Institution of MECHANICAL ENGINEERS

UNMANNED AIRCRAFT SYSTEMS

2024 CHALLENGE PAKISTAN

COMPETITION RULES V 1.0

This page is intentionally left blank.

Contents

Abbreviations

AGL	Above Ground Level
BVLOS	Beyond Visual Line of Sight
CAA	Civil Aviation Authority
CDR	Critical Design Review
CG	Centre of Gravity
COTS	Commercial off the Shelf
FRR	Flight Readiness Review
FSO	Flight Safety Officer
FTS	Flight Termination System
FW	Fixed Wing
GCS	Ground Control Station
KIAS	Knots: Indicated Air Speed
MTOM	Maximum Takeoff Mass
PDR	Preliminary Design Review
PPE	Personal Protective Equipment
RW	Rotary Wing
UA	Unmanned Aircraft
UAS	Unmanned Aircraft System(s)
VLOS	Visual Line of Sight
WP	Waypoint
LZ	Landing Zone

Chapter 1. Introduction

1.1. Challenge Overview

The aim of the competition is to engage university undergraduate teams in the design of an Unmanned Aircraft System (UAS) that focuses on collection and delivery of payload, which may be medical supplies or samples for testing. With a Maximum Take-off Mass (MTOM) limit of 10kg, which includes both the payload and UAV, teams will develop UAVs that can assist in critical situations. Operating under the CAP722 rules or operating rules issued by CAA Pakistan

The Unmanned Aircraft (UA) will be designed to perform critical tasks in scenarios such as target detection and payload retrieval.

The competition will coincide with the normal academic year to be held annually. The challenge for this academic year, will be launched in August 2024 with completion date in second quarter of 2025.

The first stage will be held virtually wherein the teams will submit a report based on the conceptual, preliminary and Detailed design reviews. It is expected that each team will perform necessary simulations and analysis to validate the chosen design and will produce CAD drawings in sufficient detail to enable prototyping of the design. Each team's score will be calculated and those proceeding to the next stage will be announced.

The qualifying teams will then enter the second stage which includes fabrication of the UAV and performing tests on the models in a Fly-off event, along with a Business Case Presentation. This period will be structured into development and demonstration stages and a flying demonstration contributing to the final scoring. All awards will be announced at the end of this stage.

The competition rules allow entrants to participate both live and virtually in various stages. if unforeseen circumstances occur, the event may be postponed by the organizing committee. Teams clearing the virtual stage but being unable to compete in the flight demonstrations due to force majeure will be refunded in full, subject to the organizing committee's decision.

1.2. Objectives of the Event

The competition has several objectives, in particular to:

I. Provide a challenge to students in studying any branch of engineering that enables design of a complex system, that fulfils one or more complex mission requirement.

II. Provide an opportunity for students to develop and demonstrate teamwork, leadership, and commercial skills as well as technical competence.

III. Stimulate interest in the diverse applications of the UAS domain and pursue enhanced employment opportunities in the sector.

IV. Foster inter-university collaboration in the UAS technology area and provide a forum for interdisciplinary research.

V. Support outstanding students with monetary awards to promote UAV development in the country.

1.3. Scenario

The challenge for 2024 revolves around the task of cargo collection from remote or inaccessible areas. The item to be collected will be a blood sample (or a similar package to represent a blood sample), which needs to undergo immediate medical testing. The goal is to design and construct an unmanned aerial vehicle (UAV) that can effectively contribute to search and recovery efforts in far-off or disconnected areas. The solution can be CTOL, VTOL or hybrid. The UAVs will play a vital role in search and collect operations where it is imperative that the blood sample be ferried to the appropriate personnel in an accelerated time frame.

The mission for the UAV will be to operate autonomously throughout its task. It will i) take off from a designated location, ii) navigate between waypoints, iii) perform image detection to identify and precisely land at the LZ, iv) allow a third party to safely place the blood sample in a designated storage container, v) take-off once again after a built-in switch is triggered by said third party, and vi) return to the launch site by means of cruising at different altitudes.

Participants will design comprehensive preflight checklists, safety procedures (ON and OFF aerodrome), storage procedures, mission plan and system safeties. Learn to effectively perform and analyze the listed preflight operations, normal takeoffs, landings and traffic pattern procedures.

2. Competition Overview

2.1. Challenge Schedule

The tentative dates for key activities for 2024’s UAS Challenge Pakistan are as follows:

Month	Activity
August	Team Registrations Go Live
October	Registration deadline
STAGE I: VIRTUAL EVENT	
November	Conceptual & Preliminary Design Report submission
January	Critical Design Report submission
	CAD Model & Simulations Package submission
March	Flight Readiness Video
	Announcement For Qualifying Teams
STAGE II: FLY-OFF EVENT	
April	Business Case submission and Presentation
	Flight Demonstrations

Note: *The timeline is subject to change, any changes will be communicated to the teams via social media and through follow up documentation.*

2.2. Eligibility and Team Structure

The teams will be put forward by universities and must only consist of undergraduate students who attend universities full-time for at least one semester during the academic year. No team member can be an employee of the university.

A team must have at least 5 students and at max 10 students. A university may have multiple teams, but a student may only be on 1 team.

2.2.1. Team Supervisors

Each team must appoint a Faculty Advisor/Team Supervisor.

- The Faculty Advisor is a member of the academic staff that offers support, guidance, and advice throughout the project.
- If your team is unable to find academic support, you can assign a Team Supervisor. The Team Supervisor should be a postgraduate student.
- All delivered documents must be approved and signed by the Faculty Advisor/Team Supervisor. Each team must also appoint a Team Leader.

The advisor will be permitted to observe the team at the flight line, but is forbidden from communicating or otherwise assisting the team during setup, mission, or tear down. While the advisor may teach concepts, answer questions, provide high-level guidance, and review deliverables before submission, the students must design, manufacture, and operate the system on their own and must produce all deliverables of their own accord.

The Team Leader is one of the team members. The Team Leader will be the primary contact for IMechE staff for the duration of the project and is deemed responsible for all competition deliverables and deadlines. At the final event, the Team Leader must be the main point of contact for the duration of the event and is responsible to:

- Communicate any issues with the aircraft to IMechE volunteers.
- Attend regular meetings with competition organizers.
- Ensure the team adheres to the event schedule and turn up for scrutineering, business case presentation and fly-off on time.

2.2.2. IMechE Membership

All team members/students must register for free affiliate IMechE membership upon entering a team. To register as an affiliate member, please click here. Please allow up to a month for your membership application to be processed.

It is not mandatory for the Faculty Advisor/Team Supervisor to register as an IMechE member to supervise a team. Free IMechE Affiliate membership is available for students only.

2.2.3. University Alliance

Universities may form an alliance to enter an individual joint team. The competition, whilst having a set of defined performance objectives, is also about the development and demonstration of team working skills.

2.2.4. Universities entering more than One Team

If a university enters more than one team, the teams must operate independently and the UAS must be entirely their own work. See also the note on Plagiarism below.

