



12th

**Design Build & Fly
Competition**

2017

Rules and Regulations

TABLE OF CONTENTS

Introduction.....	2
Judging.....	3
Competition Site	3
Team Requirements.....	4
Sponsorship	4
Schedule	5
Design Reports	5
Competition Dates.....	5
Aircraft Requirements	6
Conventional Category	6
General requirements.....	6
Safety Requirements.....	7
Physical Inspection of Aircraft to Ensure Structural Integrity.....	8
Safety Inspection of Aircraft: Structural Verification	9
Design requirements & Number of Missions.....	10
Design Report Scoring.....	10
Design Report Format.....	10
Design Report Submission Procedure.....	12
Debriefing	13
Mission Details.....	13
Mission Specifications	14
Missions.....	14
Mission-1: Without Payloads	14
Mission-2: With Internal Payload.....	15
Flight Line Order	15
General Notes	16
Protest procedure.....	16
Solar Powered Category.....	17
Contact Details.....	17

INTRODUCTION

STEM Careers Program is a joint venture of the Higher Education Commission and Pakistan Institute of Engineering and Applied Sciences for grooming talented students for careers in Science, Technology, Engineering & Mathematics (STEM).

National Engineering Competition (NEC) is one of the projects launched by STEM Careers Program along with National Science Talent Competition.

The main idea behind the NEC is to encourage undergraduate engineering students in public as well as in private sector institutions to come up with innovative solutions to problems in national interest.

STEM Careers Program has launched National Design, Build & Fly Competition (DBFC) in collaboration with GIK Institute. **The Twelfth National Design, Build & Fly Competition (DBFC-XI) will be held from 21st to 23rd April, 2017 at GIK Institute, Topi - Swabi.**

This year competition will be in the two types of unmanned, electric powered, radio controlled aircraft categories:

1. Conventional NiCAD Battery Powered Aircraft;
2. Solar Powered Aircraft (NOT Main Part of the Competition, however will be given prizes for best designs)

The Competition will provide a real world aircraft design experience to engineering students by giving them the opportunity to validate their analytical studies.

JUDGING

Students must design, document, fabricate, and demonstrate the aircraft they determine as best capable of achieving the highest score on the specified mission profile(s). The overall team score is a combination of the Design Report, Debriefing of the Design and Manufacturing of the Aircraft and Flight scores. The team with the highest overall team score will be declared the winner. Grading of complete event will be as follows:

1. **Design report: 25 %**
2. **De-Briefing and Viva Voce: 30 %**
3. **Flying: 45 %**

Each team will submit a written Design Report. A maximum of 100 points will be awarded for the design report submitted by the team. Scores for the written reports will be announced at the beginning of the fly-off. All submitted reports are the property of STEM Careers Program and may be published or reproduced at their discretion.

COMPETITION SITE

Host for the competition will be **Ghulam Ishaq Khan Institute of Engineering Sciences and Technology, Topi - Swabi, KPK, Pakistan.**

TEAM REQUIREMENTS

All team members (except for a pre-approved pilot) must be full time undergraduate students at HEC accredited Universities or Engineering Colleges of Pakistan. At least 1/3 of the team members must consist of freshmen, sophomores or juniors. There should not be more than 5 members in each team.

There can be a maximum of two (2) teams from any one educational institution for Conventional and one team for Solar Powered.

For institutions with multiple campuses in different cities/parts of the country, each campus will be considered as a separate entity.

Members of one team are not allowed to be the members of the 2nd team.

However, members can be common in Solar Powered Category. In addition, if two teams are participating from one university/institute/college then both of their designs must not be similar or the same.

SPONSORSHIP

Teams may solicit and accept sponsorship in the form of funds or materials and components from commercial organizations.

All design analysis and fabrication of the Competition entry is the sole responsibility of the student team members.

SCHEDULE

DESIGN REPORTS:

Design reports must **ARRIVE** at the Coordinator office address by 5:00PM local time by no later than **10th March 2017**. Reports will be judged “as received”, no corrections/additions/page changes will be made by the organizers so check your reports carefully before sending them. Teams must submit **5** hard copies of the report (printing details are outlined in the report section at the bottom of this document) **AND** one electronic copy in PDF. ***Only the hard copies will be used for judging.***

Note: The ***Entry Name*** may not be changed once the form is submitted, but must be retained and **used** on all reports and correspondence during the competition year.

