JET ENGINE DESIGN COMPETITON SPECIFICATION 2024

Specification Revision Tracking

Revision	Date	Explanation
1		TEKNOFEST 2024 First Version
2	20.02.2024	Competition Calendar

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1. General Content and Details of the Competition

This document has been created to define all the rules and requirements of the Jet Engine Design Competition organized within the scope of TEKNOFEST Aviation, Space and Technology Festival (TEKNOFEST) Technology Competitions. The general content consists of competition rules, design goals and constraints.

The competition aims to design a Low Bypass Fan Module for a turbofan engine. What is expected from the teams participating in the competition is to make mechanical, aerodynamic, thermal and structural designs of the low bypass fan module to be integrated into the front of a core engine that can meet the conditions in accordance with the design criteria specified in the rest of the document. As a result of the design studies, it is expected that the final design report will be prepared and presented.

The competition is structured for undergraduate and graduate students. The purpose of the competition is to help students improve their skills by growing their interest in aviation gas turbine engine technologies.

The application form must be filled out by 29.02.2024 Each participating team can only submit a single design.

Applications will be received via the official website of the TEKNOFEST Technology Competitions (www.teknofest.org).

General Information: 3D models of the designs of the winning teams will be created and will be exhibited at the TEI stand on the day of the event. The winning teams will be announced during the TEKNOFEST event.

2. Competition Conditions

- University students (undergraduate, master's and doctorate) studying in Turkey and abroad can participate in the competition.
- Teams must consist of a maximum of 10 people. Apart from this, teams can only work with 1 consultant.
- Employees and long-term interns of aviation engine companies cannot participate in the competition. If they are found to have participated, they will be disqualified from the competition.
- Design development cannot be made after the Detailed Design Report is delivered.
- A member of one team cannot be a member of another team.
- Teams can be formed from a single school or as a mixed team with one or more higher education students coming together.
- Along with the Detailed Design Report, approved student documents must be submitted

for students, and an approved document proving that they are faculty members/staff, research assistants or teachers must be submitted for consultants.

- The signed document stating that the person who will serve as a consultant will fulfill his/her consultancy duties must be uploaded to the system together with the Detailed Design Report.
- Teams at the undergraduate and graduate level may take a lecturer/member or research assistant as an advisor.
- For consultants, an approved document must be submitted showing that they are a faculty member/staff member, research assistant or teacher.
- A consultant can only advise one team.
- The consultant must upload the document stating that he/she has worked as a teacher/instructor/academic, obtained from the relevant institutions where he/she works, to the system along with the Detailed Design Report.
- Duties of the consultant; To help students plan their own education, to guide them in academic, social and cultural issues, to help prepare the appropriate environment for the development of the student's personality as a whole in terms of mental, social and emotional aspects, etc. duties and services. The advisor's role in the team; To guide team members to find solutions to their problems by providing the academic support needed in the project.
- Consultants cannot show their workforce in the competition and are prohibited from actually taking part in design and analysis activities.
- It is mandatory for the consultant to submit the assignment letter he/she will receive from the relevant education/training institutions to the TEKNOFEST Committee.
- In case of a change of consultant, they must notify the relevant TEKNOFEST Committee in writing. (This document is mandatory to change consultants.)
- KTR (Conceptual Design Report) and DTR (Detail Design Report) to be prepared within the scope of the competition can each consist of a maximum of 100 pages (the entire report; cover, introduction pages, bibliography, etc. sections are included). Teams exceeding the page limit will be assessed 10 penalty points.
- Use of information without reference in design, reporting and presentations is prohibited. Information parts that are not referenced will not be evaluated.
- Transportation and accommodation support to be provided to teams making it to the finals is limited. The number of people to be supported will be notified to the teams later by the TEKNOFEST Competitions Committee.
- Applications are made online through the www.t3kys.com application system until 29/02/2024.