In the case of entering more than one team, each university will determine the number of members in each team. However, each team should have no more than 10 members, and no less than 5. No student or advisor can be a part of multiple teams.

2.2.5. Plagiarism

The organizing committee will monitor for plagiarism (use of ready-made UAVs, unattributed use of images, overwhelming similarities with previous UAV entries, etc.), and any detected instances will result in score deductions or disqualification.

2.2.6. Industry Support

Universities are encouraged to seek potential industry sponsors for financial and technical assistance both before and during the competition. However, it is important that if technical advice is obtained from industry, the judges must be assured that the majority of the development work has been conducted by the students themselves.

For information on financial assistance, please refer to **Section 2.4: Cost and Funding**.

2.3. Availability of Certified Pilots

As the entire mission is autonomous, only a safety pilot may be required, which can be supplied by the IMechE, in the scenario that any team wishes to employ them, at their discretion and risk.

Note: *The organizing committee does not bear any liability for any accidents incurred during flights. Participants are expected to observe all safety rules at all times and take precautions for their and their fellow teams' safety.*

2.4. Cost and Funding

Teams/Universities are responsible for covering the costs associated with their UAS design, development, and attendance at the Design Review and Demonstration events. They are encouraged to seek industrial support for both technical and financial assistance, and any such support must be fully acknowledged in the Design Review submissions. The team registration fee is PKR 10,000.

2.4.1. Financial Support from Industry

For financial assistance from the industry, the sponsorship agreement will be between the team and the industry directly. IMechE will not be linked with any industry for such a sponsorship.

3. Design and Operational Requirements

The UAS shall be designed to perform the mission defined in Annex A while being compliant with the specification defined in this section. The term ‘shall’ denotes a mandatory requirement. The term ‘should’ denotes a highly desirable requirement.

3.1. UAS Design Requirements

The UAS shall be designed to meet the following constraints and have the following features:

3.1.1. Design Models

Participating teams will be required to submit two separate virtual design/simulation packages during the competition. The first model will comprise the detailed CAD assembly on any available CAD software. This CAD assembly is expected to be as detailed as possible. Scoring will be dependent on the keen emphasis of the team on the manufacturability and feasibility of the design concept.

The second package comprises Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) analyses. The simulations may be run on any commercially available and industry-standard software such as Solidworks, ANSYS, StarCCM+, etc. In the case of FEA simulations, the analyses must include, but not be limited to, load application and safety factor calculation to test structural integrity; the inclusion of vibrational analyses will be highly appreciated. In case of the CFD simulations, it is expected that the teams perform analyses on basic aerodynamic features of their UAV, including but not limited to, lift and drag profiles, and velocity and pressure characteristics.

3.1.2. Airframe Configurations and Mass

Following Airframe Configurations are allowed:

I. Fixed Wing (CTOL)

II. Rotary Wing

III. VTOL

IV. Hybrid

The Maximum Takeoff Mass (MTOM) shall not exceed 10 kg, which will comprise both the payload and UAV. The UA shall be designed for rapid assembly/disassembly to fit into the Storage Container. (**Refer to Annex A: Fly-off Mission Details**)

Note: - Necessary safety precautions must be taken; failure to do so may result in ramifications.

3.1.3. Propulsion

Electric motors and internal combustion are both allowed. However, electric motors are preferred by IMechE due to their environment-friendly nature and ease of handling.

3.1.4. Autonomy

The UAS should operate fully autonomously, handling takeoff, waypoint navigation, payload collection, and landing without manual intervention. Systems that are operated manually will incur a point deduction.

Scoring will be based on the following categories:

1. **Fully Autonomous Flight**: The UAV performs all tasks autonomously.

2. **Semi-Autonomous Flight**: The team may manually perform takeoff and landing, but the UAV must follow waypoints autonomously at cruise altitude.

Points will be deducted for semi-autonomous operation as per the discretion of judges based on the nature of semi-autonomous flight.

3.1.5. Payload Carriage

The payload for the UAV will be a blood sample in a standard container. The dimensions of the payload will be communicated. Teams must design a payload container which can safely accommodate said package without risk of breakage. Compact, ergonomic, and safe designs will be able to attain high scores.

All teams need to send in the Flight Review Report to show that the UAS is stable at both extreme locations of the center of gravity- when the UAS is fully loaded and when the payload is empty.

3.1.6. Limits on the use of COTS Items

The UAS airframe should be designed from scratch (**refer to Section 2.2.6: Plagiarism**) and not based on commercially available kits. This is a qualifying rule, meaning that an entrant based on a commercially available system will not be eligible for consideration.

Permitted Commercial Off the Shelf (COTS) stock parts include motors, batteries, servos, sensors, autopilot, and microcontroller boards. All the COTS items must be of known brands to ensure safety.

The limit of the maximum value of COTS components used is PKR 500,000 - including sponsored items. A bill of materials and costs will be required as part of the design submission. Cost-efficient solutions will score more points.

Note: *The manufactured UAS brought to the competition must match the detailed engineering drawings provided in the reports sent.*

If there are deviations, then a report must be submitted, detailing the differences and the technical reasons for the deviation. This report must be submitted at the start of the flyoff stage, and as part of the flight readiness review report.

3.1.7. Radio Equipment

Any radio equipment shall be compliant with PTA directives and licensed for use in Pakistan. It should have a reliable operating range of at least 1 km; control of the UAS and the FTS is ‘Spread Spectrum’ compliant to 100mW spread spectrum conforming to IR2030 and CE marked 4. As per PTA directives 900 MHz is not allowed.

This applies both at the flight line and in the pits. To minimize interference, teams are encouraged to use hardwired connections whenever possible. Additionally, teams should implement encryption, directional antennas, and RF filters to secure their communications.

Teams must anticipate that other teams may use similar equipment, such as the same autopilot systems, and ensure they do not connect to another team's devices. Frequency hopping or dynamic channel selection is recommended to avoid interference.

While the judges reserve the right to implement RF management, if necessary, teams should not depend on this. Any team found intentionally jamming or interfering with another team's communications will be considered cheating and can result in disqualification.

3.1.8. Flight Termination System

Teams are required to design and install their own Flight Termination Systems keeping in mind the following guidelines:

- The UA shall automatically return to the takeoff/landing zone or terminate the flight after a loss of data link of more than 15 seconds.
- The UA shall automatically terminate the flight after the loss of signal of more than 1 minute.
- The 'Return Home' signal shall be capable of activation by the pilot and via GCS.
- The UAS (fixed wing) shall be capable of terminating flight, without the use of an alternate recovery method, such as a parachute.
- Fixed Wing: throttle set to zero, full up elevator, full right rudder, full right aileron, and full flaps down.
- Rotary: contained descent at half throttle.
- A system (such as a parachute) shall ensure that the engine is cut and the UA descends at a slow speed and preferably in a gentle turn. Alternatively, a deep stall descent is permissible.
- For non-fixed-wing UAS, similar safety requirements will be assessed. These requirements ensure power-off recovery in a manner that minimizes energy impact, with the UAS landing within a 15-meter radius from the point of the termination command.
- A Fail-Safe check will demonstrate flight termination on the ground by switching off the data link for 30 seconds and observing the activation of the flight termination commands.

