CORE PROGRAM

in the

JOINT INSTITUTE FOR ADVANCEMENT OF FLIGHT SCIENCES

at the

NASA LANGLEY RESEARCH CENTER

NCC1-01-020

Final Report

December 1, 2000 – August 31, 2003

School of Engineering and Applied Science
The George Washington University
Washington, DC 20052

The objectives of the "Core Program in the Joint Institute for Advancement of Flight Sciences (JIAFS) at the NASA Langley Research Center" are described in the original proposal awarded November 1980. Funding for this program is given in Appendix A.

Participants and Activities

Participants in the "Core Program" during this period included:
Professor J. L. Whitesides
Ms. Jessie Coates
Ms. Carolyn F. Stough

Professor Whitesides has administered and provided technical direction for the JIAFS.

Research Activities

Following the precedent started several years ago, each of the graduating MS and DSc candidates in JIAFS present a seminar which is advertised throughout the area. Following the formal seminar the attendees are excused and the review committee examines the student as in a standard thesis defense. This allows the students to gain experience in presenting their research and disseminating the Institute's research results to a wider audience. A list of seminars are given in Appendix B.

Some 172 excellent applications for the Graduate Research Scholar Assistantships were received during this period. Forty-nine new GRSA were appointed by Professor Whitesides to JIAFS under the various research grants and contracts.

A list of the publications and presentations by members of JIAFS is given in Appendix C.

During this period there were 54 graduates from the academic programs in JIAFS. A list of these graduates and their initial employer upon graduation from GW is included as Appendix D. A list of the courses offered during the period Fall 2000 through Summer, 2003 is given in Appendix E.

APPENDIX A

Period of Performance

December 1, 2000 through August 31, 2003

Summary

12/01/00 – 11/30/01	New Cooperative Agreement – Funding: 102,446.00
08/09/01 – 11/30/01	Supplement 1 – Augmentation/correct award history – Funding ▮▮▮▮▮▮▮
12/01/01 – 12/31/02	Supplement 2 – Augment award history, add incremental funding and extend period – Funding: ▮▮▮▮▮▮▮
01/01/03 – 08/31/03	Supplement 3 – No Cost Time Extension

Award History
▮▮▮▮▮

Funding History
Total: ▮▮▮▮▮▮

APPENDIX   B

SEMINARS PRESENTED

1. M. A. Benes, "Investigating the Application of a Confidence Interval Methodology to Assessing Neural Network Surrogates."

2. G. C. Harding, "A High-Frequency Supersonic Pulsed Injector with Applications to Supersonic Combustors."

3. T. M. Mauery, "Assessment of A Coupled Navier-Stokes Rayleigh-Ritz Aeroelastic Analysis Method For A Transonic Transport Configuration."

4. R. L. Stephens, "Recursive Attitude and Rate Estimator."

5. J. Valez, "Post-Stall Wake Survey of Three Aircraft Models for Design Considerations of Airplane Parachute Systems."

6. M. S. Bonner, "Identification of High-Lift Configuration F/A-18 Aerodynamics From Flight Test Data Using Production Sensors."

7. T. J. Bozung, "Shuttle Orbiter Infrared Image Calibration using Thermocouple Data."

8. J. P. Tomey, "p-Version Discontinuous Galerkin Method for Heat Transfer in Built-Up Structures."

9. K. A. Waithe, "An Experimental and Computational Investigation of Multiple Injection Ports in a Convergent-Divergent Nozzle."

10. M. D. Billing, "Analytical Simulations of Energy Absorbing Impact Sphere for Mars Sample Return Earth Entry Vehicle."

11. A. M. Dwyer, "Modeling of the Mars Atmosphere for Monte Carlo Simulations of the Mars Odyssey Aerobraking Mission."

12. L. R. M. Giersch, "Pathfinder Photogrammetry Research for Ultra-Lightweight and Inflatable Space Structures."

13. A. D. Sullins, "Heat Transfer in High Porosity Open Cell Nickel Foam."

14. S. J. Alter, "The Generation of High Fidelity Structured Volume Grids For Computational Science Applications Using a System of Elliptic Partial Differential Equations."