- Between the application dates, the team captain/consultant registers through the system, registers the consultant and/or team captain/team members, if any, accurately and completely, and sends invitations to the e-mails of the consultant and members, if any. The invited member logs in to the application system, accepts the invitation from the "My team information" section and registration is completed. Otherwise, the registration will not be completed.
- All processes required within the scope of the competition (Application, Report Receipt, Report Results, Objection Processes, Member addition/removal procedures, etc.) are carried out through the QMS system. Teams must follow their processes through the QMS system.
- Member addition/removal operations are carried out until the Detailed Design Report Delivery date.
- During the competition process, applying through the QMS, uploading reports, filling out forms are within the authority of the team captain and/or consultant, and the competition processes are managed through these people.
- TEKNOFEST Competitions Committee has the authority to limit the number of members in the festival area. In case of any limitation, the committee will inform you.
- The contestant will be able to participate in the competition by reading and approving all the explanations about the competition and participation conditions before applying.

3. Fan Module Specifications and Limitations

The Low-Bypass Fan Module to be designed must comply with the specified physical limitations and meet the geometric envelope, manufacturability, performance, aerodynamics and structural requirements. Designs to be made within the scope of the competition; They will design the Fan Module that will be integrated into the front of the core engine. An example turbofan engine is presented in Figure 1. There is no need to do any work on the core engine within the scope of the competition. Fan module design inputs are presented in the relevant section of the competition specifications

3.1. Fan Module Physical Limitations

The dimensions given in the physical limitations are the dimensions that must be observed when the fan module is in a cold state.

