1. **AAE20000: Undergraduate Sophomore Seminar**

2. **Credits:** 0
   Contact hours: 1 hour every 3 weeks, 5 hours per semester

3. **Instructor's or course coordinator's name:** Professor Marc Williams

4. **Textbook:** none

5. **Specific course information**
   a. **Course description**: The courses are intended to provide a forum for guest speakers, organizational and informational meetings with undergraduates, and to provide a venue for discussion of professional development. **Offered:** Fall and Spring
   b. **Pre-requisite**: Sophomore standing in AAE only; **Co-requisite:** none
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student Learning Outcomes See Yes below:

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	No
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	No
f	An understanding of professional and ethical responsibility	Yes
g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	Yes
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	No

7. Topics

- Intro to AAE
    - Student Organizations
- Professional Development
    - Professional Ethics
    - Life Long Learning
    - Gen Eds
- Current Events
- Guest Speakers
- Coop, Internships, Study Abroad

Revision History
Prepared by: Marc H. Williams,
Date: September 7, 2011
Updated format by: T. Moore, February 4, 2013

1. **AAE20300: Aeromechanics I**

2. **Credit hours:** 3
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's name:** M. Corless, D. Sun

4. **Textbook:** Notes furnished by instructor.
   a. **Other supplemental materials:** none

5. **Specific course information**
   a. **Course description**: Fundamental concepts and principles of bodies in motion, with applications to aeronautical and astronautical problems. Subjects covered include rectilinear motion, curvilinear motion, rotation, and plane motion. The static equilibrium and quasistatic equilibrium situations are treated as a part of motion in which the acceleration is zero. Problems involving impact, separation, work, and energy are considered. **Offered**: Fall and Spring
   b. **Pre-requisite:** PHYS17200
      Co-requisite: MA26100
   c. **Course status:** required

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
      On completing this course the student shall be able to:
      1 Compute velocities and accelerations for any type of motion.
      2 Compute angular velocities and accelerations of rigid bodies.
      3 Model forces and apply Newtons Laws in particle dynamic problems.
      4 Model forces and solve general statics of bodies problems

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	No

h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics (number of lectures):

1. Dimensional Analysis (2)
2. Vectors (3)
3. Kinematics (9)
4. Statics of Particles (5)
5. Particle Dynamics (9)
6. Statics of Rigid Bodies (12)

Revision History
Prepared by: J. Longuski, Date: March 20, 2001
Revised by: J. Longuski, Date: August, 2006
Revised by: M. Corless, Date: January 31, 2102
Updated Pre-requisites on March 3, 2011
Format updated: January 31, 2011
Format updated by: T. Moore, February 4, 2013

1. **AAE 20400: Aeromechanics II**

2. **Credits:** 3
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's name(s):** Profs. W. Chen, J. F. Doyle, A. F. Grandt, M. Sangid, C. T. Sun, V. Tomar

4. **Textbook:** Gere, J. M., *Mechanics of Materials*, sixth edition, Nelson, a division of Thomson Canada Limited. ISBN 0-534-41793-0.

5. **Specific course information**
   a. **Course description**: This course is to introduce aerospace engineering students to the mechanics of solids concepts of force/stress/equilibrium, deformation/strain/ compatibility, and stress/strain material behaviors. These concepts, through examples, are applied to basic aerospace structural components of rods in tension and compression, shafts in torsion, beams in bending and shear, and thin walled vessels under pressure. **Offered**: Fall and Spring
   b. **Pre-requisite**: AAE 203 **Co-requisite**: None
   c. **Course status:** Required

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
   On completing this course the student shall be able to:
   1. Describe the material behavior of deformable bodies when subjected to loads
   2. Create and use free-body diagrams to compute resultant support forces and moments
   3. Compute internal force and moment distributions
   4. Properly select and use materials based upon their mechanical properties
   5. Compute stresses, strains, deformation and displacements of basic structural components
   6. Predict structural integrity based on the calculations
   7. Apply these ideas for analysis of components related to aerospace applications

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Yes
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes

f	An understanding of professional and ethical responsibility	Yes
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Introductions and Review of Statics and Equilibrium: Introduction and Fundamentals of Mechanics. Forces and Moments. Equilibrium and Free-Body Diagrams. 3-D Equilibrium and Structural Analysis. Statics of Structures and Internal Forces. Distributed Loads and Geometric Properties. (7 lectures)
2. Mechanical Behavior of Materials: Normal Stress and Strain. Material Properties and Behavior. Shear Stress and Strain. Allowable Loads, Failure. (5 lectures)
3. Axially-Loaded Members: Uniform Bars, Statically Determinate Structures. Axial Deformation. Nonuniform Bars, Statically Indeterminate Structures, Thermal Effects. Inclined Sections, Strain Energy. Repeated Loading and Fatigue, Stress Concentrations. (6 lectures)
4. Torsion of Shafts: Torsion of Circular Shafts. Geometry of deformation. Nonuniform Torsion. Stress and Strain in Pure Shear. Statically Indeterminate Shafts. Strain Energy in Torsion. Torsion of Thin-Walled Shafts. (6 lectures)
5. Transverse Loading of Beams: Types of Beams, Loads and Reactions. Shear Force and Bending Moment Diagrams. Bending, Stress and Strain in Beams. Design of Beams, Nonprismatic Beams, Shear Stresses. Shear Webs, Built-Up Beams, Axial Loads. Composite Beams. (9 lectures)
6. Plane Stress and Applications: Analysis of Stress and Strain. Plane Stress Topics, Principal Stresses, Maximum Shear Stress. Plane Strain. Pressure Vessels. Combined Loadings. (6 lectures)

Revision History

Prepared by: W. Chen, J. F. Doyle, T. N. Farris, and A. F. Grandt,
Date: September 12, 2006
Format updated: W. Chen, Date: November 10, 2011
Format updated: T. Moore, February 4, 2013

1. **AAE20401: Aeromechanics II Laboratory**

2. **Credits:** 1
   Contact hours: Lab that meets 1 time per week for 120 minutes per meeting for 15 weeks

3. **Instructor's name:** Professor J. F. Doyle

4. **Textbook:** No text required. Lab handout materials include instructions for procedure, basic theory of experimental methods, theory for analysis, and suggestions on what to include in the report.

5. **Specific course information**
   a. **Course description**: Introduction to strain gages, dial gages, force transducers and photoelasticity. Materials testing in tension and shear. Stress concentration around cutouts. Bending of beams. **Offered**: Fall and Spring
   b. Pre-requisite: None **Co-requisite:** AAE24000
   c. Course status: Required

6. **Specific goals for the course**

   a. Student Learning Outcomes

   On completing this course the student shall be able to:
   1. Master the basic methods in the experimental testing of solids and structures
   2. Understand and set up experimental instrumentation
   3. Set up and conduct mechanical tests on materials in tension and shear
   4. Understand the concept of stress concentration in structures
   5. Compute stresses, strains, deformation and displacements of basic structural components
   6. Set up and conduct beam bending experiments
   7. Master the basic skills in the writing of technical reports

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Yes
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Yes
d	An ability to function on multidisciplinary teams	Yes
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes

f	An understanding of professional and ethical responsibility	Yes
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Lab 1: Introduction to Electrical Resistance Strain Gages: Wheatstone Bridge and Commercial Strain Indicators
2. Lab 2: Materials Testing: Tensile Test and Poisson's Ratio Test
3. Lab 3: Beam Bending: Beam Deflections and Bending Strains
4. Lab 4: Torsion: Torsion of Shaft and Shear Test
5. Lab 5: Stress and Biaxial Stress: Uniaxial Stress Specimen and Pressure Vessel
6. Lab 6: Stress Analysis by Photoelasticity: Bending Specimen and Grooved Specimen

Revision History
Prepared by: J. F. Doyle, Date: March 18, 2001
Revised by: J. F. Doyle, Date: September 18, 2006
Updated Co-Requisite on March 3, 2011
Format updated: W. Chen, Date: November 10, 2011
Format updated: T. Moore, Date: February 4, 2013

1. **AAE25100: Introduction to Aerospace Design**

2. **Credits: 3**
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Professors Dan Delaurentis and Karen Marais

4. **Textbook:** Brandt, S. A., Stiles, R. J., Bertin, J. J., and Whitford, R., *Introduction to Aerospace: A Design Perspective,* AIAA, 1997. ISBN 1-56347-250-3
   a. Supplemental notes furnished by instructor

