

# DEVELOPMENT OF THE PROTURB v1.0 WORKBENCH PROGRAM FOR DESIGN AND ANALYSIS OF TURBOMACHINERY AND AEROSPACE PROPULSION SYSTEMS



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### AIM

To Make PAF Indigenized in Field of Analysis and Design of Turbomachinery and Aerospace Propulsion Systems.

## SCOPE

It is NGFA Research Support Project Consisting of Two Phases

 Phase-I Deals with Design and Analysis of Turbofan Engine for Next Generation Supersonic Transport Aircraft According to AIAA Requirements

## **TRADE STUDIES**



# **ENGINE SUMMARY**

| Design MN           | 1.60     |            |
|---------------------|----------|------------|
| Design Altitude     | 52500.00 | ft         |
| Design Bypass Ratio | 2.20     |            |
| Design Net Thrust   | 14694.93 | lbf        |
| Design TSFC         | 1.03     | lbm/hr/lbf |

 Phase-II Deals with Development of an Indigenous System Design and Analysis Program-ProTurb v1.0 for Aeroengine and Turbomachinery Systems

# METHODOLOGY



|  |  | _ |  |  |
|--|--|---|--|--|
|  |  |   |  |  |
|  |  |   |  |  |

# PROTURB v1.0

| roTurb_v1.0         |           |                     |              |                 |           |   |             |  |  |                  |
|---------------------|-----------|---------------------|--------------|-----------------|-----------|---|-------------|--|--|------------------|
| Edit Tools Window   | Help      |                     |              |                 |           |   |             |  |  |                  |
| DesignPointAnalysis | Rerforman | nceAnalysis         |              |                 |           |   |             | Tworth                                 |  |                  |
| roTurb v            | 1.0       | Basic Configuration | on Surrogate | s Selection B   | leeds Ext | raction                                       |             | Input                                  |  |                  |
| put Parameters      |           | Turbo Jet           |              |                 |           |   |             | Inlet Mach no                          | M1_c                                   | 0.38             |
| Configuration       |           | Inne                |              |                 | 1         | 1   |             | Inlet Total Temperature                | Tt1_c                                  | 764.14 🛨         |
| Properties of Air   |           | Inne                |              | TT Inneat       | 1 6       |   |             | Inlet Total Pressure                   | Pt1_c                                  | 13.50 -          |
| Provigne enteres    |           |                     |              |                 |           |   |             | Kinematic viscosity                    | nue1_c                                 | 0.0000000        |
| Inlets and Nozzle   |           | Single Spoo         | ol TurboJet  | Dual Spool      | TurboJet  |   |             | Inlet mass flow rate                   | m1_c                                   | 211.67 ÷         |
| Turbomachinery      |           | Fan                 |              |                 | _         |   |             | Tagential tip mach number              | Mt_c                                   | (1.30 ÷          |
| Design Point        |           | PolyTropic Effic    | iency        | ef              | 0.903     | 20  | #           | Pressure ratio                         | Pie c                                  | 16.34            |
| Performance         |           | Adiabatic Efficie   | ency         | pi_i<br>n_f     | 0.086     | 75  | #           | Number of stages                       | n                                      |                  |
| esults              |           | Compressor          | ,            |                 |           |   |             | Drequirl angle                         | Alpha 1c                               | (11.00 ···       |
| Solution            |           | PolyTropic Effic    | iency        | ec              | 0.895     | 70  | #           | Preswin drigie                         |  | 00.00            |
| Graphs              |           | Pressure Ratio      |              | pi_c            | (16.33    | 360   | #           | Ratio of axial velocities              | (22/(21                                | 1.00             |
| ptions              |           | Adiabatic Efficie   | nev          | n c             | 0.086     | 75  | #           | Polytropic efficiency                  | ec                                     | 0.85 -           |
| Save                |           | 0.07                |              | nlet Bleed Mass | Flow Rat  | io  |             | Hub to tip ratio                       | rh/rt                                  | 0.50 =           |
|                     |           | 0.06                |              |                 |           |   |             | Solidity ratio for rotor               | solidity_r_c                           | (1.00 -          |
|                     |           | 0.05                |              |                 |           |   |             | Solidity ratio for stator              | solidity_s_c                           | 1.00 ÷           |
|                     |           | 0.04<br>90/90       |              |                 | -         |   | Mach<br>0.8 | Stagger angle for rotor                |  | 30.00 ÷          |
| AL AND TRACK        | 2         | A0bler              |              |                 |           |   |             | Stager angle for stator                |  | 20.00 ÷          |
|                     |           | 0.02                |              | ~               | 1         |   | -2          | Loss coficient for rotor               | phi_r_c                                | 0.15 ÷           |
| CAL                 |           | 0.01                |              |                 | 1         |   |             | Loss coficient for stator              | phi_s_c                                | 0.06 ÷           |
|                     |           | 0                   | 0.2          | 0.4 0.6         | 0.1       | 3 1 1.  | 2           | Clear all Save                         | Run                                    | Results          |
|                     |           |                     |              | OK              | _         |   |             |  | Kun                                    | Results          |
|                     |           |                     |              |                 |           |   |             |  |  |                  |
| ation Parameters    |           |                     |              |                 |           | Stagnation Properties Plots Performance Plots |             | -00 TEC                                | CD                                     |                  |
|                     | W         | Pt                  | Tt           | ht              | P         |   | -           | CHK VS 15rC                            | urr                                    | vs Ethoency      |
| 5 00 Free Stream    | 635.721   | 6.338               | 589.235      | 141.416         | 1.4916    |   |             |  |  |                  |
|                     | 616.062   | 6 05 270            | 500 225      | 141 416         | 5 09636   |   |             |  |  | ~ooooo           |
| s_or met            | 010.002   | 0.03275             | 202.222      | 141.410         | 5.00030   | 0.8 -   |             |  | .0000                                  | ,0 <sup>00</sup> |
| 5_02 Inlet GV       | 616.062   | 5.99226             | 589.235      | 141.416         | 5.39649   |   |             |  | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ |                  |
| 5_21 Fan            | 616.062   | 13.6378             | 763.871      | 141.416         | 12.2479   |   |             | ~~~~~~                                 | 0 <sup>000~</sup>                      |                  |
| 5_23 Splitter_Comp  | 211.676   | 13.6378             | 763.871      | 183.329         | 11.9984   | 0.6   |             | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~ |  |                  |
|                     | 1         |                     |              |                 |           |   |             | - 0000                                 |  |                  |