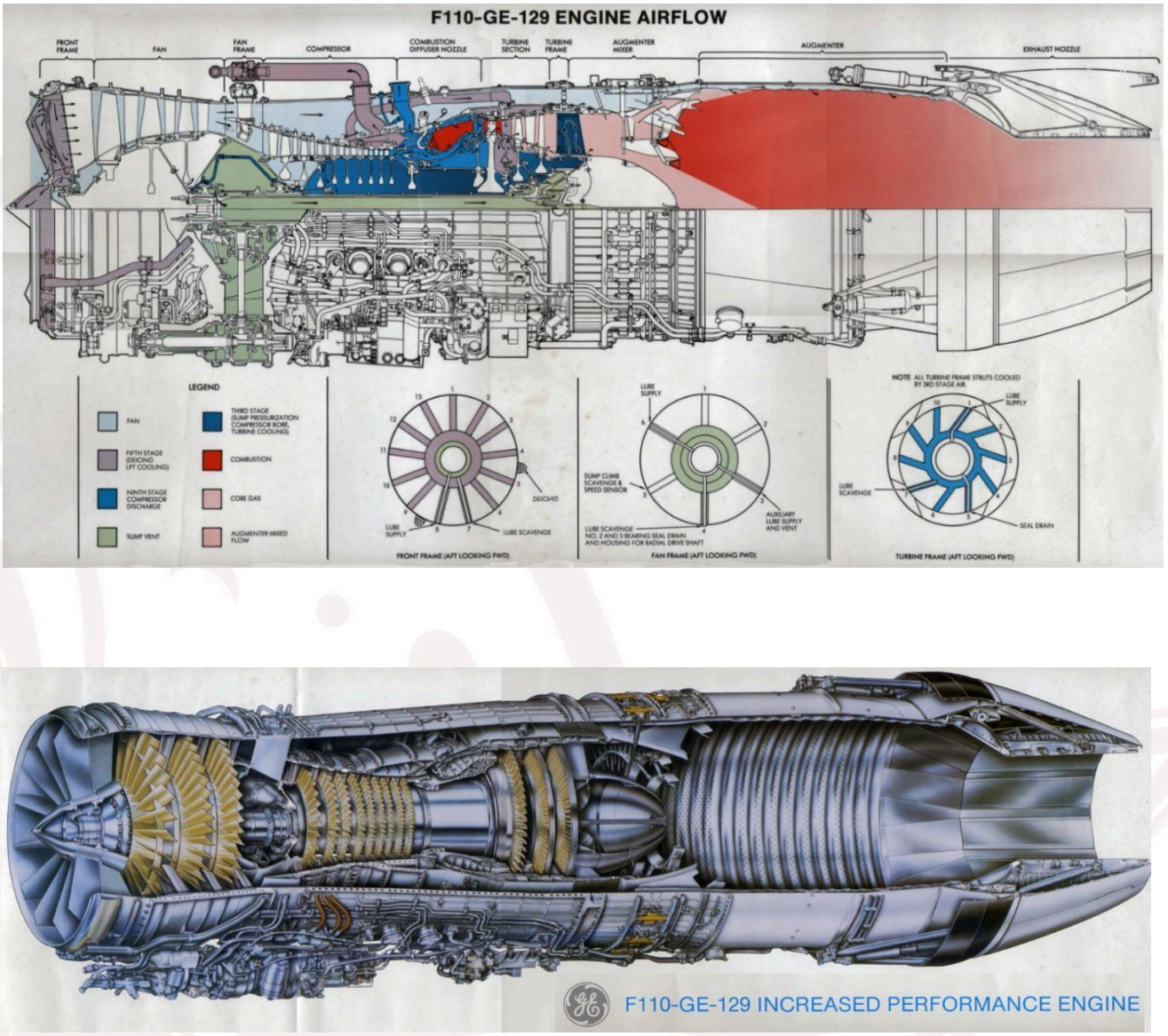

Figure 1 GE F110 Engine*

Fan geometric limitation is presented in Figure 2. Dimensions are given in millimeters for the radius. The visual shared in Figure 2 is shared as an example. The design in the visual is a literature example, an original design is expected according to the design requirements within the scope of the competition**. Features such as fan stage design, number and dimensions in the image should not be taken as a basis.**