5. **Specific course information**
   a. **Course description**: The role of design in aerospace engineering. Introduction to aerodynamics, performance, propulsion, structures, stability and control, and weights. Layout and general arrangement of aerospace vehicles. Design concept generation and selection. Computational methods for design. Trade studies and graphical optimization. Conceptual design exercise involving aircraft, spacecraft or both. Technical presentations and communication for aerospace engineering. **Offered**: Fall and Spring
   b. **Pre-requisite:** ENGR 13200 **Co-requisite:** CGT16300
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student Learning Outcomes
   On completing this course the student shall be able to:
   1. Acquire and apply basic technical knowledge about aerospace engineering
   2. Develop intuition about aerospace engineering and aerospace vehicles
   3. Understand and implement the design process for aerospace systems
   4. Use computers in aerospace design
   5. Solve problems as part of a team
   6. Design an aerospace vehicle/system
   7. Give oral presentations and write technical reports required of design engineers

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Yes
d	An ability to function on multidisciplinary teams	Yes
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes

f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Introductory Material: Class Introduction. The Design Process and the Historical Perspective. Anatomy, Parameters, and Forces. The Atmosphere. (4 lectures)
2. Aerodynamics: One-dimensional Flow. Two-dimensional Flow. Viscosity and Drag. Airfoils. Finite Wing. Wings and High-Lift Systems. Drag Prediction. (8 lectures)
3. Propulsion: Producing Thrust. Types of engines. Propulsion Design Considerations. (2 lectures)
4. Performance: The Design Mission. Range. Endurance. Climb. Descent. Takeoff. Landing. (3 lectures)
5. Aircraft Stability: Center of Gravity. Static Longitudinal Stability. Other Measures of Stability. Static Lateral Stability. Design Considerations. (2 lectures)
6. Aircraft Geometry Selection: Wing Placement. Fuselage Shape. Engine and Inlet Placement. Tails. Landing Gear Arrangement. (4 lectures)
7. The Aircraft Design Process: Generating and Evaluating Design Alternatives. Aircraft Sizing. Empty Weight Prediction. Fuel Weight Prediction. Geometry. Carpet Plots. Aircraft Cost. (5 lectures)
8. Rockets and Spacecraft: Rocket Trajectories. The Rocket Equation. Staging. Geocentric Orbits. Heliocentric Orbits. Orbital Parameters and Maneuvers. Spacecraft/Rocket Sizing. (4 lectures)
9. Structures: Structural Design Process. Design Criteria. Structural Design Layout. Aircraft Structure Types. Materials. (2 lectures)
10. Technical Reports and Presentations: Vehicle of the Week Reports and Presentations. The Design Proposal and Presentation. (2 lectures)

Revision History

Prepared by: William A. Crossley, Date: February 17, 2001
Revised by: Daniel DeLaurentis, Date: September 18, 2006
Updated Pre-Requisite: March 3, 2011
Format updated: September 2011
Format updated by T. Moore: February 5, 2013

1. **AAE30000: Undergraduate Junior Seminar**

2. **Credits:** 0
   Contact hours: 1 hour every 3 weeks, 5 hours per semester

3. **Instructor's name: Professor** Marc Williams

4. **Textbook:** None
   a. Other supplement materials: None

5. **Specific course information**
   a. **Course description**: The courses are intended to provide a forum for guest speakers, organizational and informational meetings with undergraduates, and to provide a venue for discussion of professional development. **Offered**: Fall and Spring
   b. **Pre-requisite:** Junior standing in AAE only, AAE20000 **Co-requisite:** None
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student Learning Outcomes
   See yes below

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	No
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	No
f	An understanding of professional and ethical responsibility	Yes
g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	Yes
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	No

7. **Topics**

- 2-4 topics from AAE 200
- Resume writing & Interviewing
- Curricular Choices (senior design)

Revision History
Prepared by: Marc H. Williams,
Date: September 7, 2011
Format updated by: T. Moore February 5, 2013

1. **AAE 30100: Signal Analysis for Aerospace Engineers**

2. **Credits:** 3
   Contact Hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Professors A. E. Frazho and J. Garrison

4. **Textbook:** Notes furnished by instructor
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description:** Signal processing and spectral analysis for aerospace engineering. Fourier and fast Fourier transforms. Estimation of natural frequencies. Review of Laplace transforms. An introduction to state space. Bode plots. An introduction to linear circuits and filtering. Low pass, band pass and high pass filters. **Offered:** Fall and Spring
   b. **Pre-requisites:** Math 26500 and 26600 or equivalent **Co-requisite:** MA 26100
   c. **Course status:** Required

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
   On completing this course the student shall be able to:
      1. Use fast Fourier transform techniques to estimate sinusoids from experimental data.
      2. Estimate natural frequencies from data. For example beam vibration.
      3. Extract the underlying spectrum from time history.
      4. An elementary understanding of stability and state space systems.
      5. An elementary understanding of transfer functions and Bode plots.
      6. Analyze mass spring damper systems.
      7. Analyze and design elementary linear circuits.
      8. Design low pass, band pass and high pass filters.

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Y on analyze data
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes

f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics (number of lectures):

7. Time domain analysis and Fourier series (6)
8. The fast Fourier transform (5)
9. Estimating sinusoids in noise with Aerospace Applications (3)
10. Laplace transform review (5)
11. Resistor, capacitor, inductors, operational amplifiers (4)
12. State space analysis (4)
13. Mass spring damper systems (3)
14. Tuned vibration damper (2)
15. Bode Plots (5)
16. Resonance frequencies (2)
17. Butterworth filters (4)

Revision History
Format updated: January 31, 2011
Format updated by T. Moore: February 5, 2013

1. **AAE33300: Introduction to Fluid Mechanics**

2. **Credits: 3**
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Professors Marc Williams and Alina Alexeenko

4. **Textbook:** *Fundamentals of Aerodynamics*, John D. Anderson, Jr., McGraw Hill, New York, NY
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description**: Dimensional analysis, fluid statics, conservation equations and fundamental principles, inviscid and viscous incompressible flow, evaluation of lift and drag of an airfoil. **Offered**: Fall and Spring
   b. **Pre-requisite:** none **Co-requisite:** MA30400
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student Learning Outcomes:
   On completing this course the student shall be able to:
   - Calculate aerodynamic forces and moments from pressure and shear stress distributions
   - Apply dynamic similarity to scale up data
   - Apply global conservation of mass and momentum to engineering systems
   - Apply Bernoulli's equation (relating pressure and velocity)
   - Calculate lift for an arbitrary airfoil using panel methods
   - Calculate drag for an arbitrary airfoil using integral boundary layer methods

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic,	No

	environmental, and societal context	
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Introduction
   Definition of a fluid. Continuum hypothesis. Aerodynamic variables. Dimensional analysis. Fluid statics. (8 lectures)
2. Conservation Equations and Fundamental Principles.

   Review of vector calculus. Control volumes. Conservation of mass, momentum and energy. Eulerian and Lagrangian frames of reference. Substantial derivative. Streamlines. Vorticity and rate of strain. Circulation. Velocity potential and stream function. (10 lectures)
3. Incompressible Potential Flow

   Bernoulli's equation. Laplace's equation and fundamental solutions for two-dimensional potential flow. Kutta-Joukowski theorem. Kutta condition. Kelvin's circulation theorem. Modeling flow over airfoils-Introduction to panel methods. (15 lectures)
4. Viscous Incompressible Flow

   Viscosity and thermal conductivity. Stress relation for a Newtonian fluid. Navier-Stokes equations. Dynamic similarity. Simple exact solutions. Boundary layer approximation. Blasius solution. Thwaites' method for laminar boundary layer calculations. Introduction to separation, transition and turbulence. Head's method for turbulent boundary layer calculations. (12 lectures)

Revision History
Prepared by: A. Lyrintzis
Date: February 6, 2001
Revised: September 2006
Updated Co-Requisite on March 3, 2011
Revised by Marc Williams: September 29, 2011
Format updated: September 2011
Format updated by T. Moore, February 6, 2013

1. **AAE33301: Fluid Mechanics Laboratory**

2. **Credits:** 1
   Contact hours: 2 hour laboratory, 1 hour lecture, every other week for 15 weeks.

