	Dec 15, 2020
Thanksgiving 2020	Nov 26, 2020	
Teams submit Preliminary Design Review to NASA		Dec 1, 2020
NASA disburses funds to institutions	Dec 1, 2020	Dec 30, 2020
Teams purchase material for their projects	Jan 1, 2021	Mar 26, 2021
Teams build and test their projects	Jan 15, 2021	Mar 26, 2021
Teams submit project documentation (Poster, Tech Paper/SE paper, Project Video, Team Video)		Mar 26, 2021
Teams provide NASA a ledger of materials purchased with the $1500 funding		Mar 31, 2021
Easter 2021	April 4, 2021	
Finalist teams conduct live, online presentations to NASA Subject Matter Experts	April 26, 2021	April 30, 2021
NASA selects and announces winners		April 30, 2021

All team instructions regarding deliverables will be available at https://manager.submittable.com/user/submissions **after** you create an account and **after** you are accepted as a NASA MINDS team. You will not be able to access this link unless you are an active NASA MINDS team.

IMPORTANT NOTICE:

Since Fall 2020-Spring 2021 is the NASA MINDS inaugural year, there may continue to be slight updates to the timeline. Your faculty advisor and team lead will be notified of any changes, and the website will be updated to reflect any potential changes. It is the responsibility of the teams to stay informed of these changes and follow any new guidelines.

Award Categories and Recognition Awards

Award Categories	Recognition Awards
Senior Teams: Overall Design, Build, and Demonstration	
1st Place Grand Champion	$5,000.00
2nd Place Team	$2,500.00
3rd Place Team	$1,000.00
Underclassman Teams: Overall Design, Build, and Demonstration Awards	
1st Place Champion	$3,000.00
2nd Place Team	$1,500.00
3rd Place Team	$750.00
Systems Engineering Paper (Senior Teams)	
1st Place Team	$500
Technical Paper (Underclassmen Teams)	
1st Place Team	$500
Poster Presentations Award	
1st Place Senior Team	$500
1st Place Underclassmen Team	$500
Creative Team Video Award	
1st Place Senior Team	$500
1st Place Underclassmen Team	$500

V. Rubrics and Presenting Your Project to NASA

Senior Teams: Systems Engineering Paper (Required)

Each senior team must submit a SE Paper electronically in PDF. The purpose of the systems engineering paper is for a team to demonstrate how they used the systems engineering process in designing, building and testing their project. All required elements of the rubric must be discussed in the main body of the paper; you may reference the appendix and provide supporting information there. For reference, undergraduate course materials in NASA SE are available at www.spacese.spacegrant.org.

Scoring Rubric - Systems Engineering Paper – 25 Points	
Element	**Points**
Content and Format 1) Format: The NASA MINDS SE Paper shall be formatted professionally as required for submission to a professional journal: organized clearly so that each required rubric element is easy to find; with correct grammar and spelling; with text no smaller than size 12 point font in the main body and appendices; text no smaller than size 9 point font in graphics and tables; using professional journal margins; single spaced; and, consist of a maximum of 20 pages in the main body not including the cover page, title page, table of contents, and references pages. Up to five additional pages of appendices shall be allowed and shall be referenced and discussed in the main body. Only the first 20 pages of the main body and the first five pages of appendices will be subject to judging. The cover page must include: team name, title of paper, full names of all team members, university name, and faculty advisor's full name. 2) Faculty Signature: The cover or title page shall include the signature of the sponsoring faculty advisor and a statement that he/she has read and reviewed the paper prior to submission to NASA. 3) Reason for using SE: A statement shall be included early in the main body explaining the reason the team used systems engineering in the NASA MINDS project (more than "it is required"). (e.g. What benefit did it provide? In what way was systems engineering valuable to your project?)	**There are 3 points for 3 elements, one point each (3 points max)**