Be sure to include the Phone and Fax number for your team advisor and at least one student contact so we may reach you in case of any last minute problems or changes. All teams are required to provide two points-of-contact e-mail addresses with their Competition application, one of which must be the team’s advisor. ***It is the team’s responsibility to make sure the e-mail contact addresses they supply remain active during the entire period from entry to the close of the competition, as e-mail will be the primary means to provide information and updates.***

Note: All schedule deadlines are strictly enforced mentioned by organizers. Late entries will **NOT** be accepted. Late report submissions will **NOT** be judged. Teams who do not submit the required written reports will **NOT** be allowed to fly. It is the team’s responsibility to assure that all deadlines are known, understood and met.

Note: Any report that may be subjected to plagiarism would lead to immediate disqualification of the team from the competition.

COMPETITION DATES:

- The Competition is scheduled for **22nd to 23rd April 2017**. The teams will arrive on **21st April 2017** before 5:00 pm.
- Please note that Technical inspections will be available on **22nd April 2017**.
- All teams are required to be prepared and get ready for the DEBRIEFING session on **23rd April 2017 at 9.00AM**.
- Any team which will miss DEBRIEFING session will miss marks for this activity. DEBRIEFING session is very important activity which will provide the physical and theoretical judgment of the design to fly.
- The order in which team will be judged for DEBRIEFING and FLYING will be announced after lucky draw before start of the each event.
- Team late for debriefing and flying will be given zero marks.
- Flying competition will commence on completion of debriefing session, timing of flying event will be strictly adhered. Flying will terminate at 1600 hours on **23rd April 2017**.

AIRCRAFT REQUIREMENTS

CONVENTIONAL CATEGORY

GENERAL REQUIREMENTS:

- The aircraft may be of any configuration except rotary wing or lighter-than-air.
- No structure/components may be dropped from the aircraft during flight.
- No form of externally assisted take-off is allowed. All energy for take-off must come from the on-board propulsion battery pack(s).
- Must be propeller driven and electric powered with an unmodified over-the-counter model electric motor. May use multiple motors and/or propellers. May be direct drive or with gear or belt reduction.
- Motors may be any commercial brush or brushless electric motor.
- For safety, each aircraft will use commercially produced propeller/blades. Must use a commercially available propeller hub/pitch mechanism. Teams may modify the propeller diameter by clipping the tip and may paint the blades to balance the propeller. No other modifications to the propeller are allowed. Commercial ducted fan units are allowed.
- You can change the propeller diameter/pitch for each flight attempt.
- Motors and batteries will be limited in current draw by means of a **40** Amp fuse in the line from the positive battery terminal to the motor controller.
- Fuse(s) must be located such that no propulsion system component: motor; motor controller; or battery may see more current than the stated limit (fuse value).
- Only ATO or blade style plastic fuses may be used.
- Must use over the counter NiCad or NiMH batteries. Lithium Polymer Batteries are strictly prohibited (NO EXCEPTIONS TO THIS RULE WILL BE PERMITTED UNDER ANY CIRCUMSTANCES).
- For safety, battery packs must have shrink-wrap or other protection over all electrical contact points. The individual cells must be commercially available and the manufacturers label must be readable/documented (i.e. clear shrink wrap preferred). All battery disconnects must be "fully insulated" style connectors. Batteries may be randomly asked to be unwrapped to check tempering of labels is suspected. In case of tempered batteries, team would be automatically disqualified.

- Maximum propulsion battery pack weight is defined in the mission rules section. This battery pack must power propulsion systems only. Radio Rx and servos MUST be on a separate battery pack. Batteries may not be changed or charged between sorties during a flight period.
- The aircraft must remain substantially the same as documented in the report (for example you cannot change a flying wing design to a conventional tail design). You may make small modifications to the design to improve flight performance after the report submission (one example would be changing a control surface size).
- **Teams must submit proof that the aircraft has been flown prior to the Competition date (inflight movie) to the technical inspection team.**
- **Teams must submit proof in the form of movie clips that the aircraft has been fabricated using local resources along with the written report.**

SAFETY REQUIREMENTS:

- All vehicles will undergo a safety inspection by a **designated contest safety inspector/Judges** prior to being allowed to make any competition flight. All decisions of the safety inspector are final.
- To speed the tech inspection process each team must present a **signed Pre-Tech and First-Flight Certification** when called to begin their on-site tech inspection. Teams may not begin the on-site tech inspection without a completed certification. **The Pre-Tech and First-**
- **Flight Certification sheet will be provided two weeks prior to competition date by the faculty advisor.**

The Pre-Tech must be conducted by, and signed off by, a non-team member RC pilot or the team faculty advisor. The Pre-Tech will cover the same safety of flight requirements as the on-site tech inspection and will assist teams in making sure they are ready and able to pass the on-site tech inspection the first time. An expanded First-Flight requirement, which also must be signed off by a non-team member RC pilot or the team faculty advisor, requires demonstration of a complete flight including take-off, flying a minimum flight pattern, and landing in a pre-designated location without damage to the aircraft. The non team member RC pilot who signs the inspection and flight certifications may be the same as a team's non-student contest pilot.