3. **Instructor's or course coordinator's name:** Professor Sally Bane

4. **Textbook:** Laboratory notes, J. P. Sullivan, E. Gnanamanickam, S. Bane, S. P. Schneider, S. H. Collicott
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description**: Reinforce concepts in incompressible flow taught in AAE 33300, hands-on experience with complex, nonlinear, and unsteady flows, bluff body flows and vortex shedding, boundary layers, laminar and turbulent pipe flow, pressure around cylinders, wakes and drag, introductory laboratory techniques and instrumentation
      Offered: Fall and Spring
   b. **Pre-requisite**: None **Co-requisite**: AAE33300
   c. **Course status:** Required

6. **Specific goals for the course**
   a. **Student Learning Outcomes:**
      On completing this course the student shall be able to:
      - Measure and differentiate between absolute, differential, and gauge pressure
      - Make basic pressure and velocity measurements
      - Utilize elementary flow visualization tools
      - Deduce fluid physics information from flow visualization
      - Calculate flow characteristics such as Reynolds number, friction factor, pressure and drag coefficient from laboratory measurements
      - Identify and discuss foundation-level fluid phenomena including boundary layers, wakes, laminar to turbulent transition, turbulence, flow separation, drag on a body, and surface pressure distributions

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Yes
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No

e		An ability to identify, formulate, and solve aerospace engineering problems	Yes
f		An understanding of professional and ethical responsibility	Yes
g		An ability to communicate effectively	Yes
h		An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i		A recognition of the need for, and an ability to engage in life-long learning	No
j		A knowledge of contemporary issues in aerospace engineering	No
k		An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

5. Viscous Flow

   Boundary layer along a flat plate. Bluff body wakes and visualization of Karman vortex street using a hydrogen bubble wire. (1 lecture, 1 laboratory)

6. Reynolds Pipe Flow

   Laminar pipe flow and friction. Flow instability. Transition to turbulence and Reynolds number. (1 lecture, 1 laboratory)

7. Pressure in Aerodynamics

   Pitot tube measurements. Calculating flow velocity using Bernoulli's equation. Pressure around a cylinder. Calculating pressure coefficient from manometer measurements. Inviscid ideal flow around a cylinder. (1 lecture, 1 laboratory)

8. Wakes and Drag

   Wake behind a smooth and rough cylinder. Wake behind an airfoil. Hot wire velocity measurements. Calculation of drag coefficient versus Reynolds number from wake measurements. Wake behind a smooth and rough sphere. Drag calculation from velocity versus time measurements. (2 lectures, 2 laboratories)

9. Design Your Own Experiment

   Design an experiment and write a proposal, develop a procedure, develop appropriate scientific questions and analysis for the final report (1 lecture, 1 laboratory)

Revision History

Prepared by: Steven H. Collicott
Date: August 11, 2006
Updated Co-Requisite on March 3, 2011
Revised by Sally Bane: January 25, 2012
Format updated: September 2011
Format updated by: T. Moore, February 6, 2013

1. **AAE33400: Aerodynamics**

2. **Credits:** 3
   Contact Hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Professors S. H. Collicott, M. H. Williams, G. Blaisdell

4. **Textbook:** *Fundamentals of Aerodynamics*, John D. Anderson, Jr., McGraw-Hill, N.Y., NY.
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course Description**: Thin airfoil theory, lifting line theory, compressible flow fundamentals, steady normal shock waves, steady oblique shock waves, Prandtl-Meyer expansion, shock-expansion theory for loads on airfoils, wave drag, compressible nozzle flow, linearized compressible subsonic flow, linearized supersonic flow. Design applications. **Offered:** Fall and Spring
   b. Pre-Requisites: AAE33300 and 33301, ME20000 or ME35000 **Co-Requisite:** None
   c. Course Status: Required

6. **Specific goals for the course**
   a. Student Learning Outcomes:
   On completing this course the student should be able to:
   - Calculate thin airfoil performance parameters for incompressible flow
   - Calculate general wing loading by lifting line theory and compare to elliptic loading case.
   - Compute isentropic stagnation conditions and apply in problem solving.
   - Compute jumps in properties across steady shocks and expansions
   - Determine supersonic airfoil performance by shock-expansion method
   - Determine supersonic airfoil performance by linearized supersonic theory
   - Apply subsonic compressibility corrections to incompressible results
   - Determine critical Mach number for sub-sonic flight
   - Determine supply or back pressures for supersonic nozzle operating conditions

   b. Relationship of Course to Program Learning Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	Yes

e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

10. Thin Airfoil Theory (8 lectures)
11. Lifting Line Theory (8 lectures)
12. Isentropic Flow (4 lectures)
13. Shocks and Expansions (12 lectures)
14. Compressible Nozzle Flow (6 lectures)
15. Linearized Compressible Flow (5 lectures)

With 2 class sessions for mid-term examinations.

Prepared by: Marc H. Williams, Gregory Blaisdell
Date: February 23, 2006
Updated Pre-Requisites on March 3, 2011
Format Updated: September 2011
Format Updated by T. Moore, February 6, 2013

1. **AAE33401: Aerodynamics Laboratory**

2. **Credits:** 1
   Contact hours: 2 hour laboratory, 1 hour lecture, every other week for 15 weeks.

3. **Instructor's or course coordinator's name:** Professor Sally Bane

4. **Textbook:** Laboratory notes, J. P. Sullivan, E. Gnanamanickam, S. Bane, S. P. Schneider, S. H. Collicott

5. **Specific course information**
   a. **Course description**: Reinforce concepts in compressible fluid mechanics and wing aerodynamics taught in AAE 33400, laminar airfoils, flaps and slats, pressure on an airfoil, finite wings, wing tip vortices and wing tip devices, supersonic wind tunnel, normal and oblique shock waves, expansion fans, compressible nozzle flow, optical flow visualization, wind tunnel techniques and instrumentation. **Offered**: Fall and Spring
   b. **Pre-requisite**: none **Co-requisite:** AAE33400
   Either/or option with AAE 35201
   c. **Course status:** Required

6. **Specific goals for the course**
   a. **Student Learning Outcomes:**
   On completing this course the student shall be able to:
   - Use wind tunnel instrumentation to measure flow velocity and lift and drag
   - Describe the dependence of airfoil pressure distribution, lift, and drag on angle of attack and flaps and slats
   - Describe the effect of finite span, wing tip vortices
   - Use schlieren or shadowgraph techniques to visualize compressible flows
   - Sketch pressure distributions across oblique and normal shock waves, and expansion fans
   - Describe the pressure distribution inside a compressible flow converging-diverging nozzle and possible nozzle exit conditions

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Yes
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No

e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	Yes
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

16. Airfoils

    Aifroil geometry. Pitot tube measurement and flow velocity. Lift, drag, and pitch measurement and coefficient calculation. Affect of angle of attack. Transition to turbulence and stall. Effect of flaps and slats. Pressure on airfoil surface. Calculating pressure coefficient and lift. (2 lectures, 2 laboratories)

17. Finite Wings

    Downwash. Starting, trailing, and wingtip vortices. Induced drag and aspect ratio. Drag polar. Lift and drag versus aspect ratio. Wingtip devices. (1 lecture, 1 laboratory)

18. Supersonic Wind Tunnel and Shock Waves

    Supersonic flow through a nozzle. Supersonic flow around bodies. Normal and oblique shock waves. Prandtl-Meyer expansion. Pressure across shock waves and expansion fans. Shadowgraph and schlieren visualization. (1 lecture, 1 laboratory)

19. Compressible Nozzle Flow

    Subsonic and supersonic nozzle flow. Normal shock in nozzle and nozzle exit. Exit conditions for overexpanded, underexpanded, and design condition flow. Schlieren visualization. Thrust measurement versus nozzle pressure ratio. (1 lecture, 1 laboratory)

20. Design Your Own Experiment

    Design an experiment and write a proposal, develop a procedure, develop appropriate scientific questions and analysis for the final report (1 lecture, 1 laboratory)

Revision History

Prepared by: Steven H. Collicott
Date: August 11, 2006
Updated Co-Requisite on March 3, 2011
Revised by Sally Bane: January 25, 2012
Format updated: T. Moore, March 5, 2013

1. **AAE 34000: Dynamics and Vibrations**

2. **Credits:** 3
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Professors Kathleen Howell and James Longuski

4. **Textbook:** Supplemental notes furnished by instructor.