Project Management Merit 1) Focus the paper on the systems engineering work you performed to develop the subsystems/components and incorporate them into the whole system. 2) Major reviews: At a minimum, descriptions of how the System Requirements Review (SRR), Preliminary Design Review (PDR), and Critical Design Review (CDR) were conducted, and how the system design and project plans changed as a result of external reviewers' comments. 3) Schedule of work: Discuss the project schedule and its evolution from inception to project decommissioning (original planned schedule before project start: actual schedule performance with schedule changes tracked against the original schedule, reported as a minimum at major reviews). Demonstrate in the discussion that the schedule was used to manage the project. 4) Cost budget: Discuss the budget and its evolution for total project costs (including travel if required); estimated/predicted costs before project start, with actual costs tracked against estimated, reported as a minimum at major reviews as the project matures.	**8 points for 4 elements.** **2 bonus points may be awarded for exceptional work (10 points max)**
Systems Engineering Merit 1) Concept of operations (Describe how the system elements at each system hierarchy level will be operated to accomplish the system objective) 2) System hierarchy (A top-down breakdown of the system design; the elements across each level in the hierarchy should be the central topic reviewed and baselined at each control gate or major review) 3) Interfaces (Identify key interfaces between system elements in the system hierarchy at each system hierarchy level, including external interfaces) 4) Requirements (Identify the key requirements for system design, operations, interfaces, testing, safety, reliability, etc., stated in proper "shall" language. Address system and lower level requirements. These are the requirements that should be addressed when you discuss verification.) 5) Technical Performance Measurement (Identify and discuss technical measures that are important to achieving your design, how they are allocated to system elements in the system hierarchy, and how they are tracked at each subsequent major review as the system matures through verification. Demonstrate the budgeting and management of these important technical measures throughout the design process.)	**8 points for 8 elements, one for each element.** **Up to 4 additional points for exceptional work and additional SE methods used.** **(12 points max)**

6) Trade Studies (Discuss how important system decisions were made using a trade study methodology, with key decision results captured as system derived requirements.) 7) Reliability/Safety (Discuss design and operations considerations for assuring safety in the event of a system component failure during operations, and design and operations considerations for assuring successful completion of the objective without a failure.) 8) Verification of meeting system requirements (In the context of the concept of desired operations, discuss how you assure that the as-built system satisfies all the key driving requirements identified and discussed in the paper.)	

Underclassmen Teams: Technical Paper (Required)

The technical papers will follow the format of a conference paper. Teams will summarize their methods, results and most important achievements or discoveries. You may reference https://www.ieee.org/conferences/publishing/templates.html and https://www.ieee-pes.org/templates-and-sample-of-pes-technical-papers. These templates serve as guidelines for the technical report, and references should be formatted as they are specified in the templates.

Scoring Rubric: Technical Paper - 20 points	
Element	**Points**
Content **Originality:** Content contains original treatment of, or new perspective on the topic. **Research Approach:** The research approach is novel and/or sophisticated and appropriate for the purpose of the teams' project. **Results:** Data collection and assessment results are very clear and logical, strongly supporting the goals of the paper. **Relevance:** The project concept makes a significant contribution to the Artemis mission.	**8 points for 4 elements.** **3 bonus points may be awarded for exceptional work (11 points max)**
Focus **Goals:** The goals are strongly developed and explicitly stated. **Order:** The order in which ideas are presented is clear, logical and effective. **Conclusions:** The conclusions are very well formulated and are strongly supported by the data.	**6 points for 3 elements (6 points max)**
Language **Style:** The paper is clear, concise, and consistent. **Mechanics:** In exceptional papers, the writing is easily understood and well structured, and does not contain any significant grammar or spelling errors. Poor papers include pervasive grammar or spelling errors, which distort meaning and make reading difficult.	**3 points max**

All Teams: Poster (Required)

Student teams will submit an electronic research poster, highlighting their most important or most interesting finding or implementation from their project. Posters provide a visual method to share their research or project. Teams should use the guidelines provided on "How to Create a Research Poster: Poster Basics" at https://guides.nyu.edu/posters. These posters may be used by the student teams to present in person at a conference. Other links are provided in Appendix B.