15. G. B. Haines, "Optimization of a Solar Powered High Altitude Long Endurance Aircraft with a Stirling Heat Engine."

16. J. L. Hanna, "Approaches to Autonomous Aerobreaking at Mars."

17. J. P. Hundley, "A Thermography System for Imaging Reusable Launch Vehicles."

18. C. A. Hunter, "An Approximate Jet Noise Prediction Method Based On Reynolds-Averaged Navier-Stokes Computational Fluid Dynamics Simulation."

19. B. R. Monzon, "Non-Linear Simulation Development For A Sub-Sclae Research Airplane."

20. M. T. Powers, "Material Characterization of Polyurethane Foam Under Hydrostatic Loading."

21. Y. M. Savranskaya, "Model Development and Performance Analysis of Flying Flexible Fixture."

22. T. D. Altus, "A Response Surface Methodology For Bi-Level Integrated System Synthesis."

23. D. J. Bouch, "Development and Investigation of a Hartmann-Sprenger Tube for Passive Heating of Scramjet Injectant Gases."

24. Z. Q. Chavis, "Development of a Plume Model and Application to Mars 2001 Odyssey Aerobraking."

25. C. G. Lang, "Finite Element *A Posteriori* Error Estimation for Heat Conduction."

26. D. R. Phillips, "Meshless Local Petrov-Galerkin Method for Bending Problems."

27. B. R. Rogillio, "Bending Instabilities of Ultra-Lightweight Inflatable Rigidizable Thin Walled Composite Columns."

28. J. E. VerHage, "Design and Simulation Methodologies for Radiation Shielding Using an Immersive Environment."

29. P. P. Zomkowski, "Preliminary Design and Analysis of the GIFTS Instrument Pointing System."

30. D. W. Fiala, "Shape Memory Alloy Control of a Tensegrity Structure."

31. M. J. Solter, "A Prototype Actuator Concept for Membrane Boundary Vibration Control."

32. M. P. Strauss, "A Methodology for the Synthesis of Multiple Stage Rapid Point-to-Point Transport and Reusable Launch Vehicle Systems."

33. P. E. Escalera, "Conceptual Design of the Mars Atmospheric Explorer."

34. L. Kay-Bunnell, "Orbit Determination Accuracy for Comets on Earth-Impacting Trajectories."

35. B. P. Anderson, "Spacecraft-Ballute Interactions Using Continuum and Rarefied Computational Analysis."

36. J. T. Black, "Photogrammetry and Videogrammetry Methods Development for Solar Sail Structures."

37. A. L. Martin, "Methodology for Reduced Monte Carlo Simulations with Application to Mars Science Laboratory Entry."

38. D. T. Walker, "Nonlinear Conduction Heat Transfer Using a Hierarchical Finite Element Method."

39. M. R. Werner, "Interferometer Design Considerations for Application to Extremely Low Visual Magnitude Near-Earth Objects."

40. M. C. Bastow, "A Telescope Tracking and Thermal Imaging System for High-Speed Vehicles."

41. J. F. Gragowski, "An Optimization methodology for the Synthesis of Planetary Aircraft."

42. R. M. Lunceford, "Crash Test and Analysis Validation of Aircraft Seat Structures."

43. T. D. Rawlings, "Analysis of the High-Incidence Stabilator as an Out of Control Recovery Device for a Fixed-Wing Subscale Transport Unmanned Air Vehicle."

APPENDIX C

PUBLICATIONS AND PRESENTATIONS

1.   E. L. Walker, J. L. Everhart and V. Iyer, "Sensitivity Study of the Wall Interference Correction System (WICS) For Rectangular Tunnels." Presented: 39th AIAA Aerospace Sciences Meeting and Exhibit Reno, NV, Jan. 8-11, 2001. Published: AIAA 2001-0159.