5. **Specific course information**
   a. Course description: Kinematics and kinetics of particles and rigid bodies. Topics include a particle in orbit, systems of particles, vibrations, Euler's equations of motion, Eulerian angles, and aerospace vehicle dynamics. **Offered**: Fall and Spring
   b. **Pre-requisite**: MA 26600 or MA 36600, MA 30300 or MA 30400, AAE 20300
   Co-requisite: None
   c. Course status: Required

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
   On completing this course the student shall be able to:
   1. Analyze the free and forced response of a spring/mass/damper
   2. Formulate the EOMs of particles, systems of particles and rigid bodies
   3. Solve the EOMs numerically
   4. Understand the various forms of Euler angles and be able to apply them to rigid body dynamics
   5. Simulate the motion of a spacecraft in MATLAB

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Y
b	An ability to design and conduct experiments, as well as to analyze and interpret data	N
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	N
d	An ability to function on multidisciplinary teams	N
e	An ability to identify, formulate, and solve aerospace engineering problems	Y
f	An understanding of professional and ethical responsibility	N
g	An ability to communicate effectively	N
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	N

i	A recognition of the need for, and an ability to engage in life-long learning	N
j	A knowledge of contemporary issues in aerospace engineering	N
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Y

7. Topics

1. Mass-Spring-Damper (7 lectures)
   - undamped free vibrations; under-, critically- and over-damped free vibrations; amplification factor and phase angle for forced vibrations; resonance
2. Review of Kinematics (2 lectures)
   - basic kinematic equation; coordinate systems (cylindrical, spherical, etc.)
3. Numerical Integration (1 lecture)
   - Euler, Runge-Kutta; MATLAB ode toolbox
4. Review of Particle Dynamics (8 lectures)
   - free body diagrams; kinematics; Newton's laws; equations of motion; integrals of motion; conservation of linear and angular momentum, conservation of total mechanical energy; principles of linear/angular impulse and momentum; principles of work and kinetic energy; orbital mechanics
5. Systems of Particles (7 lectures)
   - Newton's and Euler's laws for systems of particles; integrals of motion; rocket problem; collisions
6. Rigid Body Dynamics (13 lectures)
   - degrees of freedom; moments and products of inertia; inertia matrix and coordinate transformations; principal axes and principal moments of inertia; Euler's theorem; derivation of Euler's equations of motion
7. Euler Angles (4 lectures)
   - sequences (e.g., 313);angular velocities in terms of Euler angles; free motion of an axisymmetric rigid body; body cone and space cone
8. Aerospace Applications (1 lecture)

Revision History
Prepared by: James M. Longuski
Date: September 19, 2000
Revised: March 23, 2006
Updated Pre-Requisites on March 3, 2011
Revised: February 27, 2012
Format updated: T. Moore, March 5, 2013

1. **AAE35200: Aerospace Structural Analysis I**

2. **Credits:** 3
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks

3. **Instructor's or course coordinator's name:** Professors W. Chen, A. F. Grandt, C. T. Sun, and V. Tomar

4. **Textbook:** Sun, C. T., Mechanics of Aircraft Structures, 2nd edition, Wiley, 2006, ISBN 978-0-471-69966-8
   a. **Other supplemental materials:** Supplemental notes furnished by instructor

5. **Specific course information**
   a. **Course description:** Properties of wing and fuselage sections. Buckling of beams and plates. Torsion of thin-walled and skin-stringer multiple-cell sections. Failure mechanisms and predictions. Nonsymmetrical bending of skin-stringer sections. Flexural shear in open and closed thin-walled and skin-stringer sections. Deflection by energy method. Introduction to composite structures. **Offered:** Fall and Spring
   b. **Pre-requisite:** AAE20400, AAE20401 **Co-requisite:** None
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student Learning Outcomes
   On completing this course the student shall be able to:
   1. Use analytical/empirical tools for determining the distribution of load (or displacement) in typical aerospace components.
   2. Understand and implement the procedures for relating applied loads (or displacements) to component "failure."
   3. Select of materials to resist structural failure.
   4. Be exposed to other professional development topics are also be presented as time permits (e.g., technical communications, teamwork issues, economic considerations, engineering ethics, case histories, regulatory & certification topics, etc.)

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	Included?
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Yes
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Yes
d	An ability to function on multidisciplinary teams	Yes

e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Review of strength of materials and introduction to elasticity. (4 lectures)
2. Design criteria and determination of loads. (6 lectures)
3. Materials selection and evaluation. (8 lectures)
4. Bending and torsion of thin-walled structures. (13 lectures)
5. Buckling design of structural elements. (6 lectures)
6. Deflection analysis of structures. (4 lectures)
7. Tests. (2 lectures and a final exam)

Revision History
Prepared by: A. F. Grandt, Date: July 19, 2006
Format updated: W. Chen, Date: November 10, 2011
Format updated: T. Moore, Date: March 6, 2013

1. **AAE35201: Structural Analysis I Laboratory**

2. **Credits:** 1
   Contact hours: Laboratory that meets 1 time per week for 180 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Prof. J. F. Doyle

4. **Textbook:** No text required. Lab handout materials include instructions for procedure, basic theory of experimental methods, theory for analysis, and suggestions on what to include in the report.
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description:** Location of shear center. Torsion of thin-walled, open and closed sections. Nonsymmetrical bending of skin-stringer cross section. Bending of sandwich bean. Vibrations. **Offered:** Fall and Spring
   b. **Pre-requisite:** None **Co-requisite:** AAE35200
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student Learning Outcomes
   On completing this course the student shall be able to:
   1. Understand the basic methods in the experimental analysis of aerospace structures
   2. Use computer simulations to explore various aspects of structural analysis not readily amenable to experiment
   3. Understand and set up experimental instrumentation
   4. Understand the role of shear center in aerospace structures
   5. Set up and conduct thin-wall structural experiments under torsion, bending and vibration
   6. Perform full-field stress analysis using photoelasticity
   7. Master the basic skills in data analysis and results presentation

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Yes
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Yes
d	An ability to function on multidisciplinary teams	Yes
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	Yes

g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Lab 1: Strain Gage Rosette Analysis: I-Beam and Web and Flange Effects
2. Lab 2: Bending of Aircraft Wing: Symmetric Wing and the Role of Shear Center
3. Lab 3: Torsion of Airfoils: Two-cell Section and the Effect of Spar
4. Lab 4: Thin-walled Shear Beams: Three Stringer Beams and the Role of Shear Center
5. Lab 5: Structural Dynamics: Vibration of Beam and Various Vibration Modes of a Cantilevered Plate
6. Lab 6: Whole-field Stress Analysis: Photoelasticity of Grooved Specimen and Effects of Notch geometry

Revision History

Prepared by: J. F. Doyle, Date: March 13, 2001
Revised by: J. F. Doyle, Date: September 18, 2006
Updated Co-Requisite on March 3, 2011
Format updated: W. Chen, Date: November 10, 2011
Format updated: T. Moore, Date: March 5, 2013

1. **AAE 36400: Control System Analysis**

2. **Credits:** 3
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Prof. I. Hwang

4. **Text book:** Ogata, Modern Control Engineering, Prentice Hall, 5th edition
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description:** Modeling, analysis, and controller synthesis of dynamical systems with aerospace applications. Subjects covered include Laplace transforms, transfer functions, block diagrams, time-domain and frequency-domain analysis of dynamical systems, and controller synthesis using Root Locus, Bode, and Nyquist methods. **Offered**: Fall and Spring
   b. **Pre-requisite:** AAE30100 **Co-requisite:** None
   c. **Course status:** Required:

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
   On completing this course the student shall be able to:
   5 Derive transfer functions of dynamical systems.
   6 Analyze and understand the transient and steady-state response of dynamical systems.
   7 Perform analysis of dynamical systems using Root Locus, Bode, and Nyquist methods.
   8 Design a PID-type controller for a dynamical system so that the closed-loop system can satisfy the given performance specification.

   b. **Relationship of course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	No

h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics (number of lectures):

18. Examples of control systems (2 classes)
19. Review of complex numbers and complex functions (3 classes)
20. Laplace transforms (3 classes)
21. Solution to ordinary differential equations (3 classes)
22. Transfer functions and block diagrams (4 classes)
23. Transient response and steady-state error analysis (6 classes)
24. Stability and the Routh test (3 classes)
25. The root locus (6 classes)
26. Introduction to PID design using the root locus (6 classes)
27. Bode plots, transfer function estimation, and Nyquist stability criterion (6 classes)
28. Exams (3 classes)

Revision History

Prepared by: M. Rotea, Date: March 20, 2001

Revised by: I. Hwang, Date: March 23, 2006

Revised by: I. Hwang, Date: February 2, 2012

Updated Pre-requisites on March 3, 2011

Format updated: January 31, 2011

Format updated: T. Moore, March 6, 2013

1. **AAE36401: Control Systems Laboratory**

2. **Credits: 1**
   Contact hours: Laboratory that meets 1 time per week for 180 minutes per meeting for 15 weeks

3. **Instructor's or course coordinator's name:** Prof. A. E. Frazho

4. **Textbook:** Notes furnished by instructor
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description:** A laboratory course designed to illustrate fundamental aspects of dynamics and control. Dynamical modeling includes rigid body rotation, Coulomb friction, viscous friction, saturation, resonance frequency and identification. Controller design includes the proportional integral and derivative (PID) controller, eliminating integral windup, pole placement and an introduction to the linear quadratic regulator (LQR) controller. **Offered**: Fall and Spring
   b. **Pre-requisite:** AAE36400 **Co-requisite:** None
   c. **Course status:** Required

6. **Specific goals for the course**
   a. **Student Learning Outcomes**

   On completing this course the student shall be able to:
   1. To design experiments to identify the parameters in linear and nonlinear mechanical systems, including Columb friction.
   2. Set up experiments to estimate natural frequencies in mechanical systems.
   3. Program Simulink models of the mechanical systems they identified, and compare these Simulink models to the physical system.
   4. Implement PID controllers to control linear and certain nonlinear mechanical systems with saturation and Columb friction.
   5. Use pole placement to control linear and certain nonlinear mechanical systems with saturation and Columb friction.
   6. Implement LQR to control linear and certain nonlinear mechanical systems with saturation and Columb friction.
   7. Apply PID, pole placement and LQR controllers to have linear and certain nonlinear mechanical systems follow a specified path.