| 1.4916  | , adaada                                 |
|---------|--|
| 5.08636 | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~   |
| 5.39649 | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~   |
| 12.2479 | ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~   |
| 11.9984 | 8.5-<br>                                 |
| 12.1911 | 20000000000000000000000000000000000000   |
| 198.641 | 0.4 DD0000000000000000000000000000000000 |
| 203.577 |  |
| 211.64  | 02                                       |
| 210.556 |  |
| 37.2163 |  |
| 11.7223 | 0 0 20 40 60 80 100<br>CRR               |
| 12.3112 |  |

#### SERP-IFE 84-01 ENGINE



### CONCLUSION

 Engine SERP-TFE 84-01 Stood Among Top 10 Engines According to AIAA

183.329

446.349

446.349

446.349

929.25

673.326

532.795

532,795

211.676

207.443

169.346

169.346

174.041

208.964

214.255

13.5014

220.594

220.594

217.329

211.896

41.0797

12.9559

763.871

1859.79

1859.79

1859.79

2282.46

1806.08

3150

FS\_25 Swan Neck Duct

FS 31 CDP Bleed Duct

FS 32 OGV Compresso

FS 45 High Pressure Turbine

FS 05 Fan Pressure Turbine

FS\_03 Compressor

FS\_04 Burne

ProTurb v1.0 to be used as Teaching Tool
in CAE and it May be Employed for NGFA
Project