Scoring Rubric: Poster - 25 points	
Element	**Points**
Title/Tagline: Includes a title and takeaway line for the poster. School name, team name and team member names are included.	**1 point**
Readability: The poster is easy to read and has a balanced amount of graphics vs. text.	**1 point**
Problem Statement: The team adequately defines the problem being addressed (50 words maximum)	**2 points max**
Objective: This should provide a description of how the project addresses the problem and may include information about trade-off studies, desired attributes, and/or design choices. (100 words maximum)	**3 points max**
Prototype: A visual graphic of the prototype is present and highlights innovations and/or important components of the design.	**3 points max**
Trade Table: Provides an adequate description of trade-off studies completed during the design process. (Includes at least 2 points of comparison)	**3 points max**
Data: Provides a graph or table that presents relevant information from the results of testing that adequately describes the intent of the project.	**3 points max**
Results/Conclusion: Includes an adequate summary of the design process, including final results and a discussion of the next steps to improve the design.	**3 points max**
Engineering Design Process: Adequately illustrates the iterative process the team went through to accomplish their objective(s).	**3 points max**
Up to 3 additional points for exceptional work	**3 points max**

All Teams: Creative Team Video (Optional)

All teams are encouraged to document their NASA MINDS experience by submitting a Creative Team Video. This activity is not required. It is completely optional. However, this is a great way to show off on social media to friends and family.

Scoring Rubric: Creative Team Video (optional) - 10 points	
Element	**Points**
Story: Does the video paint a full picture? Does the viewer walk away with insights into the experience?	**2 points max**
Creativity: Is the approach unique and or innovative in any way?	**2 points max**
Passion and Enthusiasm: Does the video communicate the team's passion and enthusiasm for the project?	**2 points max**
Technical Quality: Is the audio/video clear, are there interesting shots, and good transitions between shots, as well as cohesiveness. Is the video between 3-7 minutes long?	**2 points max**
Up to 2 bonus points for creativity and interest	**2 points max**

All Teams: Finalists Project Demonstration Rubric

High ranking teams will be selected for a live, online demonstration of their project to a team of NASA Subject Matter Experts. It is a very prestigious honor to be selected for this final project demonstration. It means your project and deliverables were well received by the NASA judges. You should be proud of your accomplishment for making it to this level!

Scoring Rubric: Finalists Project Presentation - 50 points	
Element	**Points**
Goals and objectives: All project goals and objectives are clearly and concisely stated, presenting a strong overall message**.**	**5 points max each:** **Exceptional: 5 points** **Very Good: 4 points** **Good: 3 points** **Fair: 2 points** **Poor: 1 point** **Not included: 0 points** **50 total possible points**
Broader impacts: Many impacts are clearly presented, showing deeper insight into the project	
Creativity / Originality: Extremely creative and/or original problem-solving process is displayed in an innovative way that enhances the overall project**.**	
Verbal communication skills: Exceptional confidence with the material is displayed through clear articulation and enthusiasm**.**	
Technical merit / Soundness of the approach: The approach presented is precise, detailed, in depth, and well supported**.**	
Design completeness / Polish: The design completeness and polish provide a strong example that shows a clear structure, indicating each part of the design process in a comprehensive format.	
Consideration of stakeholder requirements: The design shows how stakeholder requirements were incorporated into design plan and tradeoff studies.	
Project demo / Display quality: The project demo / display illustrates best practices for information flow, with visual components enhancing the main points of the project.	
Teamwork / Division of Labor: All team members are extremely familiar with every aspect of the project, demonstrating a thorough understanding of what is required for a successful project.	
Overall project impression: Up to 5 bonus points for exceptional work.	

NASA judges will determine how many teams will be chosen for this live demonstration based upon the overall quality of the projects submitted each year. These student teams will be selected based upon the scores for your paper and poster deliverables, and the information in

your project overview videos. (Your team is not required to submit a Creative Team Video, and it will not count against you.) The number of teams selected for a live demonstration may vary each year. If your team is selected for a live presentation, you will receive a certificate indicating that you were selected as a finalist.

Your team will be provided complete details on the exact dates and times once the team selections are finalized. If your team cannot present during the time slot allocated, your team will forfeit the ability to provide a live demonstration and will be unable to earn the top awards. This will be a web-based presentation and will not require any specialized software. You must be prepared to present during the week of April 19-23, 2021 at the time slot allocated for your team. We will not require the entire team to be online, but you must have enough team members to thoroughly and accurately present your project and answer technical questions.

This will be an interactive, live, online session with NASA judges. Don't miss out on this prestigious event!

VI. General Information

Disputes

All issues will be forwarded to the NASA Project Manager for resolution of any NASA MINDS disputes.
The NASA MINDS Project Manager and Head Judge shall have authority for all final decisions.