2.   A. D. Cutler, J. A. White, "An Experimental and CFD Study of a Supersonic Coaxial Jet," Presented: 39th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 8-11, 2001. Published: AIAA-2001-0143.

3   A. D. Cutler, G. C. Harding, G. S. Diskin, "Supersonic Pulsed Injection," Presented: 39th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 8-11, 2001. Published: AIAA-2001-0517.

4   E. L. Walker, J. L. Everhart, V. Iyer, "Sensitivity Study of the Wall Interference Correction System (WICS) For Rectangular Tunnels," Presented: 39th AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 8-11, 2001. Published: AIAA 2001-0159.

5.   B. R. Monzon, "Experimental Determination of the Inertia Properties for a Sub-Scale Airplane," Presented: 2001 AIAA Mid-Atlantic Region I Student Conference, Morgantown, WV, April 6-7, 2001.

6   M. Powers, "Material Characterization of Polyurethane Foam Under Hydrostatic Loading," Presented: AIAA Mid-Atlantic Region I Student Conference, Morgantown, WV, April 6-7, 2001.

7.   N. Hotchko, "Design of a Separation Mechanism for the Langley Glide Back Booster Small Launcher System," Presented: AIAA Mid-Atlantic Region I Student Conference, Morgantown, WV, April 6-7, 2001.

8.   M. D. Billings, E. L. Fasanella, S. Kellas, "Impact Test and Simulation of Energy Absorbing Concepts for Earth Entry Vehicles," Presented: 42nd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, Seattle, WA, April 16-19, 2001. Published: AIAA 2001-1602.

9.   E. L. Fasanella, M. D. Billings, "Dynamic Finite Element Predictions for Mars Sample Return Cellular Impact Test #4," Published: NASA/TM-2001-211-23 ARL-TR-2539, June 2001.

10.   A. M. Dwyer, P. E. Escalera, J. L. Hanna, C. D. Hernandez, "Supporting Oasis Life (SOL) MCCS/MAV," Presented: NASA MarsPort Engineering Design Student Competition 2001, Kennedy Space Center, FL, May 7, 2001.

11.   A. D. Sullins, K. Daryabeigi, "Effective Thermal Conductivity of High Porosity Open Cell Nickel Foam," Presented: 35th AIAA Thermophysics Conference, Anaheim, CA, June 11-14, 2001. Published: AIAA 2001-2819.

12. B. M. Anderson, J. E. Nealy, G. D. Qualls, P. J. Staritz, J. W. Wilson, M.-HY. Kim, F. A. Cucinotta, W. Atwell, G. De Angelis, J. Ware, A. E. Persans, "Shuttle Spacesuit (Radiation) Model Development," Presented: 31st International Conference on Environmental Systems (ICES) Orlando, FL, July 9-12, 2001. Published: Paper Number 01ICES-2363.

13. G. D. Qualls, J. W. Wilson, C. Sandridge, F. A. Cucinotta, J. E. Nealy, J. H. Heinbockel, C. P. Hugger, J. VerHage, B. M. Anderson, W. Atwell, N. Zapp, R. Barber, "International Space Station Radiation Shielding Model Development," Presented: 31st International Conference on Environmental Systems (ICES), Orlando, FL, July 9-12, 2001. Published: Paper Number 01ICES-294.

14. R. C. Blanchard, R. G. Wilmoth, C. E. Glass, N. R. Merski, Jr., S. A. Berry, T. J. Bozung, A. Tietjen, J. Wendt, D. Dawson, "Infrared Sensing Aeroheating Flight Experiment: STS-96 Flight Results," Published: Reprinted from Journal of Spacecraft and Rockets, Vol. 38, No. 4, pp. 465-472.

15. A. M. Dwyer, R. H. Tolson, M. M. Munk, P. V. Tartabini, "Development of a Monte Carlo Mars-GRAM Model for Mars 2001 Aero-Braking Simulations," Presented: AAS/AIAA Astrodynamics Specialists Conference, Quebec City, Quebec, Canada, July 30-August 2, 2001. Published: Paper AAS 01-389.