3.2. Operational Requirements

3.2.1. Design Mission Range and Endurance

The presented models by the team must have the capability to perform flights under real-time flight and weather conditions. The control capacity and airworthiness of the models are expected to be emphasized in the CAD models submitted.

Takeoff and landing of designed models will be part of flying demonstrations and will be marked. However, the takeoff and landing approaches presented by the teams will be incorporated into demonstrations. Flights will involve taking-off, climbing to cruising altitude, following flight paths defined by waypoints, descending, landing, taking off again, and then returning to the launch site at by following a flight path at different cruising altitudes.

To size the fuel/battery load, the design team should plan on a typical target mission flight path with a distance of no more than 3 km from initial takeoff to final landing.

The mission may require the UAV to operate further than 1000 m from the pilot, so that the UAV can be safely flown and tracked within the segregated airspace. The UAV can fly at a maximum altitude of 120 m, with the minimum permissible altitude being 10 m AGL.

3.2.2. Takeoff and Landing

The UAS shall be designed to operate from a designated area. Details will be confirmed in due time. The runway will have a length of 10 meters. However, the runway will not be paved and may be dirt based. Landing includes touchdown and roll-out, with the UAS required to stop within the box. The same space will be provided to rotary wing and VTOL UAVs as well.

3.2.3. Ground Control Station

The Ground Control Station shall display the following information and be visible to the Operators, Flight Safety Officer, and Judges:

1) Current UA position on a moving map
2) Heading
3) Altitude (angles)
4) Battery Level/Consumption
5) Current Consumption
6) Local airspace, including any ‘No-Fly’ zones.
7) Search Area Boundaries.
8) Height AGL (QFE).
9) Indicated Airspeed (KTS).
10) Information on UA Health.

3.2.4. Weather limitations

The UAS should be designed to operate in winds of up to 20 kts gusting up to 25 kts, and light rain. The UAS shall typically be capable of takeoff and landing in crosswind components to the runway of 5 kts with gusts of 8 kts.

3.3. Safety and Environmental Requirements

The UAS shall comply with the safety requirements given below:

3.3.1. General Safety Requirements

- The UA shall have a maximum Takeoff Mass (MTOM) of 10 kg.
- The maximum Airspeed of the UA in level flight shall not exceed 60 KIAS.
- The design and construction of the UAS shall employ good design practice, with appropriate use of materials and components.
- The design shall be supported by appropriate analysis to demonstrate satisfactory Structural integrity, Stability, and control, Flight and Navigation Performance, and Reliability and safety of Critical Systems.

3.3.2. Design Safety Features

- Batteries used in the UA shall contain bright colors to facilitate their location in the event of a crash.
- At least 25% of the upper, lower, and each side surfaces shall be a bright color to facilitate visibility in the air and the event of a crash.
- In the opinion of the judges, any fuel/battery combination deemed to high risk, may be disqualified.
- Use materials that are highly resistant to corrosion (such as nickel or nickel-coat copper). If contact plating is an issue, use contact plating on the terminals.
- Ensure the battery pack is not compromised if the equipment is dropped or receives a sudden impact.
- For CTOL designs, all hinges used on control surfaces must be pinned, to prevent detachment.
- For VTOL designs the rotor orientation must be clearly marked, CW or CCW.
- The UA must have means of safely disconnecting the fuel supply or isolating the electrical power quickly.

3.3.3. Operational Safety Requirements

- The UA shall remain within the Remote Pilot's Visual Line of Sight (VLOS)
- The UA shall not be flown within 30 m of any person, vessel, vehicle, or structure not under the control of the Remote Pilot; during takeoff or landing, however, the UA must not be flown within 10 m of any person unless that person is under the control of the Remote Pilot.
- No radio operation will be permitted except after authorization from the Safety Officer. Radio Transmitters will be deposited for safety considerations with the Safety Officer and only issued back to the team when radio operation has been allowed.
- During the entire flight, the UA shall remain in controlled flight and within the boundary of the demonstration zone;
- Any UA appearing uncontrolled or moving into a 'No-Fly' zone shall be subject to immediate manual override. A manual override failure will result in Flight Termination.

3.3.4. Environmental Impact

In the design process, consideration should be given to environmental impact, including the use of non-hazardous and recyclable materials; low pollution; low energy usage; low noise.

4. Statement of Work

This section provides details of the activities and outputs in each stage.

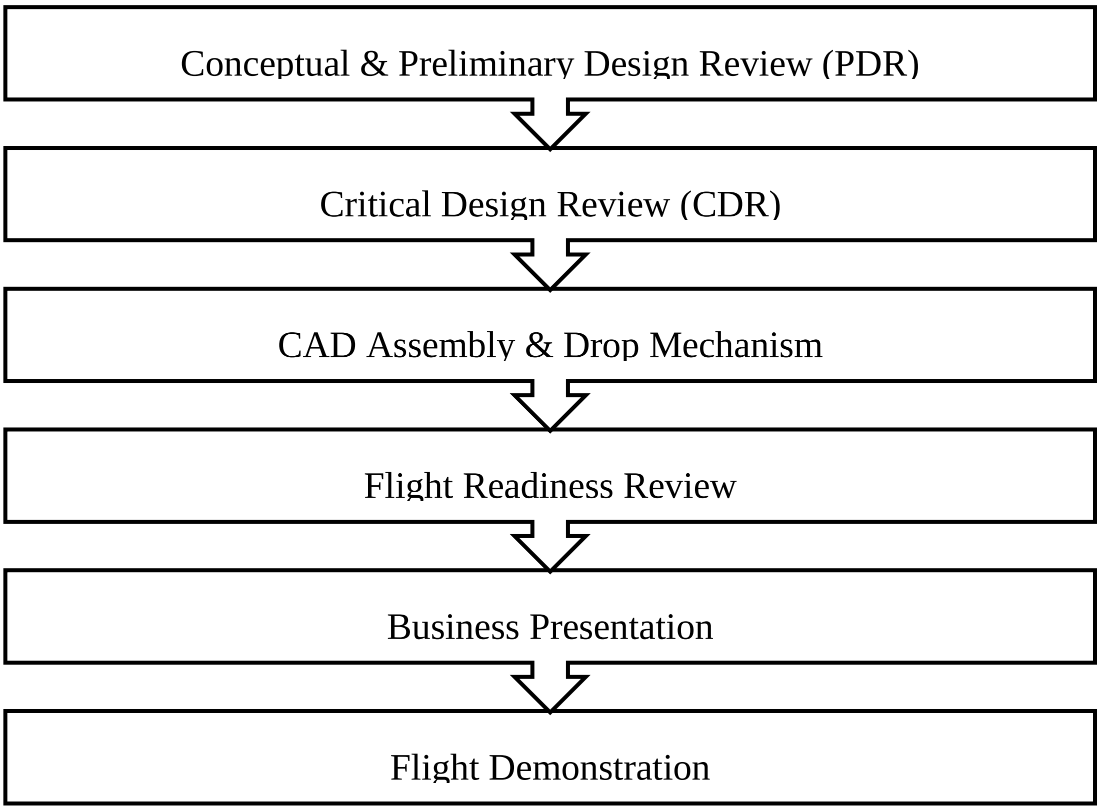
4.1. Mission Tasks

The challenge is to design and construct an unmanned aerial vehicle (UAV) that can effectively aid in payload retrieval operations as described in **Section 1.3: Scenario**. The exact mission is presented in **Annex A Fly-off Mission Details**. The competition will typically seek to test several characteristics, such as:

- Navigation accuracy via waypoint coordinates provided on the day.
- Airworthiness of the designed models.
- Flight controls and stability of the designed models.
- The extent of automatic operations from take-off to landing.
- Safety: demonstrating safe design and flight operations throughout.
- Minimum environmental impact, notably low noise levels.

4.2. Challenge Stages

The competition for 2024 will comprise of the Design, Fabrication and Demonstration stages. As scheduled in **Section 2.1: Challenge Schedule**, the key events in the competition are:



4.2.1. Conceptual & Preliminary Design Review (PDR)

This is a written report including a Technical Section with an outline of the proposed technical solution and the rationale for the approach adopted. Additionally, it should include a Project Management section describing the team organization and roles and a project plan, a Commercial section summarizing the estimated costs, a Safety section giving an initial view of the approach to ‘Certification and Qualification', and the safety risks and their mitigation. The key features should include:

- UAS requirements.
- UAS overall layout & prescription.
- Preliminary weight report.
- Preliminary safety report.
- System requirements, with functional descriptions & schematics for each of the systems, including:
  - Airframe
  - Propulsion
  - Flight controls
  - Navigation & mission control
  - Sensors
  - Payload collection
  - Flight termination

The body of the report should be no longer than 10 pages**. (For detailed information, refer to Annex B Documents Requirements)**

4.2.2. Critical Design Review (CDR)

The CDR comprises a written submission. The report should follow the structure of the PDR report, giving full technical details of the UAS and its subsystems, including a rationale for their selection/design specification. It should include engineering drawings, analysis of the projected flight performance, a structural analysis of the airframe and its aerodynamic characteristics, assessment of the search and navigation performance, and analysis of the payload collection dynamics.

Teams should mention how they will approach the manufacturing of the components of their aircraft, if that component is not included in the COTS item and is an integral functional part of the UAS. Furthermore, if teams are to procure any component from overseas, they should cater to the shipping time that may be required. Hence, teams are encouraged to use locally procured items for their UAS.

The Project Management section should note any update to the information presented in the Project Outline. A Commercial section should include an update of the materials (and external labor) cost estimates.

The Safety Case section should present the approach to demonstrating the airworthiness of the UAS. It should summarize the key safety risks and their mitigation, with arguments supported by evidence from design, analysis or test.

The key features should include:

- UA Structural Loads Analysis.
- UA Performance Analysis.
- Weights Report.
- Requirements Verification & Validation Matrix for each of the systems: Propulsion, Flight Controls, Navigation & Mission Control and Payload Delivery.
- Design Dossier and Bill of Materials with costs for COTS components.

- Design Dossier and Bill of Materials with costs for Manufactured components.
- Qualification Test Plan.
- Updated Safety Case.
- Preliminary Environmental Impact Statement.
- Business case: discussion on how the design would scale into a useful operational system, including sales projections, manufacturing methods and production costs.

As a guide the body of the report should be no longer than 25 pages, supported by appendices where appropriate, plus the design dossier. Teams exceeding the page count will not be judged on the exceeding pages, and will be marked zero for any missing sections (**Annex B: Documents Requirements)**

4.2.3. Computer-Aided Design (CAD) Model

This stage holds critical importance in this challenge as at this stage you will be presenting the complete model. CAD model must be the complete replica of your physical model, representing all the key features and components presented in the reports submitted.

CAD models must be carefully designed as it will be the base of judgment for the models at the flight demonstrations. CAD models must hold detailed considerations for all working mechanisms. Dimension parameters will be counterchecked with the submitted reports. The placement of electrical and other auxiliary components is expected to be shown in the CAD assembly. Teams are expected to work on their CAD model with clear manufacturability, harnessing and packaging in mind. Design and manufacturing defects will cost marks. CAD assemblies should be saved in STEP format or SolidWorks Pack & Go Zip file. In case of .STEP format, the teams should upload a video of all mechanical movements of the aircraft within their own CAD software environment.

The CAD models should be emphatically detailed in terms of the payload carriage design. Teams are required to fabricate the payload mechanism as it is described and indicated in their reports. Video recordings of the working mechanism are to be submitted later on, along with the FRR. The video will serve the purpose of demonstrating the clear working of the mechanism. The size and integration of the system needs to be the same as described in their reports and CAD model. For score break down, refer to (**Annex B: Documents Requirements**)

4.2.4. Finite Element Analysis (FEA) and Computational Fluid Dynamics (CFD) Simulations

Teams are expected to present their FEA and CFD simulations as well. Any commonly available software can be used for the analyses. The CFD must be done keeping real life situations at hand, mimicking the conditions of the competition. The FEA must also be thorough, with keen detail to all types of loadings the CAD model can manage to ensure precise and accurate simulation results. Both the CFD and FEA simulations will be judged on the basis of their depth, complexity, and the number of physical parameters investigated.

4.2.5. Business Presentation

During the flight demonstrations at the specified location, each team will be required to give a presentation consisting of 10 slides on their business case. This takes the form of an illustrated pitch (PowerPoint presentation) to a group of judges. This should demonstrate the team's understanding of the potential market, outline a revenue model (direct sale, lease, operate, etc.), the scale of the opportunity, and how their design will be competitive. The team also needs to show how they have promoted the competition and their design locally with schools, the media, and social media.

Refer to Annex B.6, for detailed score breakdown and marking criteria.

4.2.6. Outreach

During the period of the competition, teams are encouraged to publicize the competition and their participation. An award is for the most effective use of outreach to promote the competition.

Detailed scoring criteria alongside its weightage is provided in **Annex B.7**.

4.2.7. Flight Readiness Review:

The Flight Readiness Review (FRR) submission is a critical safety and operational review to confirm whether your aircraft is ready to undertake demonstration flights.

This is a critical safety and operational review and must be passed before the mission flights at the final event can be undertaken. Typically, you would have completed at least 10 flights, exploring elements of your flight and mission envelope and at least 2 full mission test flights. The physical test should include a subsystem test, as well as flight testing of the complete UAS. Failure to submit your complete FRR on time may result in exclusion from the Demonstration Event.