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Yes
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political,	No

	ethical, health, and safety, manufacturability, and sustainability	
d	An ability to function on multidisciplinary teams	Yes
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics (number of lectures):

29. The cart experiment Columb friction and saturation(1)
30. PID controllers for the cart and integral windup(1)
31. The gantry experiment its dynamic model and resonance frequency(1)
32. State space integral controllers, and pole placement for the gantry experiment(2)
33. The inverted pendulum experiment its dynamic model and state space(1)
34. LQR controllers for the inverted pendulum(2)
35. The helicopter experiment and its dynamic mode(1)
36. Identification of the parameters in the helicopter model including Columb friction and motor gains(1)
37. PID controllers for the helicopter experiment(2)
38. LQR controllers for the helicopter experiment(2)

Revision History

Format updated: January 31, 2011
Format updated: T. Moore, March 5, 2013

1. **AAE37200: Jet Propulsion Powerplants**

2. **Credits 3**
   Contact hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks

3. **Instructor's or course coordinator's name:** Professors Li Qiao, William Anderson, and Stephen Heister

4. **Textbook:** Mechanics and Thermodynamics of Propulsion, Hill and Peterson
   a. **Other supplemental materials:** Notes furnished by instructor

5. **Specific course information**
   a. **Course description:** The course is intended to serve as an introduction to air breathing propulsion systems. Students are given a basic background in combustion, one-dimensional compressible internal flows, and the thermodynamics of Brayton-cycle engines. In addition, the students are provided with more detailed discussion of the major components in an air breathing engines ranging from inlets and compressors to combustors, turbines, and nozzles. **Offered:** Spring
   b. **Pre-requisite:** None **Co-requisite:** AAE33400
   c. **Course status:** Required

6. **Specific goals of the course**
   a. **Student Learning Outcomes**
      On completing this course the student shall be able to:
      9 Determine the thrust and fuel consumption of gas turbine and turboprop engines
      10 Understand advantages/disadvantages of turbojet, turboprop, turbofan, and ramjet air breathing propulsion systems
      11 Understand the thermodynamics of the Brayton cycle and how they contribute to overall propulsion system performance
      12 Understand the role and fundamental performance of gas turbine components
      13 Determine the basic performance and/or design of axial turbines and compressors
      14 Determine the basic performance of air breathing combustors

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Yes

d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	Yes
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Introduction: Components of a jet engine and brief history of gas turbine propulsion for aerospace applications (1 lecture)
2. Thermodynamics and Combustion Fundamentals: Laws of thermodynamics, mixtures of perfect gases, reacting flow analysis assuming complete combustion. (6 lectures)
3. Fundamentals of 1-D Compressible Flow: 1-D isentropic flow, Fanno and Rayleigh flows, normal shocks. (6 lectures)
4. Powerplants and Jet Engine Ratings: Brayton thermodynamic cycle, air standard cycles, engine performance ratings, aircraft range. (4 lectures)
5. Turbojet Engine Cycle Analysis: Real and ideal engine cycle analysis, component efficiencies. (6 lectures)
6. Other Airbreathing Engine Cycles: Turbofan, turboprop, and ramjet engine cycles. (5 lectures)
7. Turbomachinery Fundamentals: Euler momentum equation, axial compressors, axial turbines, turbine/compressor matching. (7 lectures)
8. Combustors, Inlets and Nozzles: Constant pressure mixer analysis, subsonic and supersonic inlets, nozzles. (6 lectures)
9. Rocket Propulsion or Other Topics (time permitting): rockets, air-turbo rockets, pulse detonation engines. (2 lectures)
10. Tests (2 lectures)

Revision History

Prepared by: Stephen D. Heister, Date: April 6, 2006
Updated Pre-Requisites and Co-Requisites on March 3, 2011
Format updated: October 2011
Format updated: T. Moore, Date: March 6, 2013

1. **AAE 40000 - Undergraduate Senior Seminar**

2. **Credits:** 1 **Contact hours:** 1 every 3 weeks, 5 hours per semester

3. **Instructor's or course instructor's name:** Prof. Marc Williams

4. **Textbook:** None required
   a. **Other supplemental materials**: None

5. **Specific course information**
   a. **Course description**: A lecture-demonstration series emphasizing evaluation of career options, identification and development of professional skills. Examples of career-related topics include choosing a job, and post graduate education in engineering or other disciplines. Examples of professional skill topics covered include interviewing, writing, and ethics. Assessment of program learning outcomes. **Offered:** Fall and Spring
   b. **Pre-requisites**: Senior standing in AAE only, AAE 30000 **Co-requisite:** None
   c. **Course status:** Required

6. **Specific goals of the course**
   a. **Student Learning Outcomes**
   We will assess student learning in everyone (a-k) of the outcomes below

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	No
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	No
f	An understanding of professional and ethical responsibility	Yes
g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	Yes
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	No

7. Topics

- Professional Development
  - Ethics
  - Life Long Learning
- Current Events
- Guest Speakers
- Resume writing & Interviewing
- Assessment of AAE Program Outcomes

Revision History
Prepared by: Marc H. Williams,
Date: September 7, 2011
Format updated by: T. Moore, March 19, 2013

1. **AAE42100: Flight Dynamics and Control**

2. **Credits:** 3
   Contact Hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Prof. Martin Corless

4. **Textbook:** Notes furnished by instructor
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description**: Flight vehicle rigid-body equations of motion; linearization via small perturbation techniques. Trim analysis, static and dynamic stability, aerodynamic stability derivatives and control effectiveness. Vehicle transfer functions, stability augmentation, aircraft handling qualities. **Offered:** Fall and Spring
   b. **Pre-requisite:** None **Co-requisite:** AAE34000
   c. **Course status:** Required if AAE44000 is not taken

6. **Specific goals for the course**
   a. **Student Learning Outcomes**

   On completing this course the student shall be able to:
   - Develop state space and transfer function models of physical systems
   - Simulate nonlinear systems
   - Linearize nonlinear systems
   - Analyze a system for stability
   - Design a feedback controller to meet stability and performance requirements
   - Analyze a flight vehicle for trim conditions, stability and handling qualities

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	No
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No

g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics (number of lectures):

1. Modeling of systems with aerodynamic forces (5)
2. State space and transfer function representation of dynamical systems (5)
3. Linearization (3)
4. Nonlinear model of flight vehicle dynamics (6)
5. Linear model of flight vehicle dynamics (2)
6. Modes and dynamic behavior of linear systems (4)
7. Flight vehicle modes: phugoid, short period, dutch roll, roll and spiral (2)
8. Stability, flying handling qualities (4)
9. Feedback control (4)
10. Controllability (2)
11. Stability augmentation, control augmentation. (5)

Revision History

Prepared by M. Corless, March 1, 2001

Revised by M. Corless, July 28, 2006

Revised by M. Corless, January 31, 2102

Updated Pre-requisites on March 3, 2011

Format updated: January 31, 2011

Format updated by T. Moore, March 19, 2013

1. **AAE43900: Rocket Propulsion**

2. **Credits:** 3
   Contact Hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Professors William Anderson and Stephen Heister