16. J. L. Hanna, R. H. Tolson, "Approaches to Autonomous Aerobraking at Mars," Presented: AAS/AIAA Astrodynamics Specialists Conference, Quebec City, Quebec, Canada, July 30-August 2, 2001.

17. A. D. Cutler and S. E. Doerner , "Effects of Swirl and Skew Upon Supersonic Wall Jet in Crossflow," Published: Journal of Propulsion and Power, Vol. 17, No. 6, November-December 2001.

18. A. D. Cutler, P. M. Danehy and R. R. Springer, "CARS Thermometry in a Supersonic Combustor for CFD Code Validation," Presented: 40th AIAA Aerospace Sciences Meeting & Exhibit, Reno, NV, January 14-17, 2002. Published: AIAA-2002-0743.

19. J. L. Gasper, M. J. Solter and R. S. Pappa, "Membrane Vibration Studies Using a Scanning Laser Vibrometer," Presented: International Modal Analysis Conference, IMAC, Los Angeles, CA, February 4 - 7, 2002.

20. R. S. Pappa, T. W. Jones, J. T. Black, A. Walford, S. Robson, and M. R. Shortis, "Photogrammetry Methodology Development for Gossamer Spacecraft Structures," Presented: 43rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference 3rd AIAA Gossamer Spacecraft Forum, Denver, CO, April 22-25, 2002. Published: AIAA-2002-1375. Published: NASA/TM-2002-211739, June 2002.

21 I. S. Raju and D. R. Phillips, "A Local Coordinate Approach in the MLPG Method for Beam Problems," Published: NASA/TM-2002-211463, April 2002.

22.   P. M. Denehy, R. DeLoach and A. D. Cutler, "Application of Modern Design of Experiments to CARS Thermometry in a Supersonic Combustor," Presented: 22nd AIAA Aerodynamic Measurement Technology and Ground Testing Conference, St. Louis, MO, June 24-26,2002. Published: AIAA-2002-2914.

23.   A. D. Cutler, G. S. Diskin, P. M. Danehy, and J. P. Drummond, "Fundamental Mixing and Combustion Experiments for Propelled Hypersonic Flight," Presented: 38th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, Indianapolis, IN, July 7-10, 2002. Published: AIAA-2002-3879

24.   I. S. Raju and D. R. Phillips, "A Meshless Local Petrov-Galerkin Method for Euler-Bernoulli Beam Problem," Presented: International Conference on Computational Engineering and Sciences, Reno, NV, July 30-August 2, 2002.

25.   R. C. Blanchard, B. P. Anderson, S. S. Welch, C. Glass, S. A. Berry, N. R. Merski, D. W. Banks, A. Tietjen, and M. Lovern, "Shuttle Orbiter Fuselage Global Temperature Measurements from Infrared Images at Hypersonic Speeds," Presented: AIAA Atmospheric Flight Mechanics Conference, Monterey, CA, August 5-8, 2002.

26.   J. L. Hanna, Z. Q. Chavis, and R. G. Wilmoth, "Modeling Reaction Control System Effects on Mars Odyssey." Presented: Astrodynamics Specialist Conference and Exhibit, Monterey, CA, August 5-8, 2002. Published: AIAA 2002-4934.

27.   J. Sobieszczanski-Sobieski, T. D. Altus, M. Phillips, and R. Sandusky, "Bi-Level Integrated System Synthesis (BLISS) for Concurrent and Distributed Processing," Presented: 9th AIAA/NASA/USAF/ISSMO Symposium on Multidisciplinary Analysis and Optimization, Atlanta, GA, September 4-6, 2002. Published: AIAA 2002-5409.

28.   D. J. Bouch and A. D. Cutler, "Investigation of a Hartmann-Sprenger Tube for Passive Heating Of Scramjet Injectant Gases." Presented: AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 6-9, 2003. Published: AIAA 2003-1275.

