J58 Preliminary Design and Analysis

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**As part of the INME 4707 course offered at the Department of Mechanical Engineering, University of Puerto Rico at Mayaguez, we are required to model and analyze the thermal performance of a J58 Turbojet engine.**

1. **Nomenclature**

*A* = amplitude of oscillation

*a* = cylinder diameter

*Cp*= pressure coefficient

*Cx* = force coefficient in the *x* direction

*Cy* = force coefficient in the *y* direction

c = chord

d*t* = time step

*Fx* = *X* component of the resultant pressure force acting on the vehicle

*Fy* = *Y* component of the resultant pressure force acting on the vehicle

*f, g* = generic functions

*h* = height

*i* = time index during navigation

*j* = waypoint index

*K* = trailing-edge (TE) nondimensional angular deflection rate

1. **Introduction**

INSERT INITIAL INTRODUCTION

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Table 1: Temperatures and Compression Ratios per Station at Cruise [1]

|  |  |  |  |
| --- | --- | --- | --- |
| COMPONENT/STAGE | TEMP (ºF) | TEMP (ºC) | Compression Ratio |
| Inlet/1 | 800+ | 426.67 | 38.8 |
| COMPRESSOR Inlet/2 | 800+ | 426.67 |  |
| COMPRESSOR 4th Stage/D | 1050 | 565.56 |  |
| COMBUSTOR Inlet/3 | 1300 | 704.44 | 112 |
| TURBINE Inlet/4 | 2000 | 1093.33 | 112 |
| TURBINE Exit/5 | 1450 | 787.78 | 35.5 |
| Afterburner Rings/6 | 1450 | 787.78 |  |
| Exhaust NOZZLE/8 | 3200 | 1760 |  |

Table : Engine Specs

|  |  |  |
| --- | --- | --- |
| SPECIFICATION | VALUE RANGE [EN] | VALUE RANGE [SI] |
| **Altitude** [2] | **25K-90K ft** | **7.62 – 27.43 km** |
| **Speed** [3] | **Mach 0.8 – 3.2** | |
| **Fuel** [4] | **JP-7** | |
| **Thrust** [4] | **32,500 lbf** | **144,567 N** |
| **Air Volume Flow @ Cruise** [5] | **100K ft3/s** | **2831.68 m3/s** |
| **Compression Ratio < Mach 2.2** [6] | **8.8:1** | |
| **Compressor** [6] | **8-Stage Axial** | |
| **Turbine** [6] | **2-Stage** | |
| **Weight** [6] | **6,500 lb** | **2,948 kg** |

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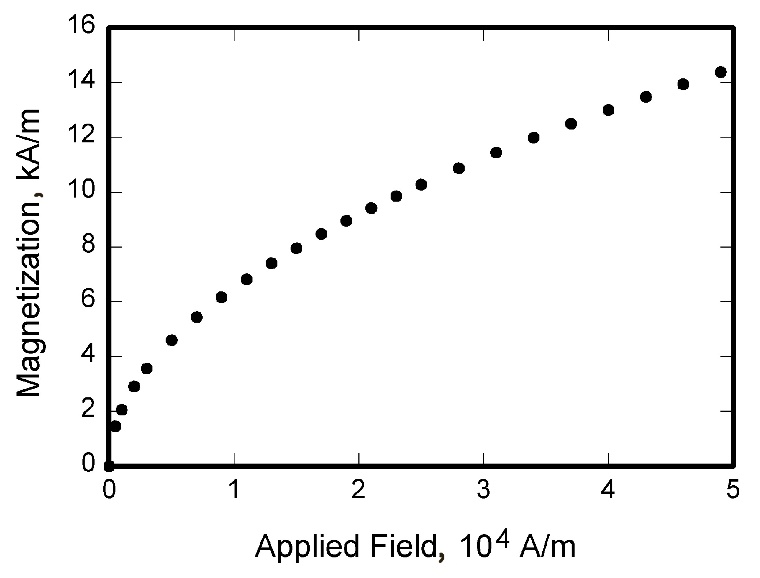
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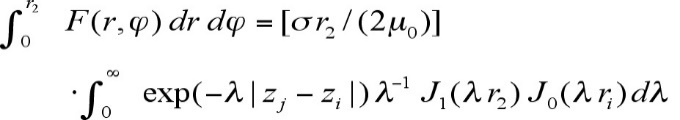
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Enter the equation number in parentheses.