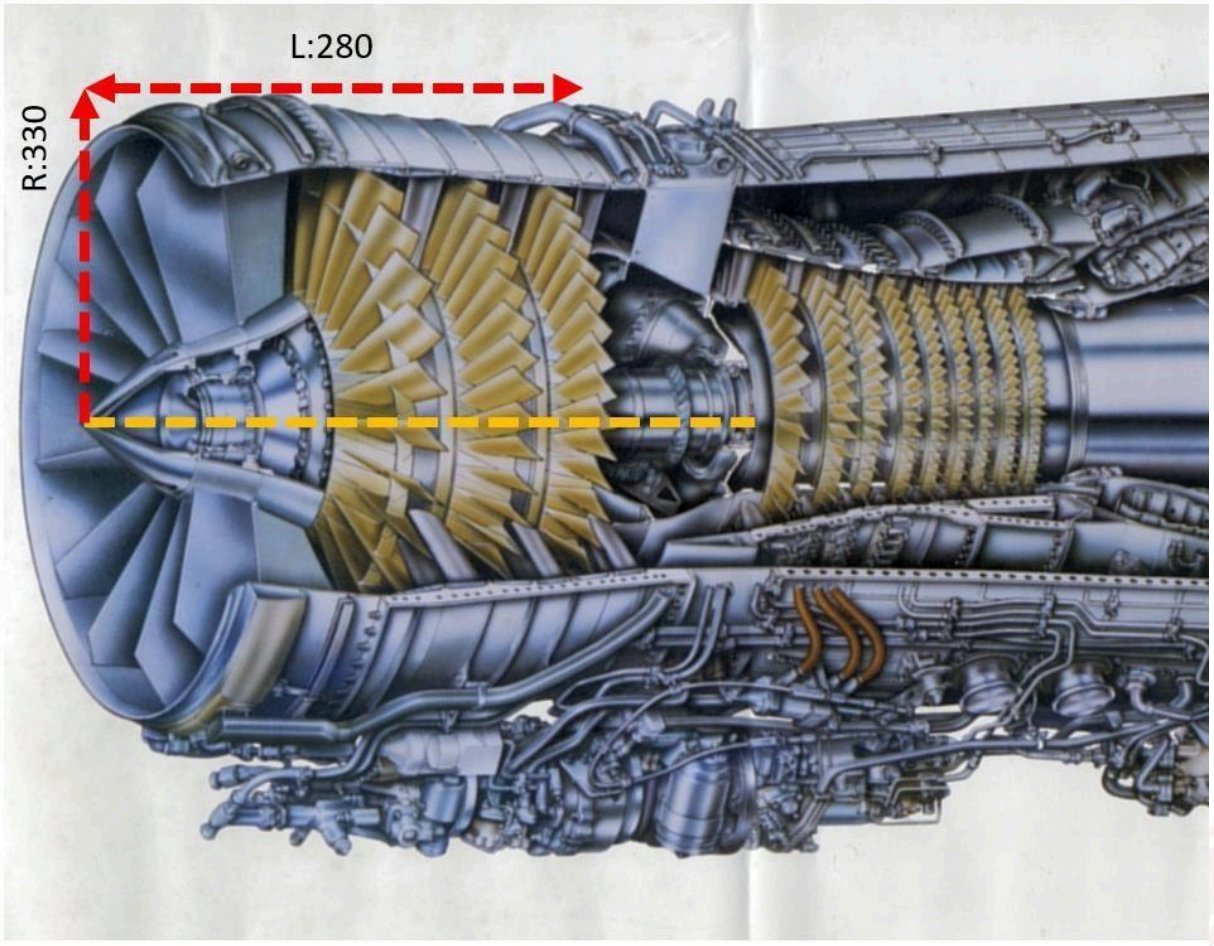

Figure 2 Core Engine Output Geometric Limitations*

*Anonim, https://www.enginehistory.org/GasTurbines/GE/GE.shtml, D: 20.11.2023

3.2. Performance Limitations

Performance requirements are the requirements that the fan module must meet when it is hot (the engine is running).

3.2.1. Design Point

The design point is sea level (SLS ISA)(101.325 kPa air pressure) standard day (15°C air temperature) and 0.9 Mach ISA 35000ft navigation condition. The lines specified as design inputs express the analysis inputs and indicate the conditions under which the design must be made. The lines specified as design requirements express the target values to be reached as a result of the analysis.

Table 1 Design Geometric Limitations

Design - Geometric	Max Diameter [mm]	330	It is the maximum diameter allowed for the sections to be designed within the scope of the competition.
	Max Length [mm]	280	It is the maximum length allowed for the sections to be designed within the scope of the competition.

Table 2 Desing Inputs

	Paremeter	**Value**	**Explanations**
Design Inputs	Inlet Total Pressure [kPa]	• TKOF SLS ISA • CRUISE 35kft M=0.9 ISA	It is the fan total pressure value at design point and cruise.
	Inlet Total Temperature [K]	• TKOF SLS ISA • CRUISE 35kft M=0.9 ISA	It is the fan total temperature value at design point and cruise.
	Mass Flow [kg/s]	• 13kg/s TKOF SLS ISA • 11.5kg/s CRUISE 35kft M=0.9 ISA	It is the corrected mass flow rate at the design point and at the cruise fan inlet.

Table 3 Design Requirements

Parameter	**Value**	**Explanations**
Pressure Ratio [-]	>2.2	It is the lower limit of the fan compression ratio at 100% corrected speed (at take-off condition, that is, at the design point).
Pressure Ratio [-]	>1.8	It is the lower limit of the fan compression ratio at 90% corrected speed (cruise condition).
Isentropic Efficiency [%]	>83%	100% is the lower limit of fan isentropic efficiency at corrected speed.
Isentropic Efficiency [%]	>85%	90% is the lower limit of fan isentropic efficiency at corrected speed.
Surge Margin [%]	>15%	It is the fan surge margin value at constant speed, 2 operating points.
Life [hours]	100	It is the minimum operating life that the module must provide.
Weight [Kg]	X	If the design is made with lightness in mind, it will be evaluated as a bonus parameter that brings additional points. The team that produces the lightest design will be rewarded with additional points.

4. Competition Process, Scoring and Evaluation

Evaluation; It will be made in three different stages: Conceptual Design Report, Detailed Design Report and Final Evaluation Presentation among the finalist teams. Teams that do not submit Conceptual Design and/or Detailed Design Reports will not be eligible to continue the competition.