- A 10-minute video showing evidence of the development testing undertaken, including a continuous flying sequence showing at least a manual take- off, autonomous controlled flight, including any transition, manual landing and payload collection.
- A full statement and justification of any changes introduced since the critical design review with any impact on the safety or performance of the vehicle.
- A pre-flight checklist
- Confirmation that the team pilot has experience of operating the UAS during development testing.

This is your confirmation that you are Flight Line ready and can safely proceed to the Flight Demonstration event. **(For detailed information, refer to Annex B: Documents Requirements**)

4.2.8. Flying Demonstration - Mission

The Pre-Flight Inspection will comprise of the following tests:

Static Examination:

The model will be examined while its engine power is shut down. Important aspects considered in the test will be the structural and electrical integrity of the model.

- Verify all components are adequately secured, fasteners are tight and locked.
- Verify propeller structural and attachment integrity.
- Visual inspection of all electronic wiring to assure adequate wire gauges have been used, wires and connectors are properly supported.
- Radio range check
- Verify if all controls operate in the correct sense or not.
- Check general integrity of the payload and deployment system.
- Verify correct operation of the fail-safe and flight termination systems.

Verify the following list

1. Weight should be not more than 10 kg.
2. Centre of Gravity
3. Compass heading matches with reference headings
4. GPS Lock has been achieved
5. The battery is more than 90% charged

4.2.9. Dynamic Test:

The model will be examined on a testing bench with full throttle. The important aspects considered will be the structural and electrical integrity of the model. After testing all Radio controls will be tested.

On satisfactory completion of the Inspection and Testing, the inspector will allow the team to proceed in the event. The Flight Safety Officer shall have absolute discretion to refuse team permission to fly or to order the termination of a flight in progress. Only teams issued with a ‘Permit to Fly’ will be eligible to enter the Fly – Mission zone.

Upon successful issue of a Permit to Fly, the mission will be flown, as explained in **Annex A**. This will be flown on Day 2 of the competition.

A detailed briefing will be given prior to the Demonstration event covering the logistics and timings for the event, rules and good conduct for safe operations, pre- flight briefings etc.

The competition will be assessed across eight elements, comprising:

Note: *The test is subject to the discretion of judges.*

Element	Score
Virtual Events	
Conceptual & Preliminary Design Review	50 points
Critical Design Review	150 points
CAD Model and Simulations	50 points
Outreach	50 points
Flight Readiness Review	100 points
Total Points	**400 points**
Fly-off Events	
Business Case Presentation	100 points
Flying Demonstration	500 points
Total Points	**600 points**

Detailed information on the scoring of the PDR, CDR and CAD Modeling is provided in **Annex B: Documents Requirements**, and of the Flight Demonstration in Annex A Fly-off Mission Details.

5. Prizes and Awards

There are a few categories for which prizes will be awarded. The allocation of cash prizes will be communicated.

Prize	Award Criteria
Winner	Highest aggregate score from the design & Development and the Flight Demonstration
Runner Up	2nd highest aggregate score from the design & Development and the Flight Demonstration
Value Proposition	For the entrant with the most promising business case, reflecting a well-articulated understanding of the market and good alignment of the UAS capabilities and cost projections with the target market.
Safety and Airworthiness	For the entrant developing the best combination of a well-articulated safety case, with evidence that safety and airworthiness have been considered throughout the design, the UAS exhibits practical safety features and demonstrates safe operation.
Outreach	For the team which engages most effectively with local media, schools, social media, to promote participation and engagement with the challenge.
Distinguished Design	Will be awarded to the team with the most points in the virtual stage of the competition

6. Guidance to Teams (UAS Configuration)

Rotary Wing UAS (UAS-R) and Fixed Wing UAS (UAS-A) have pros and cons for collecting blood samples for immediate testing. UAS-R allows for accurate descent to collect the sample, but may be slower in transit and have limited payload capacity compared to UAS-A. UAS-A presents challenges in precise targeting but offers higher range and mobility for transporting a sample.

Either electric or internal combustion engines are permitted. Note there are marks for quiet and environmentally friendly operations. The assessment panel will be looking for teams to explain their rationale in making their system design decisions and trade- offs.

7. Annex A Fly-off Mission Details

7.1. Mission Overview

The mission comprises a mandatory core mission and an optional mission.

7.1.1. Core Mission

The core mission scenario is: An Unmanned Aircraft (UA) flying to a remote area where a person is in need of medical testing of their blood. Keeping in view the theme which is payload retrieval, the UAV should be able to visually detect the area where it needs to land and assist the needs of said patient at the Landing Zone (LZ) via defined waypoints (WP), and then return to base within a specified time limit. There are short, medium, and long-distance routes to reach the Landing Zone (LZ) starting from the base station. However, a UA flying through a longer route will score more points. Thus, the teams need to plan carefully and be familiar with the performance of their UA.

Note: *A follow up document for core mission will be issued to all teams consisting of a map in which the way points for short, medium and long-distance routes will be marked. The LZ will also be marked along with dimensions. The UA will have to detect the LZ, and land precisely at a marker placed in the region. The UAV will then have to take off and cruise at different altitudes until it reaches home (base) for the core mission.*

The UA shall be stored and transported in a box or container and assembled quickly to be ready for deployment at short notice. The total time to deploy the system, from opening the container to being ready for takeoff, shall form part of the challenge. The challenge aims to test the structural efficiency, flight performance, navigation, modularity, and load-carrying capacity of the UAS designs.

7.1.2. Optional Mission

As opposed to the Core Mission, which requires teams to include the use of a camera and software stack to locate the marker at the LZ, the optional mission requires the Unmanned Aircraft (UA) to fly to the area where the patient is present by means of already-given coordinates. It simulates only the step of the operation where the UAV lands at the LZ and collects the sample for medical testing, without prompting it to perform a search operation first. The UA will be required to navigate through waypoints and approach the location of a predefined area before collecting the material and returning to the launch site by cruising at different altitudes.

Note: *A follow up document for the optional mission will be also issued to all teams consisting of a map in which the way points for short, medium and long-distance routes will be marked. The concerned area for the optional mission will be also marked along with its dimensions. The UA will just have to follow the way points, collect the sample, and return to base.*

Note: A team failing to perform the core mission, will be allowed to perform the optional mission upon the team leader's request. However the optional mission carries less points than the core mission. The teams participating must try to design a UAS that is able to perform both core and optional mission so in case of failure of core mission, they can request for the Optional mission.

The team permitted to perform the optional mission must make sure that their UA is ready before the next team completes their core mission. The team will be permitted the choice of optional mission after all flight attempts have been completed, and is subject to availability of time.

7.2. Mission

The mission comprises pre-flight preparation, recon operation, and a medical sample collection task. The actual positions of WPs are provided to teams at the start of the Demonstration Event.