Frequently Asked Questions (FAQ)

The FAQ portion of this document in Appendix Z is updated regularly. It is the responsibility of the teams to read, understand, and abide by all of the rules, rubrics and FAQs, communicate with NASA's representatives and complete all forms.
Send questions about the application, rules and rubrics to NASA MINDS at:
support@nasaminds.org.

Updates

These rules and rubrics are subject to updates at any time. It is the responsibility of the teams to stay current. We will socialize any changes through the website, via contact with the team leads and via contact through your "Submittable" account.
Please log in to your "Submittable" account regularly to check on deliverables and any updates.

All team instructions regarding deliverables will be available at https://manager.submittable.com/user/submissions **after** you create an account and **after** you are accepted as a NASA MINDS team. You will not be able to access this link unless you are an active NASA MINDS team.

Appendix A: Acronyms

Acronym	Meaning
AANAPISI	Asian-American and Native American Pacific Islander Serving Institutions
ANNHSI	Alaska Native and Native Hawaiian-Serving Institutions
CDR	Critical Design Review
FAQ	Frequently Asked Questions
HBCU	Historically Black Colleges and Universities
HEO	Human Exploration and Operations
HSI	Hispanic Serving Institutions
ISS	International Space Station
JPL	Jet Propulsion Laboratory
KSC	Kennedy Space Center
MINDS	MUREP Innovative New Designs for Space
MSI	Minority Serving Institution
MUREP	Minority University Research and Education Project
NASNTI	Native American-Serving Nontribal Institutions
OSTEM	Office of STEM Engagement
PBI	Predominately Black Institutions
PDR	Preliminary Design Review
PPE	Personal Protective Equipment
SCaN	Space Communications and Navigation
SE	Systems Engineering
SRR	System Requirements Review
STEM	Science, Technology, Engineering and Math
TCU	Tribal Colleges and Universities

Appendix B: Useful Links and Websites

Technical Resources

This is NOT a comprehensive list. Students are encouraged to do their own research and utilize their own resources. This is a starting point for your journey!

The Artemis Program

What is the Artemis Program?
NASA is committed to landing American astronauts, including the first woman and the next man, on the Moon by 2024. To accomplish this, the agency is implementing the Artemis lunar exploration program, which will require a vast array of new and innovative technologies. The Artemis program seeks to establish sustainable missions by 2028. The technological breakthroughs and knowledge gained from building a presence on the Moon, will be leveraged to help NASA take the next giant leap – sending astronauts to Mars.

What is Artemis?
Artemis program
Artemis Resources
Space Launch System
Orion Spacecraft
Artemis I Mission

Want to watch some inspiring and informational videos? Check out these links.

We Go as the Artemis Generation
We Are NASA
We Are Going
We Go Together
Are You Ready?
Dreamed of This
How Are We Going to the Moon

Human Exploration and Operations Mission Directorate

The Human Exploration and Operations (HEO) Mission Directorate provides the Agency with leadership and management of NASA space operations related to human exploration in and beyond low-Earth orbit. The ISS, currently orbiting the Earth with a crew of six, represents the NASA exploration activities in low-Earth orbit. Exploration activities beyond low Earth orbit include the management of Commercial Space Transportation, Exploration Systems Development, Human Space Flight Capabilities, Advanced Exploration Systems, and Space Life and Physical Sciences Research & Applications.

Exploration Systems Development
- Space Launch System
- Orion Spacecraft
- Ground Systems Development
- Commercial Space Transportation

Research and Technology
- Advanced Exploration Systems
- Space Life and Physical Sciences Research and Applications
- Space Biology Program
- Physical Sciences Research Program
- Human Research Program

Operations
- Launch Services
- Rocket Propulsion Test
- Space Communications and Navigation (SCaN)
- Swampworks
- In-Situ Resource Utilization

NASA Office of STEM Engagement

NASA OSTEM Engagement resources for Educators and Students: http://www.nasa.gov/stem
Apply for internships: http://intern.nasa.gov
Review NASA Artemis Challenges: https://www.nasa.gov/stem/artemis.html
MSI Capability Gateway: https://msigateway.larc.nasa.gov/

New to coding? Need to brush up?