PHYSICAL INSPECTION OF AIRCRAFT TO ENSURE STRUCTURAL INTEGRITY

- Verify all components adequately secured to vehicle. Verify all fasteners tight and have either safety wire, loctite (fluid) or nylock nuts. Clevises on flight controls must have an appropriate safety device to prevent their disengaging in flight.
- Verify propeller structural and attachment integrity.
- Visual inspection of all electronic wiring to assure adequate wire gauges and connectors in use.
- Radio range check, motor off and motor on.
- Verify all controls move in the proper sense.
- Check general integrity of the payload system.

SAFETY INSPECTION OF AIRCRAFT: STRUCTURAL VERIFICATION

All aircraft will be lifted with one lift point at each wing tip to verify adequate wing strength (this is "roughly" equivalent to a 2.5g load case) and to check for aircraft cg location. Teams must mark the expected empty and loaded cg locations on the exterior of the aircraft. Special provisions will be made at the time of the contest for aircraft whose cg does not fall within the wing tip chord. This test will be made with the aircraft filled to its maximum payload capacity.

Radio fail-safe check: All aircraft radios must have a fail-safe mode that is automatically selected during loss of transmit signal. The fail-safe will be demonstrated on the ground by switching off the transmit radio. Every aircraft must pass this test before flight is permitted. In case test is failed in Queue, the team will forfeit one attempt). During fail-safe the aircraft receiver must select

<i>Throttle</i>	<i>Closed</i>
Elevator	Full up
Rudder	Full right
Aileron	Full right
Full Flaps down (if so equipped)	

DESIGN REQUIREMENTS & NUMBER OF MISSIONS

- Battery pack(s) maximum weight limit is **1.75 lb.**
- Teams will be allowed a maximum of **3 flight attempts** for each mission and one successful scoring flight. Once a mission has a successful scoring flight it may NOT be repeated to try to improve the score.
- All payloads must be secured sufficiently to assure safe flight without possible variation of aircraft cg during flight.
- Assembly/flight line crew is limited to pilot, observer and 1 ground crew.
- Scoring measurement units are feet, lbs and seconds.

DESIGN REPORT SCORING

At least **50% marks** in the Design Report are required to enter into the next stage of the competition, as this activity includes all the steps followed during design and manufacturing of the plane.

DESIGN REPORT FORMAT

All section scores shall include format, completeness and readability.

Executive Summary (10 points):

- Provide a summary description of your selected design and why it is the best solution to the specified mission requirements.
- Describe your key mission requirements and design features keyed to those requirements.
- Document the performance/capabilities of your system solution.

Management Summary (5 points):

- Describe the organization of the design team.
- Provide a chart of design personnel and assignment areas.
- Provide a milestone chart showing planned and actual timing of the design / fabrication / testing processes.

Conceptual Design (15 points):

- Describe mission requirements (problem statement).
- Translate mission requirements into design requirements.
- Review solution concepts/configurations considered.
- Describe selection process and results.

Preliminary Design (20 points):

- Describe design/analysis methodology
- Document design/sizing trades
- Describe/document mission model (capabilities and uncertainties)
- Provide estimates of the aircraft lift, drag and stability characteristics.
- Provide estimates of the aircraft mission performance.

Detail Design (30 points total: 15 points for discussion items, 15 points for drawing package):

- Document dimensional parameters of final design.
- Document structural characteristics/capabilities of final design.
- Document systems and sub-systems design/component selection/integration/architecture.
- Document Weight and Balance for final design. Must include a Weight & Balance table for the empty aircraft and with each of the possible payloads
- Document flight performance parameters for final design.
- Document mission performance for final design.
- Drawing Package
- 3-View drawing with dimensions.
- Structural arrangement drawing.
- Systems layout/location drawing.
- Payload(s) accommodation drawing(s)

Manufacturing Plan and processes (5 points):

- Document the process selected for manufacture of major components and assemblies of the final design.
- Detail the manufacturing processes investigated and the selection process/results.
- Include a manufacturing milestone chart showing scheduled and actual event timings