7.2.1. Task 1: Pre-Flight Preparation

This task follows satisfactory scrutineering and is done at the Pre-Flight Inspection area, just before going to the airstrip. Starting with the UAS stored in its container, the team shall unpack the UAS, and prepare it for flight, including airframe assembly, connecting the battery and flight controls, loading the payload mechanism, check of the pre-programmed mission, check of control functions. This shall be a timed task supervised by a Scrutineering Official. The task completes successfully when the Official is satisfied that the pre-flight safety checks have been completed thoroughly and safely. Therefore, the team members must demonstrate the safety checks clearly to the Official.

Maximum marks are given for the quickest time (T1) to complete the pre-flight preparation.

7.2.2. Transfer to the Flight Line

Following the pre-flight preparation, the team and UAS shall move to the Flight Line takeoff area. The Flight Safety Officer (FSO) shall give the team a short safety briefing, noting any local issues of wind or weather, safety hazards, etc. Note that this is not a scored or timed task.

7.2.3. Final Check-out

The team shall prepare the UAS for takeoff. This task should take no more than 2 – 3 minutes, with a maximum time limit of 5 minutes.

7.3. Task 2: Flight Mission

Flight Mission shall begin when FSO has granted clearance. Teams can choose between different routes for the mission. However, fewer points shall be awarded for choosing the shortest route.

The organizers will provide details of the routes from the Launch Point to the LZ at the start of the demonstration event; teams will have a choice to select either of the mission routes leading to it. The below image describes a sample recon operation overview from last year’s challenge.

Note: *The mission below is for reference only. Accurate waypoints and routes will be communicated at the fly-off event. The site and waypoints for the flights may be different and will be communicated.*

7.3.1. Task 2a: Take off

When the FSO is satisfied that the team is ready, they will give clearance to take- off, and the mission time will start. The team will launch the UA, which shall take off, climb out in a controlled manner, and head toward the first WP.

7.3.2. Task 2b: Navigation and Recon

The UA shall navigate to the marker at the Landing Zone (LZ) by scanning for its location. The UA shall fly through waypoints, and cutting corners when flying around WPs will incur penalty points. Points shall be awarded according to the following:

- The path chosen.
- The number of WPs crossed.

7.3.3. Task 2c: Collecting the Payload at the LZ

Continuing the task, the UA, having flown through the waypoints, shall effectively search for, and land at, the marker in the LZ. Points will be scored based on how close the landing is to the marker placed. No points will be awarded for this criterion if the UAV does not manage to land within a 5 m radius of the marker.

The UAV will then have to disarm to allow for safe sample placement, and re-arm by means of a switch which can be activated by the person placing the sample. It will then take off, and make way towards the launch site.

7.3.4. Precision Landing

After accurately collecting the sample at the LZ, the UA will return towards the launch area by cruising at different altitudes and land within the landing box.

7.4. Finish Core Mission

A judge shall record the mission time, T2. There are penalties for exceeding the maximum T2 time of 12 minutes (**Refer to Section A.3.4).** Teams will be marked based on how quickly they are able to complete the task.

7.5. Optional Mission

The UA will land after attempting to complete the core mission and can perform the optional mission while the other teams are being scored for their core missions. The UA will take off and navigate through a series of waypoints to the area where the sample is to be collected. The UA will then return to the launch site and disarm.

Note: The locations of the area of interest and waypoints will be provided in the follow-up document.

7.6. Scoring

The scoring is presented in Section A3.4. Teams should study this carefully when selecting the UA concept and defining the performance characteristics at the start of the design process.

7.6.1. Mission Times

There are several measured times related to the mission:

- The pre-flight preparation time T1 is measured without a strict time limit. A shorter preparation time will result in a greater score. (Note that this refers to the ground-side preparation before transferring to the Flight Line).

- Once at the Flight Line, after the safety brief, the team has up to 5 minutes to prepare the UA for takeoff. This is a strict time limit, and the Flight Safety Officer can use his/her authority to substitute another waiting team if the time limit is breached.
- The core mission time limit, T2, is 12 minutes.

Exceeding the time T2 will result in penalty points being applied, as set out below.

7.6.2. Route distances

The organizers will provide details of the routes from the Launch Point to the Drop Zone at the start of the demonstration event; as guidance for the teams, the approximate distances are expected to be:

Route A: 4.0 km; Route B: 3.0 km; Route C: 2.0 km

All distances quoted are the straight-line distances (displacement) between waypoints and do not account for positioning maneuvers or turn radii.

7.7. Scoring of Repeated Mission attempts

If there is time in the flying schedule, teams may be allowed up to two attempts at the mission. Requests for a second attempt will be subjected to the priority queue method. Teams in the queue for their first attempt will be given a higher priority. Hence, a second attempt cannot be guaranteed.

For example, Team A wants to attempt a second flight, but teams that did not get the first attempt will be prioritized first. Team A will only get to fly a second time if no teams are in the flight line for their first attempt.

The score which is used in the final judging will be the score of the best attempt. If only one attempt is made, the judging will use the score from that single attempt.

Example 1: If Team A scores 120 points on Attempt #1 and doesn’t have a second attempt, the judging will use that score of 120.

Example 2: If Team A scores 140 points on Attempt #1, and only 60 points on Attempt #2, the judging will use the score of Attempt #1, i.e., 140 points.

7.8. Flight Demonstration Scoring (600 points)

Task	Scoring
Pre-Flight Preparation (50)	
Packaging and Storage	The storage container is well-designed and compact. The disassembled UAS is packaged tidily within the container, including the Ground Controller unit. Components are well protected and secure. The maximum score is 20 points.
Preparation and Time, T1	Time to assemble and ready the UAS for flight, starting with the UAS packaged in the closed Storage container. Includes the installation of batteries, loading pre-programmed route, initializing GPS, and performing all pre-flight checks to the satisfaction of the Scrutineering Official. The maximum score is 30 points. Time taken by each team will be noted. The fastest time will be allocated a score of 20 points. The rest of the teams will be allocated scores based on the percentile basis, rounded to the nearest integer. Example: The fastest time is 250s, while Team A and Team B took 300 and 350s seconds respectively. In this case, scoring will be as follows: Team A: (250/300) * 30 = 25 Team B: (250/350)* 30 = 21
Payload Collection (200)	
Landing Accuracy	100 points will be awarded if the landing takes place within a 1 m radius of the LZ marker; 80 points will be given for landing within a 2m radius, and so on. No points will be awarded if the UA does not land within a 5m radius.
Payload Placement and 2nd Takeoff	The strategy used to disarm, and upon placement of the blood sample, re-arm the drone autonomously, will be scored on a scale of 0-10. The final score will be multiplied by 10. Maximum marks gained in this area can be 50. Example: A team scoring 7 in this criterion will have a final score of 7*10=70 points
Navigation (50)	
Score	5 points for each WP successfully navigated around the declared route. Example: Route A may comprise Launch - WP1 – 2 – 3 – 4 – 5 – LZ – 6 – 7 – 8 - WP9. Total 10 WPs including the LZ. Score = 50 points.
Missed WPs	Score zero for each missed WP. This is where the UA ‘cuts the corner’, misses a WP by a margin of >5m.
Mission Path and Duration (100)	