4.1. Calendar

The competition calendar is stated in Table 4.

Table 4 Calendar

Date	Explanation
29.02.2024	Competition application deadline
21.04.2024 - 22:00	Conceptual Design Report deadline
29.04.2024	Announcement of the teams that passed the preliminary elimination according to the results of the Conceptual Design Report
Mayıs 2024	Providing training to teams that passed the preliminary elimination
20.06.2024	Detailed Design Report deadline
19.07.2024	Announcement of teams qualifying for the finals
August-September 2024	Competition Finals
August-September 2024	Creating 3D models of the winning designs
August-September 2024	TEKNOFEST

Evaluation; It will be done in three different stages: Conceptual Design Report, Detailed Design Report and presentation. Teams that do not submit the Conceptual Design Report, Detailed Design Report and Presentation files will not be eligible to participate in the competition.

Report submission must be uploaded via the CMS system within the day and time specified in the calendar. The appeal process is notified to the teams by the TEKNOFEST competitions committee via e-mail sent after the results are announced. TEKNOFEST Competitions Committee has the right to make changes to the calendar and hours.

4.2. Conseptual Design Report

Teams are obliged to submit their conceptual design reports on the date specified in Table 4. It is recommended that the conceptual design report includes the following sections.

- Summary
- Introduction
- Literature research
- Conceptual Design Development and Feasibility Studies
- Describing the conceptual design
- One-dimensional calculations
    - Aerodynamic calculations
    - Secondary Flow and thermal calculations
    - Mechanical design and calculations
    - Part Dimensions
    - Connection Types
    - Weight calculations
    - Structural calculations
- Material selection
- Cost and manufacturability analysis
- Evaluation of Conceptual Designs
- Further Studies and Business Plan Proposal
- Risk analysis
- Conclusion
- Source
- Attachments
    - Technical drawings related to conceptual design
    - Detailed information about calculation methods

The assumptions accepted for the design should be stated in detail in the Conceptual Design Report. It is necessary to show all requirements, boundary conditions, constraints and data provided and obtained in the report. If there is any accepted value, its source must be stated.

In order to proceed to the next stage within the scope of this competition, the preliminary design report must be submitted and approved. Teams deemed successful in the conceptual design phase will be eligible to move on to the next stage. As a result of conceptual design evaluations, the teams that pass to the Detail Design stage will be announced on the date specified in Table 4.

4.3. Detail Design Report

Teams that proceed to the detailed design report stage are obliged to submit their reports on the date specified in Table 4. The following details must be included in the detailed design report. Analysis results and CAD models will be sent in the relevant format.

- Summary
- Entrance
- Literature research
- Detailed Design Development and Feasibility Studies
- Describing the detailed design
    - Detailed aerodynamic calculations
    - 2D througflow calculations
    - Stage Matching
    - 3D CFD (CFD) analysis
    - Detailed aerothermal results
    - Aerothermal results
- Mechanical Design Details
    - Aeromechanical Calculations
    - Detail Part Dimensions
    - Detail Connection Types
    - Detailed Weight calculations
- Structural Analyzes
    - Two-dimensional stress calculations
    - Three-dimensional stress calculations
    - Part integrity calculations
    - Low cycle and high cycle fatigue life calculations
- Material and Manufacturing Method
- Equipment Selection Details
- Manufacturability and Installability Evaluation
- Discussion of Results and Suggestions for Future Studies
- Risk analysis
- Source
- Attachments
    - Technical drawings regarding detailed design
    - Detailed information about calculation methods
    - 3D CAD model of the detailed design

Boundary conditions used in all analyzes/calculations should be stated in detail. Teams that have progressed to the detail design phase are obliged to demonstrate the accuracy of their analyzes/calculations in their work (comparison with simple hand calculations and correlations, etc.).
The report should state in detail the assumptions adopted for the design. It is necessary to show all requirements, boundary conditions, constraints and data provided and obtained in the report. According to the results of the Detailed Design Report, the teams that will participate in the final evaluation will be announced on the date specified in

4.4. Competition Scoring and Evaluation

Report scoring types and percentages are listed in the table below. Scoring will be done out of 100, and the reports and presentation will constitute the entire score. Reports will account for 70% of the total score, and presentations will constitute the remaining 30%. The scoring criteria for the Conceptual Design Phase are presented in Table 5, the scoring criteria for the Detail Design Phase are presented in Table 6, and the presentation scoring calculation is presented in Table 7.