Testing Plan (5 points):

- Detail testing objectives, schedules, and check-lists

Performance Results (10 points):

- Describe the demonstrated performance of key subsystems and compare it to predictions from Section 5. Explain any differences and improvements made
- Describe the demonstrated performance of your complete aircraft solution and compare it to predictions from Section 5. Explain any differences and improvements made

Other Important Requirements to be fulfilled in the Design Report:

- Detailed calculations for the design and selection of different components performed with references from where formulae or information is taken.
- Components/materials selected/purchased with their references and/or source of purchase with quantity and cost.
- Video clips of the manufacturing process including e.g. for paint, coats, fabrications and assembly etc.
- In addition with written details of processes used in fabrication, painting, assembly such as different machines or tools etc should be provided.
- References of clubs/institution should be clearly mentioned from where guidelines/help is taken during design and manufacturing of the planes.

DESIGN REPORT SUBMISSION PROCEDURE

Each team must provide an electronic copy of their final design report in addition to the hard copies used for the report judging as outlined below.

Electronic copy must be RECEIVED by the same deadline as documented for the written reports. Both the Word and PDF files are requested to be submitted on CD.

Electronic report files must be named: **“2017DBF_[university]_[team name].PDF”** and **“2017DBF_[university]_[team name].doc”**

Electronic report must be a single file with all figures/drawings included in the proper report sequence in PDF format. (Free PDF file conversion programs are available on the Internet, such as www.pdf995.com.)

Electronic reports should have all figures compressed to print resolution to minimize file size.

Any report that may be a copy of any reports submitted during previous episodes of DBFC would lead to immediate disqualification.

DEBRIEFING

Debriefing session is an essentially important activity which will provide the physical and theoretical judgment of the design to fly.

- Each team has to appear for the written multiple choice question (MCQ) test of maximum 30 minutes duration.
- The judges will select one candidate from each team for the test.

Test is divided into two section as:

- MCQs regarding Basic Concepts – 15 minutes
- Design of Aircraft Calculations – 15 minutes

MISSION DETAILS

1. **Missions must be flown in order.** A new mission cannot be flown until the team has obtained a successful score for the preceding mission.
2. Aircraft must be designed to be capable of performing all required missions. Specifically this requires that teams must show that all payloads fit in the aircraft during the tech inspection. **If in doubt, Judges will have discretion to ask team to demonstrate most demanding mission.**
3. Teams will be asked to load configuration #1 (of mission #2) and must present photographs showing configurations #2-6 installed.
4. Aircraft must pass the wing tip load test with the larger of 4 internal stores.
5. The number of internal stores demonstrated will be recorded and cannot be altered after completing tech inspection.
6. The aircraft will enter the assembly area with the payload for mission 2.
7. The team will have a total of 5 minutes to load the payload and checkout the aircraft systems as fully functional.
8. There is no work allowed on the aircraft after the loading/checkout time.
9. The RC receiver should be able to be turned on externally or must be left on. You will not be allowed to re-open any compartment after the loading/checkout time to turn on the receiver.

10. Only the assembly crew member, pilot and pilot assistant may go to and enter the staging box.
11. After the checkout is complete the assembly crew member may be swapped for a different flight line crew member if desired.
12. The initial upwind turn on the first lap of each mission will occur after passing the turn judge (signaled by raising a flag). The aircraft must remain in unaided visual control distance of the pilot at all times. The **Flight Line Judge** may require turns to be made to remain in a safe visual control range at his discretion.

MISSION SPECIFICATIONS:

In the event that, due to time or facility limitations, it is not possible to allow all teams to have the maximum number of flight attempts as mentioned below, the Competition committee reserves the right to ration and/or schedule flights. The exact determination of how to ration flights will be made on the Competition day based on the number of entries, weather, and field conditions.

- The maximum number of attempts is **3**.
- Missions must be completed in order as: Mission 1; Mission 2.
- During each mission Aircraft will take-off and must fly at least 3 laps.
- One lap means that the aircraft must complete a 360 degree turn.
 1. Lap 1 = 360 left
 2. Lap 2 = 360 right
 3. Lap 3 = 360 vertical
- Time for 3 laps will be scored.
- There is no score for partial missions.
- Aircraft will fly this mission without payload

MISSIONS:

1. Aircraft will use ground rolling take-off and landing:
 - Missions will simulate take-off from a small austere field.
 - **The aircraft must take off within 60 ft.**
2. Aircraft must complete a successful landing at the end of each mission for the mission to receive a score:
 - A successful landing is outlined in the general mission specification section below.