Core Mission Time, T2	T2 will include the entire duration of time from the moment the drone is cleared for flight, up until it lands again at the launch site. Time taken by each team will be noted. The fastest time will be allocated a score of 50 points. The rest of the teams will be allocated scores based on the percentile basis, rounded to the nearest integer Example: The fastest time is 250s, while Team A and Team B took 300 and 350s seconds respectively. In this case, scoring will be as follows: Team A: (250/300) * 50 = 42 points Team B: (250/350)* 50 = 36 points .
Penalty for Core Mission Time, T2	Teams will incur a penalty for exceeding the core mission time limit, T2. Score -1 points for every five seconds over the limit, and round up. Example: actual core mission duration recorded as 12:35 min:sec, against T2 limit of 12 mins. Penalty incurred of -14 points.
Route Taken	Teams will be provided with a choice of 3 routes having a difference of ~1km. The longest route will hold 50 points, while the second longest will score 35 points, and the shortest will score 20 points. Example: Team-A decides to go for Route 2 (3km, which is 1km shorter than Route 1). In this case, 15 points shall be deducted from overall score. Similarly, if Team-B decides to go for Route 3 (which is 2km less than Route 1), 30 points shall be deducted in this case.
Precision Takeoff and Landing (50)	
Precision Takeoff	25 points scored if the UAV takes off within the 30x10m runway
Precision Landing	25 points are scored if the UAV lands and halts within the 30x10m runway pad. Deduct 10 points if the touchdown was accurate but UAV did not come to complete halt within the designated area
Operation (50)	
Degree of Autonomy	50 points awarded if the UAV performs the entire flight in autonomous mode 30 points awarded if the UAV performs the flight in semi-autonomous mode (manual takeoff and landing) 10 points if the UAV experiences manual inputs at any point in the flight envelope other than take-off and landing.

Note: *The above scoring criteria is strict however the judges are authorized to make changed as they see fit. Additionally, force majeure may lead to new guidelines upon the discretion of the judges.*

8. Annex B - Documents Requirements

8.1. Deliverable Documents

This Annex covers the mandated requirements and guidance on the structure and content of the deliverable documents. Documents must be submitted as a .pdf file. The judges will be seeking evidence that you have understood the engineering challenges summarized below. which indicates what the Judges are looking for throughout the competition. It is important that each deliverable is submitted on time. For late submission, a total of 5% marks per day will be deducted from the total score using the straight-line method.

For example: If the total score of CDR is 200, 3-day late submission will have a penalty of 30 points (10+10+10) from the total score of the team.

Engineering Challenges

- A methodical system engineering approach to identify the requirements, selection of the concept with a design to meet those requirements, and then integration and test to confirm that the actual system meets the requirements in practice.
- An elegant and efficient design solution supported by an appropriate depth of analysis and modelling.
- Innovation in the approach to solving the engineering challenges.
- Due consideration of the safety and airworthiness requirements which shall be addressed from the early concept stage right through into the flying demonstration.
- Construction quality, paying attention to good aerospace practice for such details as connection of control linkages, use of lock nuts, security of wiring and connections, resilience of the airframe and undercarriage.
- Good planning and team-working; organizing the team to divide up roles and responsibilities. Good communication and good planning will be essential to achieve a successful competitive entry, on time and properly tested prior to the Demonstration Event.
- Automatic or autonomous operations; the UAS shall be able to operate automatically, without pilot intervention from takeoff to touchdown.
- A strong business proposition for your design, demonstrating good commercial understanding of how your design might be developed to generate revenue for an operator.
- Attention to environmental impact, including developing an efficient aircraft design which minimizes energy consumption, and attention to minimizing use of hazardous materials.

Teams will be given preliminary scores following each submission, but this will not be formalized until judges have inspected the UAS at the Demonstration Event to confirm that the UAS is as described in the submissions.

Each submitted document must have a cover page with the following information:

- Team name
- University
- List of team members, their courses and year
- Name of supervisor
- Sketch or image of your aircraft
- Signature of person compiling the document (normally team leader)

- Signature of person authorizing its issue (normally Supervisor). Ideally an additional signature that your mentor has checked the submission.
- Sponsor logos (if applicable)

8.1.1. Conceptual & Preliminary Design Review (PDR) (50 points)

The Preliminary Design Review is a short description of your chosen concept to address the requirements of the UAS Challenge. It takes the form of a report of no more than 10-pages of text out of which 2-page must be of drawings/sketches. You should use the 10-pages to describe the aircraft configuration, the propulsion and control systems, any image identification systems and your package carriage and release system. You should also highlight any aspect of your concept or design process that you think is novel. Your drawings or sketches should show the major features of the design and be clearly labelled. The assessment panel will be looking for several factors including:

- Clear articulation of your concept
- Extent of Innovation in the Outline Design
- Adherence to the rules
- Depth and extent of underpinning engineering analysis
- Consideration of safety and airworthiness requirements
- Evidence of sound project management, planning, budgeting
- Demonstrating a well-considered business case
- Demonstrating good teamwork and organization
- Overall Quality of PDR submission

8.2. Critical Design Report (CDR) (150 points)

This is a detailed description of your design of no more than 25-pages, including diagrams, tables and charts. This report shall follow the structure described below as the individual sections will be allocated to expert judges for review. This report shall establish that you have understood and are compliant with all the requirements of the competition and that your design will be safe to fly.

Cover Page (not included in the page count)

- For PDR

Summary description of the design

- A text description of the proposed design.
- List and reason for all significant changes since the PDR
- List any contributions from sponsors
- Weight of cargo to be carried in main mission and tasks to be undertaken in optional mission

Project Management

- A review of progress against your project plan with any necessary amendments and with further detail for the remaining steps in the program. It should show lead times and dependencies that will have to be managed.
- A table summarizing the project (resourcing, skills, procurement, manufacturing, etc.) risks and their mitigation.

Requirement Review

- A table with a configured list of all the key Requirements, including regulatory requirements, and Mission objectives and how they are being met (e.g.):

Requirements	Verification
All up mass <= 10 kg	Detailed weight budget has been produced with 10% contingency
Compliant with PTA directives, and licensed for use in the Pakistan. Reliable operating range of 1 km. Control of the UA and the FTS is 'Spread Spectrum' compliant to 100mW spread spectrum	Control and FTS transmissions are 100mW spread spectrum conforming to IR2030 and CE marked
FTS design which transforms the UA into a low energy state if the data links between the GCS and UA are lost, and lands the UA as soon as possible after initiation	Configured in the autopilot with motor power cut within 1s and controls set for spiral dive

Design Description

- A functional description, and the rationale for selection of each of the proposed systems, including airframe, propulsion, flight controls, navigation & mission control, sensors, image processing, autonomy / automatic operation, payload carriage and mechanism, and flight termination system, highlighting any novel features.
- Aerodynamic, structural, and performance calculations supporting the sizing, stability, and control calculations that supports the design configuration. Indicate any uncertainties that still need addressing.
- A detailed weight breakdown.
- A diagram showing the system architecture and data flow for the navigation and mission control, flight control, vision sensor and the design for automatic operation.
- UAS overall layout & description with a three-view scale drawing.