Links for learning C++ https://www.learncpp.com/

Learn Java: https://www.codecademy.com/learn/learn-java

Learn LabVIEW: http://www.ni.com/academic/students/learn-labview/

Other technical skills

Undergraduate course materials in NASA Systems Engineering: www.spacese.spacegrant.org

Technical papers for conferences:
https://www.ieee.org/conferences/publishing/templates.html and https://www.ieee-pes.org/templates-and-sample-of-pes-technical-papers.

Poster templates:
For Latex:
https://www.overleaf.com/articles/the-flyby-model-of-chondrule-formation-an-investigation-into-the-viability-ofgranoblastic-olivine-aggregates-as-type-i-chondrule-precursor-material/wbcdppbrfbpn

For Microsoft PowerPoint:
https://templates.office.com/en-US/Poster-blue-and-brown-design-TM00001023

North Carolina State University has helpful advice on how to create an effective poster presentation:
https://projects.ncsu.edu/project/posters/index.html

"How to Create a Research Poster: Poster Basics": https://guides.nyu.edu/posters.

NOTE: All links provided throughout this document were active at the time of publication. These links are provided as potential team resources, and NASA is not responsible for the content provided on external pages.
If any links are no longer active, please report them to support@nasaminds.org.

Appendix C: Application and Proposal Information

Your team will need to fill out an application to submit a proposal for a funding request. This proposal **MUST** be completed **online** in order to be eligible to receive funding. Email submissions will **NOT** be accepted under any circumstances.

Teams will adhere to all the requirements in the online proposal and in this rule document. The application is available at https://tinyurl.com/NASAMINDS. Remember to meet all due dates as indicated online.

Teams are requested to set up a team email address before applying. You will apply on a software platform called Submittable. Your first step will be to create an account on Submittable. You need to use the **team email address** in this first step of creating an account, which is required in order to submit a proposal. Your team email address will allow any team member with access to that email to log in and check team acceptance status and team deliverables status. Please read all details carefully in the application and follow all instructions when applying and submitting your proposal. You can check on your **application status** at https://manager.submittable.com/user/submissions. Create your account and log in **EARLY** to ensure you understand and can follow all requirements.

The application form will request the following information:

- Official School Name
- Team Nick Name
- Student Team Lead Name and Email Address
- Your school MSI classification
- Name of Faculty Advisor and Email
- Signed Letter from Faculty Advisor (see Appendix D)
- Name of Collaborating School and Faculty (if applicable, this is optional)

The proposal form will require the following information:

- Title of your team's Proposed Project (15 words max)
- Technology Area of Focus (10 words max)
- Description of what you plan to design and build, including what technological gap or problem this project seeks to address (500 words min to 1,000 words max)
- How does this project support the NASA's Artemis Mission? (25 words min to 100 words max)

Appendix D: Faculty Support Letter

When you submit your proposal, it must include a signed letter from your faculty advisor. The faculty member will receive a $1,000 stipend upon successful completion of the project.

After acceptance as a NASA MINDS team, NASA will request a list of students registered with the university who will be participating in the project from the faculty, certifying that the students are enrolled at the university and are in good standing.

The faculty advisor letter must include the following:

- A statement that the college/university is aware of and in support of the team's participation in this design project.
- A statement that they have agreed to serve as the team's Faculty Advisor for the duration of the project.
- The faculty must agree to track and manage the $1500 funding provided to the team to design and build the project.
- The letter must be on the college/university's letterhead.
- The letter must be signed by the faculty.

Appendix X: Safety

General Safety Guidelines:

- Follow safe work practices, safe use of all hand tools, and maintain a healthy attitude regarding safety. Encourage safe behaviors with everyone around you. Always walk and work in a controlled and thoughtful manner.
- Use personal protective equipment (PPE), safeguards, and other safety equipment as required, such as eye protection and hearing protection.
    - Wear closed-toe/closed-heel shoes where needed. In some cases, safety shoes or toe guards are appropriate for areas where heavy objects can fall on your foot.
    - Hand protection such as gloves are designed to protect against heat, electrical, chemical and mechanical hazards.
    - Wear eye protection such as safety glasses or goggles in the following situations:
        - When doing any work such as grinding, drilling, soldering, cutting, welding, etc.
        - When there is risk of exposure to flying particles or chemical exposure (such as splashes, splatters, and sprays).
- De-energize equipment as needed before working on components. Disconnect the hardware from the electric power source.
- Ensure that team members are not wearing ties, loose clothing, jewelry, or hanging key chains when near or working on moving or rotating machinery. Tie hair back or cover it.
- Use the right tool for the right job, do not take short cuts. Before using any tool, check to see if it is in good condition. Don't use defective, dull, or broken tools. Store sharp-edged or pointed tools in a safe place.
- Maintain a clean, neat, and orderly work station at all times, including tidy storage of personal belongings and equipment.
    - Are heavy or bulky items stored below shoulder level?
    - Are floors free of slipping and tripping hazards?
    - Are all light fixtures functional?
    - Is illumination level sufficient for the detail of work performed?

- Make sure you know where the fire exits, fire extinguishers and eyewash stations are located.

This is not a comprehensive list but can serve as a quick safety checklist of your workstations.

Always ensure that you have checked on the safety regulations specific to your work area and that you adhere to them at all times.

A) HAND & PORTABLE TOOLS

_____ Are powered tools in good condition with no evidence of damage?

_____ Are tools properly stored when not in use?

_____ Are guards and safety devices in place and operational?

B) CHEMICALS

_____ Are chemical containers properly labeled, in good condition, with no sign of damage?

_____ Are MSDSs posted/readily available and team members aware?

C) ELECTRICAL

_____ Are cords and plugs free of broken insulation, exposed wiring, and provided with grounded connections, or double insulated?

_____ Are electrical outlets overloaded? (1 power strip used per outlet)

_____ Are batteries visibly ok, terminals not bent, and no cracks in case?

D) THE WORK STATION

_____ Is team equipment within the designated space? Aisle clear?

_____ Is the area free of slipping and tripping hazards?

_____ Is the storage of materials orderly?

_____ Are the work surfaces neat and uncluttered?

E) PERSONAL PROTECTIVE EQUIPMENT

_____ Is PPE (such as gloves, closed shoes, goggles, etc.) available and worn by team members where required/posted?

_____ Is PPE properly maintained and stored?

F) RESPECT OF STORED ENERGY DANGERS

_____ Ensure that no one is working on components while they are energized.

_____ Ensure energy sources are removed once the team is done working for the day.

Appendix Y: 2020-2021 Rules and Rubrics Updates

Appendix Y - 2020-2021 Rules and Rubrics Updates	
Summary of change	**Date updated**
Updates to the **2020-2021 Academic Year Schedule** under *Section IV. Timeline and Deliverables*	9/1/20
Page 16 update: Was: All items are due by 12 midnight Eastern Time on the date listed. New: All items are due by 3:00PM Eastern Time on the date listed.	9/1/20

Appendix Z: Frequently Asked Questions

What college and universities are eligible to participate in NASA MINDS?

Any college or university which has been designated as an MSI is eligible to apply. If you do not know if your college or university is an MSI, you can ask your Administrative office OR check the list on this PDF provided by the Rutgers Graduate School of Education.

Can one or more universities partner together to form a team?

Yes. This is allowed provided that:
1) all the universities and colleges that form the team must be MSIs
2) There must be a plan to collaborate allowing for full participation from both schools.
3) Each college / university has a designated faculty advisor.
4) Even if multiple universities and colleges form a team, the maximum amount of funds available for faculty will still be $1,000.00 total, and the maximum amount of funds available for the team's build will still be $1,500.00.

Can high school students participate?

Only students enrolled at a college or university designated as a MSI are eligible to participate. Unfortunately, high school students are not eligible at this time.

Are colleges and universities outside the United States able to participate?

No, unfortunately not. NASA MINDS is reserved for MSIs located within the United States and its territories. If you are an international student you may want to consider exploring NASA Internships and Fellowships as described HERE.

This sounds like a lot of work. What will I get out of it as a student?

If you ever dreamed of working for NASA or an aerospace contractor, this is one of the best ways to get a head start. You'll be working on technologies of relevance to NASA, your work will be reviewed by NASA subject matter experts, and your participation will make you stand out from your peers. Employers want to hire students with "real world" experience, and the proven ability to contribute as a member of a team.