4.4.1. Report Scoring and Evaluation (70%)

Teams that pass the Conceptual Design Report stage will be eligible to participate in the Detail Design Stage. Teams that pass the Detailed Design Report stage will be eligible to participate in the presentation evaluation. The top 3 rankings will be determined at the TEKNOFEST event according to the presentation to be made on the final day. Presentation evaluation will be made by the competition jury based on the oral presentation and the answers to the evaluators' questions. The final evaluation and presentation format will be opened on the Detailed Design Report delivery date. Although the scoring criteria express the general approach, they will be evaluated by breaking them down into sections within the report content, taking these criteria into consideration.

Table 5 Conceptual Design Report Scoring Criteria

Criteria	(%)
Approach to the design problem	10
Conceptual design development	20
Using technical calculation methods and meeting the requirements	55
Discussion and interpretation of the results	10
Reporting quality	5

Table 6 Detail Design Report Scoring Criteria

Criteria	(%)
Approach to the design problem and planning	10
Using technical calculation methods and meeting the requirements	60
Discussion and interpretation of the results	15
Full participation in Phase 2 training	10
Raporlama kalitesi	5

4.4.2. Presentation Scoring and Evaluation (30%)

Table 7 Presentation Evaluation Criteria

Criteria	(%)
Conceptual and Detail Design Development Skills	30
Presentation quality, Time management, Expression	20
Technical Analysis Skills	40
Team work	10

4.4.3. Total Scoring

The total score that can be obtained at the end of the competition will be a maximum of 100 points and will be calculated as follows.

Total Score = 0.20 * CTR Score + 0.50 * DTR Score + 0.30 * Presentation Score

5. Awards

As a result of separate evaluation in three stages in the competition, the teams that pass the report stages and reach the final in their category and rank in the final evaluation will be given a cash prize. The awards stated in the table below show the total amount to be given to the teams that are entitled to receive awards; individual awards will not be made. First, second and third place awards will be divided equally according to the total number of Team Members (all members registered in the system) and deposited into the bank account specified by each person

Degree	REWARD AMOUNT	ADVISOR
First	150.000 ₺	4.000 ₺
Second	120.000 ₺	4.000 ₺
Third	100.000 ₺	4.000 ₺

Payment is made to the consultant of the winning team within the scope of the competition. Payments will also be made to the consultants of our winning teams. If the consultant does not come to the competition area, the consultant award will not be given. Additionally, the best presentation award will be given among the finalist teams.

Best Presentation Awards

It is an award given to the teams that best meet criteria such as presentation time, question- answer performance, body language, attitude towards the audience, fluency of the presentation, presentation draft - regardless of whether they place in the competition or not. The award stated is for prestige purposes and has no financial equivalent.

5.1. Minimum Success Criteria for Award Rankings

The minimum success criteria that contestants must meet in order to be included in the award rankings are to have progressed to the presentation stage and be present at the festival area on the day of the event.

6. General Rules and Regulations

Click here to access the general rules document within the scope of the competition.

7. Ethics

Click here to access the ethic rules document within the scope of the competition.

Statement of Liability

T3 Foundation and TEKNOFEST are not responsible in any way for any injury or damage caused by the contestant or any product delivered by the contestants. T3 Foundation and organization officials are not responsible for any damages caused by the contestants to third parties. T3 Foundation and TEKNOFEST are not responsible for ensuring that the teams prepare and implement their own systems within the framework of the laws of the Republic of Turkey.

Turkish Technology Team Foundation reserves the right to make any changes to this specification.

7th YEAR

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