4. **Textbook:** *Rocket Propulsion Elements* 6th Edition, Sutton & Biblarz. *Analysis and Design of Chemical Rocket Propulsion Systems*, S. Heister, Extended Course Notes/Text, 2010.
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description:** The course is intended to serve as an introduction to rocket propulsion systems. Students are exposed to ideal rocket propulsion system performance prediction and a brief discussion of various efficiencies associated with deviations from ideal behavior. Basic propulsion system design is stressed with a brief discussion of mission requirements and trajectory analysis included to enable complete sizing studies. A class project involving analysis, thrust and drag measurements, and parachute behavior provides background in actual issues associated with operation of these systems. **Offered:** Fall
   b. **Pre-requisite:** None **Co-requisite:** AAE33400
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student Learning Outcomes
   On completing this course the student shall be able to:
   15 Determine the thrust and fuel consumption of gas turbine and turboprop engines
   16 Understand advantages/disadvantages of turbojet, turboprop, turbofan, and ramjet airbreathing propulsion systems
   17 Understand the thermodynamics of the Brayton cycle and how they contribute to overall propulsion system performance
   18 Understand the role and fundamental performance of gas turbine components
   19 Determine the basic performance and/or design of axial turbines and compressors
   20 Determine the basic performance of airbreathing combustors

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political,	Yes

	ethical, health, and safety, manufacturability, and sustainability	
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	No
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	Yes
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Introduction: Brief history of rocketry, classification of rocket propulsion systems. (2 lectures)
2. Ideal Rocket Nozzle Performance: Review of 1-D compressible flow, rocket performance fundamentals, nozzle design, deviations from ideal performance. (8 lectures)
3. Rocket Design Fundamentals: Mission requirements for launch vehicles, upper stages, ballistic missiles, and interceptors. (5 lectures)
4. Trajectory Analysis: The rocket equation, vertical trajectories, multistage rockets, generalized 2-D trajectories. (5 lectures)
5. Combustion and Thermochemistry: Perfect gas law and thermodynamics review, chemical equilibrium, adiabatic flame temperature calculations, rocket nozzle thermochemistry. (7 lectures)
6. Solid Rocket Motors: General description, interior ballistics, component design techniques. (6 lectures)
7. Liquid Rocket Engines: General description, engine cycles, power balance calculations, component design fundamentals. (6 lectures)
8. Electric Propulsion (time permitting): Classification of electric propulsion systems, performance analysis. (3 lectures)
9. Tests and Rocket Launch Project. (3 lectures)

Revision History
Prepared by: Stephen D. Heister
Date: February 6, 2001
Revised: April 4, 2006
Updated Pre-Requisites on March 3, 2011
Updated Format in October, 2011
Updated Format: T. Moore, March 19, 2013

1. **AAE44000: Spacecraft Attitude Dynamics**

2. **Credits:** 3
   Contact Hours: Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Prof. Kathleen Howell

4. **Textbook:** No text required
   a. **Other supplemental materials:** Notes furnished by instructor

5. **Specific course information**
   a. **Course description**: The development of spacecraft rigid body equations of motion in terms of direction cosines, angles and quaternions, with external torques. Determination of the attitude stability of the resulting rotational motion of the spacecraft. Stabilization techniques presented and the impact determined through numerical simulations. Introduction to attitude control. **Offered:** Spring
   b. Pre-requisite: AAE34000 **Co-requisite:** None
   c. Course status: Required

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
   On completing this course the student shall be able to:
   21 Acquire and apply basic technical knowledge about vehicle orientation
   22 Develop intuition about natural spacecraft attitude motion
   23 Introduction to the dynamical basis for attitude control
   24 Extensive computational analysis and interpretation of results
   25 Communication of the analysis techniques and written interpretation of their own results
   26 Explore spin stabilization of a satellite by designing a rotor to accomplish a specific stability objective

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	Yes
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health, and safety, manufacturability, and sustainability	Yes
d	An ability to function on multidisciplinary teams	No
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	Yes

g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. **Topics**:
    1. Introduction to modern spacecraft dynamics (background and motivation)
    2. Fundamental concepts including the mathematical formalism of dyadics and the mechanics of energy and angular momentum; rotational kinematics including direction cosines, Euler angles, and Euler parameters (quaternions) as kinematic variables; coordinate systems and transformations, angular velocity and kinematic differential equations
    3. gravitational interactions between particles and bodies; center of gravity and centrobaric bodies
    4. External Torques on a spacecraft details of gravity torques
    5. Simple spacecraft (axisymmetric and unsymmetric) and dynamic differential equations. Torque-free rotational motion; stability analysis; impact of external torques; spin stabilization; gravity gradient stabilization; dual-spinners; mass movement and momentum exchange techniques (momentum wheels, reaction wheels, control moment gyros); three-axis stabilization
    6. Depending on the launch schedules during the current semester, the projects/homework are correlated to actual spacecraft/missions. Previous missions are used as examples as well.

Revision History

Prepared by: Kathleen C Howell, Date: August 21, 2000
Revised by: Kathleen C. Howell, Date: July 17, 2006
Pre-Req reconciled with Banner: Lisa Crain, Date: October 15, 2010
Format updated: Kathleen C. Howell, February 17, 2012
Format updated: T. Moore, March 19, 2013

1. **AAE 45000: Spacecraft Design**

2. **Credits:** 3
   Contact Hours: Lecture that meets 2 times per week for 50 minutes per meeting for 15 weeks. Lab that meets 1 time per week for 3 hours per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** Professors James Longuski and James Garrison

4. **Textbook:** Supplemental Notes furnished by instructor, Space Mission Analysis and Design, Wertz and Larson (eds.)
   a. **Other supplemental materials:** None

5. **Specific course information**
   a. **Course description**: Senior students perform a team-based spacecraft design, requiring application of the education and skills developed in the aerospace curriculum. Components include analysis methods for preliminary design, development of an initial spacecraft and mission concept, and development of a complete numerical model of the mission, culminating in oral and written reports by the teams. **Offered**: Fall and Spring
   b. **Pre-requisite**: None **Co-requisite:** None
   c. **Course status**: Required, Either/Or Option with AAE 451, Sem 8

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
   On completing this course the student shall be able to:
   1. Understand and implement the design process for aerospace systems
   2. Solve problems as part of a team
   3. Conduct open-ended, iterative tasks associated with spacecraft, rocket and mission design and system integration.
   4. Properly integrate a variety of systems and sub-systems within a spacecraft, rocket and mission to demonstrate design feasibility.
   5. Demonstrate design viability through testing, both real and virtual.
   6. Prioritize design requirements and organize work schedules.
   7. Use formal, structured design methods to develop superior products that meet or surpass customer expectations.
   8. Give oral presentations and write technical reports required of design engineers

   b. Relationship of Course to Program Outcomes

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political,	Yes

	ethical, health, and safety, manufacturability, and sustainability	
d	An ability to function on multidisciplinary teams	Yes
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	No
i	A recognition of the need for, and an ability to engage in life-long learning	No
j	A knowledge of contemporary issues in aerospace engineering	No
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Analysis Methods to be used for Preliminary Spacecraft Design Loads, mass distribution, and center of gravity. Simplified estimation of structural weight. Orbital mechanics above a spherical rotating earth. Newtonian aerodynamics. Skin friction and heat transfer using simplified correlations. Static stability. Lumped heat-capacity model for thermal protection system. Selection among existing propulsion systems. Boost trajectory analysis. Space communications. Instrumentation. Use and adaptation of existing software
2. Development of an Initial Spacecraft and Mission Concept Selection is based on historical background and engineering judgment, plus qualitative studies of vehicle requirements, mission goals, and possible vehicle concepts. Fundamentals of project management. The spacecraft and mission concept will include a number of free parameters, such as vehicle length, slenderness, mass, tank position, orbit selection, power system, attitude precision and so on. First formal report.
3. Development of a Numerical Model for the Vehicle Concept Based on sections 1 and 2, a numerical model must be coded and checked. The concept in section 2 must be sufficiently specific that it is feasible to develop this model in the time available. Validation of model for second formal report
4. Configure Vehicle using Trade Studies based on the Simulations Quantitative trade studies performed using the model. Traceability of design parameters to mission requirements. Risk assessment and cost estimation. Selection of final configuration. Reporting of vehicle characteristics and performance. Final report.

Revision History

Prepared by: Steven P. Schneider, Date: February 16, 2001
Revised by: James M. Longuski, Date: March 31, 2006
Updated Pre-Requisite: March 3, 2011
Format updated: September 2011
Format updated by: T. Moore, March 20, 2013

1. **AAE45100: Aircraft Design**

2. **Credits:** 3
   Contact Hours: Lecture that meets 2 times per week for 50 minutes per meeting for 15 weeks. Lab that meets 1 time per week for 4 hours.