29.   R. C. Blanchard, K. A. Boyles, G. J. LeBeau, and F. E. Lumpkin, "The Use of Virtual Sub-Cells in DSMC Analysis of Orbiter Aerodynamics at High Altitudes Upon Reentry." Presented: 41st AIAA Aerospace Sciences Meeting and Exhibit, Reno, NV, January 6-9, 2003. Published: AIAA 2003-1275.

30.   F. R. Garza and E. A. Morelli, "A Collection of Nonlinear Aircraft Simulations in MATLAB" Published: NASA/TM-2003-212145, January 2003.

31.   R. S. Pappa, J. T. Black, J. R. Blandino, T. W. Jones, P. M. Danehy, and A. A. Dorrington, "Dot-Projection Photogrammetry and Videogrammetry of Gossamer Space Structure." Presented: 21st International Modal Analysis Conference, Kissimmee, Fl, February 3-7, 2003. Published: NASA/TM-2003-212146, January 2003.

32.   J. T. Black and R. S. Pappa, "Videogrammetry Using Projected Circular Target: Proof-of-Concept Test." Presented: 21st International Modal Analysis Conference, Kissimmee, Fl, February 3-7, 2003. Published: NASA/TM-2003-212148, February 2003.

33. B. E. Green and J. L. Whitesides, "Method for Designing Leading-Edge Fillets to Eliminate Flow Separation." Published: J. of Aircraft, Vol. 40 No. 2, Mar.-Apr. 2003, pp. 160-170.

34. J. Leifer, J. T. Black, W. K. Belvin, and V. Behun, "Evaluation of Shear Compliant Borders for Wrinkle Reduction in Thin Film Membrane Structures." Presented: 44th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics, and Materials Conference, April 7-10, 2003, Norfolk, VA. Published: AIAA 2003-1984.

35. J. R. Blandino, R. S. Pappa and J. T. Black, "Modal Identification of Membrane Structures with Videogrammetry and Laser Vibrometry." Presented: 44th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics, and Materials Conference, April 7-10, 2003, Norfolk, VA.

36. J. Johnston, J. Blandino, J. Black, and R. Pappa, "Structural Analysis and Testing of a Subscale Sunshield Membrane Layer." Presented: 44th AIAA/ASME/ASCE/AHS Structures, Structural Dynamics, and Materials Conference, April 7-10, 2003, Norfolk, VA.

37. B. P. Anderson, "Computational Continuum and Rarefied Flow Results for Ballute Applications." Presented: AIAA Mid-Atlantic Region 1 Student Conference, College Park, MD, April 11-12, 2003.

38. J. Black, "Photogrammetry and Videogrammetry Methods for Solar Sails and Other Gossamer Structures." Presented: AIAA Mid-Atlantic Region 1 Student Conference, College Park, MD, April 11-12, 2003.