Safety

- Describe your overall approach to safety and how you will establish the airworthiness of the system.
- Record your main safety risks, presented as a table of hazards and how they will be mitigated, together with your assessment of 'severity' and 'probability' for each hazard, considering the examples provided below.

Severity	Examples
Marginal	Irreparable damage or loss of the UAS
Minor	Minor injury to a participant. Damage to public property.
	Damage to public property.
Major	Single major injury to a participant.
	Single injury to a member of the public

Catastrophic	Multiple injuries.
	Death of any party

Probability	Example
Frequent	Likely to occur frequently during UAS Challenge.
Occasional	May occur occasionally during UAS Challenge.
Remote	Remote possibility of occurring during UAS Challenge
Improbable	highly unlikely to occur during UAS Challenge

Manufacturing and support description

- Describe the proposed manufacturing process and construction techniques to be used, including any safety and environmental issues and how they will be addressed. Any special equipment should be listed. Final assembly should be undertaken in-house and any outsourcing of major subsystems must be justified.
- Describe the support equipment, handling and storage fixtures necessary to the development flight trials and prototype customer demonstration at the event.
- Highlight any innovative aspects.

Qualification Test Plan

Using a table format, summarize your test plan indicating how each performance and safety requirement will be verified (e.g.)

Cost Breakdown

- A detailed table listing all the bought-out items, including their actual or estimated costs. This must include any costs incurred through outsourcing any manufacturing.
- A total cost and a separate sub-total cost for the COTS items, as defined in

Section: 3.1.7: Limits on use of COTS Items Guidance on how the Design Report will be assessed

The assessment panel will be looking for a number of factors including:

- Demonstration of a sound systems engineering approach to meeting the design requirements.
- A structured design process adopted by the team, and how the derived performance requirements are developed for each of the sub-systems such as wing (or rotor), airframe, propulsion, control, navigation, cargo handling etc.
- Extent of Innovation in Outline Design.
- Adherence to the rules.
- Depth and extent of underpinning engineering analysis;
- Design and planning to meet safety and airworthiness requirements;
- Evidence of sound project management, planning, budgeting;
- Overall Quality of the submission.

Summary Chart for CDR

Team name	
Team Lead and Supervisor name	
Review Items	Requirements & Compliance Project Approach Manufacturing Approach / Progress Testing Approach / Progress Schedule Safety Risks
Changes since PDR	
Main issues arising and actions to be taken	
Supervisor + Team Leader Signature	

8.3. CAD and Simulations (50 Points)

Submission	Scoring
Design Concept and Detailing	The overall design of the model will be scrutinized in light of the submitted PDR and CDR. Movement of control surfaces, amount of detail in payload mechanism, and accuracy of component dimensions will be checked against the submitted reports. Component placement and resulting CG will be checked to see if it is balanced.
Parameters	Teams are required to incorporate all the material selections into their model. Weight limits are to be kept in mind since exceeding weight will cost points.
Payload Mechanism	Mechanical integration of the system, overall working, ease of loading/unloading. The more compact the mechanism is, the better.
FEA	The simulations will be checked for inclusion of load analyses on all critical UAV components. Up to 5 bonus marks may be awarded for a vibrational analysis.
CFD	The package will be checked to ensure that adequate investigation has been performed on the lift, drag, velocity and pressure characteristics of the UAV in real time flight conditions. Up to 5 bonus marks may be awarded on the inclusion of an acoustic analysis.

8.4. Flight Readiness Review (FRR) (100 points)

The Flight Readiness Review (FRR) submission should include:

- A 10-minute video showing evidence of the development testing undertaken, including a continuous flying sequence showing a fully autonomous takeoff, controlled flight, including any transition, and landing.
- A full statement and justification of any changes introduced since the Design Report with any impact on the safety or performance of the vehicle.
- A pre-flight check lists.
- A report about how any Corrective Actions required by the judges from the Design Report have been fully addressed.
- Confirmation that the team Pilot has experience of operating the UAS during development testing.
- A signed declaration by a suitably qualified Chartered Engineer and Member (or Fellow) of a Professional Engineering Institution, that in their opinion:
    - The UAS appears compliant with the requirements noted in Section 3.
    - The design and build quality are satisfactory.
    - Safety and Airworthiness aspects have been addressed satisfactorily, with appropriate fail-safe mechanisms and a risk register completed.
    - The system has been tested, both by modelling and demonstration, to evaluate the performance and reliability.
    - The team members preparing and operating the UAS are suitably competent to ensure safe operations.

This is your confirmation that you are Flight Line ready and can safely proceed to the Flight Demonstration event in December 2024 or January 2025, where your vehicle will be scrutinized and be issued with a ‘Permit to Test’ by the Flight Safety Officer. A panel of judges and scrutineer representatives will review the FRR submission and assess whether the team has reached the maturity necessary to enter the flight demonstration phase of the competition. The assessment panel will be looking for evidence in the FRR Video about the extent and rigor of testing to demonstrate the performance and safety features of the UAS.

8.5. Business Proposition award (100 points)

Task	Scoring
Overall Business Plan [10%]	
Vision	The vision of the project should be unambiguously defined, describing what the team will accomplish upon completion of the project.

Realistic Approach	The documents should not contain imaginary, unrealistic data/content that is not practically achievable depending upon your skills, idea, knowledge etc.
Market Share	The introduction of the following product to the market should be explained. This means your presentation should include the marketing strategy, market entry and market penetration.
USP explained	Explanation of what makes the model unique and why it stands out in contrast to other models.
About the Company [15%]	
Technical use of Product	Presentation should include the technical aspect of the product and its potential use cases (target area, flight time, battery, etc.).
Feasibility of Product	How the product planned is made and if the plan to market etc. is feasible or not.
Market Analysis	The people and companies that the product targets.
Commercial Setting	An account of how the product features will be beneficial to the commercial market and why companies should consider investing in the product
Market Sales Plan and Pricing [10%]	
Marketing Strategy	Overall Judgment of the marketing strategy deployed (target market, engagement, keeping potential customer’s long term)
Overview of Distribution	Plan of whom and where product will go through before reaching the final consumer (such as wholesalers, retailers, distributors, direct buying etc.)
Product Promotion	The presentation must include the strategy to promote the product, e.g. social media marketing strategy.
Financial Plan and Funding [25%]	
	Financial plan and funding mean estimation of amount of capital requirements, Break-even point, BOM, cost profit analysis, and company forecast.
Presentation Skills [40%]	

8.6. Outreach Scoring Table (50 points)

Marking Criteria	Grading Percentage
Likes related to the social media campaigns executed during the competition	20%
STEM / sustainability-related content	10%
Content about the UAS	5%
Physical drives	5%
Overall engagement of page	60%

Note: *Additional details will be communicated in due course of time.*