3. **Instructor's or course coordinator's name:** Professors Dominick Andrisani and William Crossley

4. **Textbook:** Raymer, D., *Aircraft Design: A Conceptual Approach*, Fourth Edition, AIAA Education Series, 2006.
   a. **Other supplemental materials:** Notes furnished by instructor

5. **Specific course information**
   a. **Course description:** Senior students perform a team-based aircraft design, requiring application of the knowledge acquired and skills developed in the aerospace curriculum. Aircraft mission requirements include engine cycle selection and airframe/engine integration, performance, stability and control, structures, human factors, avionics, sensors and manufacturing processes. The teams present oral and written reports on their designs. **Offered**: Fall and Spring
   b. **Pre-requisite:** None **Co-requisite:** Senior Standing in AAE
   c. **Course status:** Required, Either/or Option with AAE 45000

6. **Specific goals for the course**
   a. **Student Learning Outcomes**
   On completing this course the student shall be able to:
   27 Understand and implement the design process for aerospace systems
   28 Solve problems as part of a team
   29 Conduct open-ended, iterative tasks associated with aircraft/engine design and airframe/engine integration.
   30 Properly integrate a variety of systems and sub-systems within aircraft to demonstrate design feasibility.
   31 Demonstrate design viability through testing, both real and virtual.
   32 Prioritize design requirements and organize work schedules.
   33 Use formal, structured design methods to develop superior products that meet or surpass customer expectations.
   34 Give oral presentations and write technical reports required of design engineers

   b. **Relationship of Course to Program Outcomes**

	Program Learning Outcomes	**Included?**
a	An ability to apply knowledge of mathematics, science, and engineering	Yes
b	An ability to design and conduct experiments, as well as to analyze and interpret data	No
c	An ability to design an aerospace system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical,	Yes

	health, and safety, manufacturability, and sustainability	
d	An ability to function on multidisciplinary teams	Yes
e	An ability to identify, formulate, and solve aerospace engineering problems	Yes
f	An understanding of professional and ethical responsibility	No
g	An ability to communicate effectively	Yes
h	An understanding of the impact of engineering solutions in a global, economic, environmental, and societal context	Yes
i	A recognition of the need for, and an ability to engage in life-long learning	Yes
j	A knowledge of contemporary issues in aerospace engineering	Yes
k	An ability to use the techniques, skills and modern engineering tools necessary for aerospace engineering practice	Yes

7. Topics

1. Requirements development
2. Concept development-structured design methods, functional requirements, quality function deployment (QFD)
3. Team formation and interaction
4. Weight estimation, cost estimation and constraint diagrams
5. Concept generation and selection; preliminary sizing - Design requirement sensitivities, weight estimation, wing area selection, power/propulsion system requirements
6. Design refinement
7. Technical writing and presentations; design reviews (oral and written reports)
8. Stability and control surface sizing
9. Mission simulation and performance verification
10. Prototype development; real or virtual models and products
11. Design justification via analyses and / or flight verification and
12. Final report

Revision History
Prepared by: William A. Crossley, Date: February 17, 2001
Revised by: Daniel DeLaurentis, Date: September 18, 2006
Updated Pre-Requisite: March 3, 2011
Format updated: September 2011
Updated format: T. Moore, March 20, 2013

1. **<u>CGT 16300 – Introduction of Graphics for Manufacturing</u>**

2. **Credits and contact hours:**
   2 credits
   Lecture that meets 1 time per week for 50 minutes per meeting for 15 weeks.
   Lab prep that meets 1 day per week for 50 minutes per meeting for 15 weeks.
   Laboratory that meets 1 day per week for 100 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:**
   C. Miller

4. **Textbook:** *Fundamentals of CATIA*, Miller, C.L. 3rd Edition, (Available only at the University Bookstore) 2006.

5. **Specific course information**
   a. **Catalog description:** An introductory course in computer graphics applications for mechanical- and aeronautical-related professions. Experiences focus on visualization, sketching, graphic standards, and problem-solving strategies for engineering design. The course will emphasize the proper use of parametric solid modeling for design intent.
   b. **Prerequisites &/or corequisites:** None
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student learning outcomes
   On completing this course the student shall be able to:
   - Demonstrate the knowledge, technical skills and personal discipline required to be successful utilizing sketching abilities for creative problem solving in an engineering environment.
   - To discover miscellaneous solid modeling CAD database issues such as file formats and translations and database management strategies.
   - Demonstrate the knowledge, technical skills and personal discipline required to be successful utilizing visualization abilities for creative problem solving in an engineering environment.
   - Systematically identify, evaluate and solve problems using points, lines, surfaces, and solid geometric forms in the solution of engineering problems.
   - To develop an understanding, and be able to use, common geometric construction techniques when creating 2D and 3D geometric forms for the solution of engineering problems.
   - Acknowledge the history, research, and implications of the engineering design process, as well as the importance of engineering graphics for its successful implementation.
   - To develop skill and proficiency in the ability to present clearly identified solutions using graphical communication conventions and standards in an engineering environment.

b. Relationship of course to program outcomes

(c) an ability to design a system, component, or process to meet desired needs with realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

(g) an ability to communicate effectively

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering

7. Topics

- Introduction to Engineering Graphics / Introduction to 3D Solid Modeling Interfaces
- Basic Workbenches and Visualization
- Orthographic Projection Standards and Conventions / Creating Sketched Geometry Points,
- Lines, & Planes, Auxiliary Views / Geometric & Dimensional Constraints
- Pictorial Projection Systems, & Pictorial Sketches / Creating 3D Solid Geometry
- Isometric Sketches / Revolved 3D Geometry
- Sections Standards and Conventions / Patterns & 3D Transformations
- Dimensioning Standards & Conventions / October or Spring Breaks
- Dimensioning Standards & Conventions / Lofted Surfaces
- Sketch Examination
- Tolerancing Standards & Conventions / CAD Assemblies
- Threads / CAD Working Drawings
- Working Drawings / CAD Exploded Assemblies
- Fasteners & Mechanisms
- Product Lifecycle Management / CAD Practical Examination
- Product Lifecycle Management / Digital Mock Up

Prepared By:..

Date : ....

1. **<u>CHM 11500 – General Chemistry</u>**

2. **Credits and contact hours:**
   4 credits
   Lecture that meets 3 times per week for 50 minutes per meeting for 16 weeks.
   Recitation that meets once per week for 50 minutes per meeting for 16 weeks.
   Laboratory that meets once per week for 150 minutes per meeting for 16 weeks.

3. **Instructor's or course coordinator's name:**
   Ms. Marybeth Miller, Instructional Specialist; Dr. Marcy Towns, Director of General Chemistry

4. **Textbook:** *Chemistry: The Molecular Nature of Matter and Change,* 6th Ed., by M. S. Silberberg, McGraw-Hill, 2012.
   a. Other supplemental materials:
   Chemistry 11500 Laboratory Manual, 2011-2012, Hayden-McNeil Publishing, Inc., 2011.
   Student Laboratory Notebook, Hayden-McNeil Publishing, Inc., 2012.

5. **Specific course information**
   - **a. Catalog description:** Stoichiometry; atomic structure; periodic properties; ionic and covalent bonding; molecular geometry; gases, liquids, and solids; crystal structure; thermochemistry; descriptive chemistry of metals and non-metals. Required of students majoring in science and students in engineering who are not in CHM 12300.
   - **b. Prerequisites:** MA 15900; **Co-requisites:** MA 16100 or 22300
   - **c. Course status:** Required

6. **Specific goals for the course**
   a. Student learning outcomes
   On completing this course the student will be able to:
   - Develop a broad understanding of energy, fuels and the chemical basis of biochemical processes.
   - Develop a basic knowledge of nuclear chemistry and kinetics and energetics of nuclear decay.
   - Learn the fundaments of atomic structure, bonding, Lewis structures, and the VSEPR model for predicting molecular structures.
   - Build on this molecular background and discuss hydrocarbons, organic functional groups, and polymers, then use bond energies to discuss the molecular sources of energy in exothermic reactions
   - Develop an introductory knowledge of inter-molecular forces and of biochemical molecules to enable discussion of solution properties, the chemical basis for biochemical reactions, how typical drugs function, and shape recognition.
   - Learn the basic structures of simple inorganic solids and use these to describe metals, semiconductors, insulators, solar cells, and solar energy.

   b. Relationship of course to program outcomes
   (a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

7. Topics

- Introduction/Review of Chemistry Concepts
- Review of Chemistry Concepts
- Nuclear Reactions and Their Applications
- Quantum Theory and Atomic Structure
- Electron Configuration and Chemical Periodicity
- Models of Chemical Bonding
- The Shapes of Molecules
- Theories of Covalent Bonding
- Ultraviolet/Visible Spectroscopy
- Intermolecular Forces: Liquids, Solids, and Phase Changes
- Organic Compounds and the Atomic Properties of Carbon
- The Properties of Mixtures: Solutions and Colloids
- Infrared Spectroscopy
- Intermolecular Forces: Liquids, Solids, and Phase Changes

Lab

- Check-in; Safety Procedures; Review of Course Policies; Course Packet
- Characterization of Compounds from Chemical Interactions
- Reenactment of an 18th Century Analysis: Amount of Acid in Solution
- Chemical Synthesis
- Preparing and Standardizing a Solution
- Enthalpy of Solutions
- Molecular Structure and Geometry
- Spectrophotometric Analysis
- Where's The Iron?
- Models of the Solid State: Visualizing Crystal Structures
- Investigation of Polymers
- Gold Nanoparticles

- Prepared By: ....
- Date : ....