APPENDIX D

GRADUATES - 2000-2003

	Concentration		Employed by
Fall 2000			
Michael A. Benes	Aero	GRSA	Visteon Steering Systems, MI
Gregory C. Harding	Aero	GRSA	Schweizer Aircraft Corp, NY
Timothy M. Mauery	Aero	GRSA	Lockheed Martin Aircraft & Logistics, SC
Robert L. Stephens	SDyn	GRSA	Swales & Assoc @ NASA Langley
Javier Velez	Aero	GRSA	Raytheon Missile Systems, AZ
Spring 2001			
Michael S. Bonner	Aero	GW	Naval Air Warfare Ct, CA
Timothy J. Bozung	Astro	GRSA	Stryker Instruments, MI
Jeffrey S. Parker	Astro	GRSA	Allied Signal Technical Services, MD
James P. Tomey	SDyn	GRSA	Ford Motor Co, MI
Kenrick A. Waithe	Aero	GRSA	AS&M @ NASA Langley
Summer 2001			
Marcus D. Billings	SDyn	GRSA	ATA Engineering, CA
Alicia M. Dwyer	Astro	GRSA	ICASE @ NASA Langley
Louis R. Giersch	Astro	GRSA	University of Kentucky, KY
Kristopher R. Horne	SDyn	GRSA	Lockheed Martin, CA
Alan D. Sullins	Astro	GRSA	Aerospace Corp, CA
Fall 2001			
Stephen J. Alter	Aero	NASA	NASA Langley
Brooke M. Anderson	Astro	GW	Swales @ NASA Langley
Frederico R. Garza	Aero	GW	Swales @ NASA Langley
Benjamin E. George	Astro	GRSA	USAF
Govinda B. Haines	Aero	GRSA	Unknown
Jill L. Hanna	Astro	GRSA	ICASE @ NASA Langley
Scott A. Hill	S/Dyn	N	NASA Langley
Jason P. Hundley	Aero	GRSA	Northrop-Grumman, CA
Craig A. Hunter (DSc)	Aero	GRSA	NASA Langley
Byron R. Monzon	Aero	GRSA	Pratt & Whitney, CT
Matthew T. Phillips	Aero	GRSA	USAF
Michael T. Powers	S/Dyn	GRSA	Lockheed Martin Missiles & Space Systems, CA
Jason B. Prince	Aero	GRSA	Aerotech Research, USA Inc., VA
Yelena M. Savranskaya	Astro	GRSA	Aerospace Corp, CA

Spring 2002

Troy D. Altus	Aero	GRSA	ATK Tactical Systems Co., MD
Adam C. Olsen	Aero	GRSA	Unknown

Summer 2002

Dustin J. Bouch	Aero	GRSA	Eidetics Corp, CA
Zachary Q. Chavis	Astro	GRSA	Pratt & Whitney, CT
Christopher G. Lang	Astro	GRSA	NASA Langley
Dawn R. Phillips	Aero	GRSA	Lockheed Martin Space Operation @NASA Langley
Brendan R. Rogillio	Astro	GRSA	Unknown
Joshua E. VerHage	Astro	GRSA	Unknown
Paul P. Zomkowski	Astro	GRSA	Aerospace Corp, CA

Fall 2002

David W. Fiala	Astro	GRSA	Unknown
Corey D. Hernandez	Astro	GW	Swales & Associates @ NASA LaRC
Micah J. Solter	Astro	GRSA	Lockheed Martin Missiles & Space, CA
Michael Pl Strauss	Aero	GRSA	Sikorsky Aircraft Corp, CT
Jeffrey I. Walters	Aero	GRSA	Lockheed Martin Missiles & Space, CA

Spring 2003

Paul E. Escalera	Astro	GRSA	Orbital Sciences Corp, VA
Linda Kay-Bunnell	Astro	GRSA	Analytical Mechanics Assoc @ NASA LaRC
Derek S. Liechty	Aero	NASA	NASA Langley

Summer 2003

Brian P. Anderson	Astro	GRSA	Combustion Research & Flow Technology, PA
Jonathan T. Black	Astro	GRSA	University of Kentucky
Craig P. Hugger	Aero	GW	Unknown
Alex L. Martin	Astro	GRSA	Aerospace Corporation, CA
Kyle G. Moss	Aero	GRSA	Swales Aerospace @ NASA Langley
Michael E. Theriot	Astro	GRSA	George Washington University
David T. Walker	SDyn	GRSA	Thiokol, UT
Martin R. Werner	Astro	GRSA	Spectrum Astro, AZ

APPENDIX E

ACADEMIC PROGRAM

FALL 2000

ApSc 212	Analytical Methods in Engineering II
ApSc 213	Analytical Methods in Engineering III
MAE 207	Theory of Elasticity
MAE 221	Fluid Mechanics
MAE 224	Viscous Flow
MAE 248	Aircraft Design II
MAE 253	Aircraft Structures
MAE 274	Spacecraft Dynamics
MAE 275	Stability and Control of Aircraft
MAE 276	Space Flight Mechanics
MAE 286	Numerical Solution Techniques in MAE
MAE 292	Special Topics in Aerospace Engineering
MAE 298	Research (arr.)