MISSION-1: WITHOUT PAYLOADS

- Take-off within the prescribed area.
- Maximum number of complete laps within a 4 minute flight time
- Time starts when the throttle is advanced for the (first) take-off (or attempt)
- A lap is complete when the aircraft passes over the start/finish line in the air
- Mission performance will be normalized over all teams successfully completing this mission.
- Must complete a successful landing to get a score

MISSION-2: WITH INTERNAL PAYLOAD

- 3 Lap payload flight.
- **Payload will be a standard Nestle 500 ml water bottle.**
- The payload must be secured in place to ensure that it does not jerk around during flight.



FLIGHT LINE ORDER

- A flight order list will be generated and posted at the beginning of flying. Teams will always rotate in this order. The flight order will be repeated continuously and will be carried over at whatever spot in the rotation it leaves off.
- Each team's position in the flight order will be determined from their written report score, highest report score goes first.
- There will be four staging box positions near the flight line. While in the staging box, teams can make any final preparations and checkout required prior to flight.
- If you are not in place in a staging box when your rotation number comes up you will miss your opportunity for that rotation.

Note: We will not call teams to the staging box, it is the team's responsibility to monitor the progress of the Competition and decide when they need to get ready to enter an open spot in the staging box. A Competition official will be available to help teams in entering the staging box area.

- Electing to enter one of the staging box positions on your turn in the rotation order will constitute using a flight attempt.
- If you choose to leave the staging box for any reason you will forfeit that flight attempt.
- If you go to the flight line and are not able to begin your takeoff when instructed you will forfeit that flight attempt.
- Only **5 extra minutes** will be given to each team to prepare for takeoff.

GENERAL NOTES

- The aircraft propulsion system(s) must be "safed" (fuse removed) during any time when crew members are preparing/handling the aircraft.
- Maximum flight support crew is: pilot, observer, and ground crew.
- Observer and all ground crew must be students. Only the pilot may be a non-student.
- The upwind turn will be made after passing the upwind marker. The downwind turn will be made after passing the downwind marker. Upwind and downwind markers will be 500ft from the starting line. Aircraft must be "straight and level" when passing the turn marker before initiating a turn.
- Aircraft must land on the paved portion of the runway. Aircraft may "run-off" the runway during roll-out. Aircraft may not "bounce" off the runway.
- Aircraft obtaining "significant" damage during landing will not receive a score for that flight. Determination of "significant" is solely at the discretion of the Flight Line Judge.

Flight altitude must be sufficient for safe terrain clearance and low enough to maintain good visual contact with the aircraft. Decisions on safe flight altitude will be at the discretion of the Flight Line Judge and all rulings will be final.

PROTEST PROCEDURE

- Submitting a protest is a serious matter and will be treated as such. Teams may submit a protest to the Competition Administration at any time during the competition. Protests may not be submitted after the conclusion of the competition. Protests must be submitted in writing and signed by the team advisor, designees are not allowed for protest submissions. If the team advisor is not present, he may FAX a signed protest to the team for them to present.
- Protests and penalties (up to disqualification from the Competition for deliberate attempts to misinform officials, violate the Competition rules, or safety infractions) will be decided by the Competition Administration. The decision of the Competition Administration is final.

SOLAR POWERED CATEGORY

This category is being introduced as an incentive to those teams who accept the challenges of shrinking energy resources and can design UAVs that are powered by alternate energy sources. Following rules will apply to this category:

- a) Safety, General Requirements, Structural Verification and Physical Inspection Requirements (Pars 7 to 9 above) remain the same.
- b) Aircraft is to be powered and fly on Solar Energy only. (No battery will be allowed for power).
- c) Aircraft should takeoff within 150 feet distance.
- d) Aircraft shall fly one complete lap similar to the one specified above.
- e) Winning concept will be the one that flies one complete lap (as defined in Mission 1 above) and is **the lightest weight**.

CONTACT DETAILS

Questions regarding the Competition, schedules, or rules interpretation may be sent to the Competition Coordinator by e-mail mentioning team name and personal name. Written reports (only) should be sent at the following postal address:

Dr. Khalid Rehman

Coordinator Design, Build and Fly Competition (DBFC)

Faculty of Mechanical Engineering, GIK Institute, Topi – 23460 KP. Pakistan

Email: khalid.rehman@giki.edu.pk

Ph: 0938-28102661, Ext: 2315, 2351, Fax: 0938-28100