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*Periodicals*

[1] Vatistas, G. H., Lin, S., and Kwok, C. K., “Reverse Flow Radius in Vortex Chambers,” *AIAA Journal*, Vol. 24, No. 11, 1986, pp. 1872, 1873.

doi: 10.2514/3.13046

[2] Alyanak, E. J., and Pendleton, E., “Aeroelastic Tailoring and Active Aeroelastic Wing Impact on a Lambda Wing Configuration,” Journal of Aircraft, published online 10 Nov. 2016.

doi: 10.2514/1.C033040

[3] Dornheim, M. A., “Planetary Flight Surge Faces Budget Realities,” *Aviation Week and Space Technology*, Vol. 145, No. 24, 9 Dec. 1996, pp. 44–46.

[4] Terster, W., “NASA Considers Switch to Delta 2,” *Space News*, Vol. 8, No. 2, 13–19 Jan. 1997, pp. 1, 18.

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*Books*

[5] Peyret, R., and Taylor, T. D., *Computational Methods in Fluid Flow*, 2nd ed., Springer-Verlag, New York, 1983, Chaps. 7, 14.

[6] Oates, G. C. (ed.), *Aerothermodynamics of Gas Turbine and Rocket Propulsion*, AIAA Education Series, AIAA, New York, 1984, pp. 19, 136.

[7] Volpe, R., “Techniques for Collision Prevention, Impact Stability, and Force Control by Space Manipulators,” *Teleoperation and Robotics in Space*, edited by S. B. Skaar and C. F. Ruoff, Progress in Astronautics and Aeronautics, AIAA, Washington, DC, 1994, pp. 175–212.

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*Proceedings*

[8] Thompson, C. M., “Spacecraft Thermal Control, Design, and Operation,” *AIAA Guidance, Navigation, and Control Conference*, CP849, Vol. 1, AIAA, Washington, DC, 1989, pp. 103–115

[9] Chi, Y. (ed.), *Fluid Mechanics Proceedings*, NASA SP-255, 1993.

[10] Morris, J. D., “Convective Heat Transfer in Radially Rotating Ducts,” *Proceedings of the Annual Heat Transfer Conference*, edited by B. Corbell, Vol. 1, Inst. of Mechanical Engineering, New York, 1992, pp. 227–234.

*Reports, Theses, and Individual Papers*

[11] Chapman, G. T., and Tobak, M., “Nonlinear Problems in Flight Dynamics,” NASA TM-85940, 1984.

[12] Brandis, A. M., Johnston, C. O., and Cruden, B. A., “Nonequilibrium Radiation for Earth Entry,” AIAA Paper 2016-3690, June 2016.

[13] Steger, J. L., Jr., Nietubicz, C. J., and Heavey, J. E., “A General Curvilinear Grid Generation Program for Projectile Configurations,” U.S. Army Ballistic Research Lab., Rept. ARBRL-MR03142, Aberdeen Proving Ground, MD, Oct. 1981.

[14] Tseng, K., “Nonlinear Green’s Function Method for Transonic Potential Flow,” Ph.D. Dissertation, Aeronautics and Astronautics Dept., Boston Univ., Cambridge, MA, 1983.

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[15] Atkins, C. P., and Scantelbury, J. D., “The Activity Coefficient of Sodium Chloride in a Simulated Pore Solution Environment,” *Journal of Corrosion Science and Engineering* [online journal], Vol. 1, No. 1, Paper 2, URL: <http://www.cp/umist.ac.uk/JCSE/vol1/vol1.html> [retrieved 13 April 1998].

[16] Vickers, A., “10-110 mm/hr Hypodermic Gravity Design A,” *Rainfall Simulation Database* [online database], URL: <http://www.geog.le.ac.uk/bgrg/lab.htm> [retrieved 15 March 2006].

Break website addresses after punctuation, and do not hyphenate at line breaks.

*Computer Software*

[17] TAPP, Thermochemical and Physical Properties, Software Package, Ver. 1.0, E. S. Microware, Hamilton, OH, 1992.

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Patents appear infrequently. Be sure to include the patent number and date.

[18] Scherrer, R., Overholster, D., and Watson, K., Lockheed Corp., Burbank, CA, U.S. Patent Application for a “Vehicle,” Docket No. P-01-1532, filed 11 Feb. 1979.

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[20] Doe, J., “Title of Chapter,” *Name of Book*, edited by…, Publisher’s name and location (to be published).

[21] Doe, J., “Title of Work,” Name of Archive, Univ. (or organization), City, State, Year (unpublished).

Unpublished works in an archive *must* include the name of the archive and the name and location of the university or other organization where the archive is held. Also include any cataloging information that may be provided.

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