SPRING 2001

ApSc 214	Analytical Methods in Engineering IV
ECE 202	Linear Systems Theory
MAE 225	Computational Fluid Dynamics
MAE 228	Compressible Flow
MAE 234	Composite Materials
MAE 247	Aircraft Design I
MAE 250	Launch Vehicle Design
MAE 257	Theory of Vibrations
MAE 277	Spacecraft Attitude Control
MAE 286	Numerical Solution Techniques in MAE
MAE 292	Special Topics in Aerospace Engineering (Astro Project)
MAE 298	Research (arr.)

ACADEMIC PROGRAM (continued)

ApSc 212	Analytical Methods in Engineering II
ApSc 213	Analytical Methods in Engineering III
MAE 207	Theory of Elasticity
MAE 221	Fluid Mechanics
MAE 227	Aeroelasticity
MAE 248	Aircraft Design II
MAE 274	Spacecraft Dynamics
MAE 275	Stability and Control of Aircraft
MAE 276	Space Flight Mechanics
MAE 286	Numerical Solution Techniques in MAE
MAE 291	Special Topics in Mechanical Engineering [Heat Transfer]
MAE 292	Special Topics in Aerospace Engineering [Engineering Optimization]
MAE 292	Special Topics in Aerospace Engineering [Orbit and Trajectory Optimization]
MAE 298	Research (arr.)

SPRING 2002

ApSc 214	Analytical Methods in Engineering IV
ECE 202	Linear Systems Theory
MAE 228	Compressible Flow
MAE 234	Composite Materials
MAE 247	Aircraft Design I
MAE 257	Theory of Vibrations
MAE 277	Spacecraft Attitude Control
MAE 286	Numerical Solution Techniques in MAE
MAE 288	Adv Finite Element Methods in Structural Mech
MAE 292	Special Topics in Aerospace Engineering [Spacecraft Navigation]

FALL 2002

ApSc 212	Analytical Methods in Engineering II
ApSc 213	Analytical Methods in Engineering III
MAE 207	Theory of Elasticity
MAE 221	Fluid Mechanics
MAE 229	Propulsion
MAE 248	Aircraft Design II
MAE 249	Spacecraft Design
MAE 253	Aircraft Structures
MAE 274	Spacecraft Dynamics
MAE 275	Stability and Control of Aircraft
MAE 276	Space Flight Mechanics
MAE 286	Numerical Solution Techniques in MAE
MAE 298	Research (arr.)

ACADEMIC PROGRAM (continued)

SPRING 2003

ApSc 214	Analytical Methods in Engineering IV
ECE 202	Linear Systems Theory
MAE 222	Applied Aerodynamics
MAE 228	Compressible Flow
MAE 234	Composite Materials
MAE 247	Aircraft Design I
MAE 257	Theory of Vibrations
MAE 270	Theoretical Acoustics
MAE 271	Time Series Analysis
MAE 277	Spacecraft Attitude Control
MAE 278	Space Flight Guidance and Navigation
MAE 286	Numerical Solution Techniques in MAE
MAE 288	Advanced Finite Element Methods in Structural Mechanics
MAE 292	Special Topics in Aerospace Engineering
MAE 298	Research (arr.)
MAE 298-Z1	Research (arr.)

FALL 2003

ApSc 213	Analytical Methods in Engineering III
ApSc 214	Analytical Methods in Engineering IV
MAE 225	Computational Fluid Dynamics
MAE 229	Propulsion
MAE 248	Aircraft Design II
MAE 249	Spacecraft Design
MAE 275	Stability and Control of Aircraft
MAE 276	Space Flight Mechanics
MAE 286	Numerical Solution Techniques in MAE
MAE 292	Sp Topics in Aerospace Engineering (Engineering Optimization)
MAE 298	Research (arr.)