1. **CS 15900 – Programming Applications for Engineers**

2. **Credits and contact hours:**
   3 credits
   Lecture that meets 2 times per week for 50 minutes per meeting for 15 weeks.
   Laboratory that meets 1 day per week for 110 minutes per meeting for 15 weeks.
3. **Instructor's or course coordinator's name:**
   W. Crum
4. **Textbook(s):** Course Notes Package.
   a. **Other supplemental materials:** none

5. **Specific course information**
   a. **Catalog description:** Fundamental principles, concepts and methods of programming (C and MATLAB), with emphasis on applications in the physical sciences and engineering. Basic problem solving and programming techniques; use of programming logic in solving engineering problems. Students are expected to complete assignments in a collaborative learning environment.
   b. **Prerequisites:** Co-Requisite: ENGR 13200
   c. **Course status:** Science Selective (FYE)

6. **Specific goals for the course**
   a. Student learning outcomes
   On completing this course the student shall be able to:
   - Demonstrate competency in the fundamental principles, concepts and methods of programming (C and MATLAB), with emphasis on applications in the physical science and engineering.
   - Demonstrate the ability to function as part of a technical team
   - Explore programming concepts in various computing environments and implement the concepts across more than one language.

   b. Relationship of course to program outcomes
   (a) an ability to apply knowledge of mathematics, science and engineering
   (d) an ability to function on multidisciplinary teams

7. Topics:

- **MATLAB Review from ENGR 13200 (1 week)**
  - MATLAB Desktop, M-Files
  - Variables, Assignment, Expressions
  - If selection construct
  - For repetition construct
- **Structured Programming Concepts (5 weeks)**
  - Top down design
  - Calling functions, passing values to functions
  - Pass by value/address
  - Using structure charts to design functions to solve a problem
  - Logical and relational operators.
  - Two-way and multi-way selection.

- Pretest and post-test repetition.
- Recursion.

- **Other Data Structures (2 weeks)**
  - Character arrays (strings).
  - Substring searching/Pattern matching.
  - Structs and arrays of structs.
- **Structured Programming Problem-Solving (1 week)**
  - Flowcharting
    - Need for Selection and Repetition
  - Relational and Logical Operators and Expressions
  - Developing and Efficient Algorithm to Problems with no Unique Solution
- **File I/O (1 week)**
  - Obtaining data from an external file and producing output to a destination other than the monitor
  - End of file detection
  - Using standard file I/O functions
- **Pointers and Pointer Applications (1 week)**
  - Pointers and pass by address.
  - Pointer value assignment.
  - Dynamic memory allocation, overcoming the limitations of static memory allocation.
  - Pointers, arrays, and pointer arithmetic.
  - Returning pointer values from a function
- **The Transition to C, Structure of a C Program (1 week)**
  - Computer Hardware Fundamentals
  - The Idea of a Programming Language
  - The Compiler • Intro to the C Language
  - Data types
  - Symbolic Constants
  - Standard Input/Output Functions
  - Error Types
  - Expressions, Operators, Operands, Precedence

- **Dealing with Large Amounts of Data (2 weeks)**
  - Retaining and manipulating larger data sets in memory.
  - Single and multi-dimensional arrays.
  - Static memory allocation.
  - Data sorting algorithms: bubble, selection, and insertion.
  - Data searching algorithms: linear and binary.
  - Analysis of algorithms that utilize arrays.

- **Prepared By: ....**

- **Date :..**

1. **<u>ENGL 10600 – Introductory Composition</u>**

2. **Credits and contact hours:**
   4 credits
   Lecture – 2 days per week at 50 minutes for 15 weeks.
   Recitation – 1 day per week at 50 minutes for 15 weeks.

3. **Instructor's or course coordinator's name:** A. Hawkins

4. **Textbook(s):**
   Richard Bullock, *The Norton Fieldguide to Writing, With Readings and Handbook,* 2nd edition (Norton Publishers)
   Mark Z. Danielewski, *House of Leaves,* 2nd edition (Pantheon Publishers)

5. **Specific course information**
   a. **Catalog description:** Extensive practice in writing clear and effective prose. Instruction in organization, audience, style, and research-based writing.
   b. **Prerequisites &/or co-requisites:** None
   c. Course status: Required

6. **Specific goals for the course**
   a. Student learning outcomes
   On completing this course the student shall be able to:
   - produce between **7,500-11,500** words of *polished* writing (or **15,000-22,000** total words, including drafts) or the equivalent. Some of this text production will be done using multimedia, and some of it may be given through short assignments. Your writing topics will be closely tied to the course's theme or approach, and may include personal experiences as well as research-based arguments. On the surface we are here to practice our communication, but don't forget we're also here to explore, to expand and enliven our potential as great thinkers and (inevitably) movers in our world.
   - conduct different types of research and create a final project that demonstrates the expertise you have gained over the semester. So, we will be using planning assignments in order to help you discover and explore a topic, perspective, or audience. We will also spend some time in exploration of topics and rhetorical contexts, and in the production, interpretation, and analysis of multimedia environments.
   - read and discuss writing by you, your peers, and professionals. This reading and discussion will be accomplished through in-class review sessions or in bi-weekly conferences.

   b. Relationship of course to program outcomes
   (g) an ability to communicate effectively
   (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
   (i) a recognition of the need for, and an ability to engage in life-long learning

7. Topics

Critical Thinking and Analytical Writing in Different Genres

- Essay #1 - Calvin and Hobbes Diagnostic Writing Assignment

- Essay #2 - Textual Analysis or Reporting Information

- Essay #3 - Arguing a Position or Evaluations
- Mid-Term Exam
  - Question 1 text - "Dagon" by H.P. Lovecraft
  - Question 2 text - "The College Bound Kid"

- House of Leaves Unit
  - Reading Response Discussion Board

- Final Project - Argumentative Research Paper
  - Annotated Bibliography - Due on Friday, April 13

➢ Three Essays (5 percent each)	15%
➢ *House of Leaves* Unit: Four response papers 5% each)	20%
➢ Mid-term exam with literary analysis	15%
➢ Class discussion/occasional quizzes/attendance	20%
➢ One in-depth final research project	30%

Prepared By: Song No ....

Date : July 20, 2012...

1. **<u>ENGR 13100 – Transforming Ideas to Innovation I</u>**

2. **Credits and contact hours:**
   2 credits; Studio that meets 2 times per week for 110 minutes per meeting for 16 weeks.

3. **Instructor's or course coordinator's name:** Faculty Course Coordinators: Prof. Matthew Ohland and Prof. Monica Cardella; Other Faculty Instructors: Robin Adams, Monica Cox, Bill Oakes, Larry Nies, Senay Purzer, Ruth Streveler; Staff Instructional Team: Eric Holloway, Jim Whitford, Lynn Hegewald, Patrick La Petina

4. **Textbook(s):**
   Ideas to Innovation, 3rd Edition, H. Moore/Purdue, Pearson Education, ISBN 1-256-75227-4.

5. **Specific course information**
   a. **Catalog description:** A partnership between Schools and Programs within the College of Engineering, introduces students to the engineering professions using multidisciplinary, societally relevant content. Developing engineering approaches to systems, generating and exploring creative ideas, and use of quantitative methods to support design decisions. Explicit model-development activities (engineering eliciting activities, EEAs) engage students in innovative thinking across the engineering disciplines at Purdue. Experiencing the process of design and analysis in engineering including how to work effectively in teams. Developing skills in project management, engineering fundamentals, oral and graphical communication, logical thinking, and modern engineering tools (e.g., Excel and MATLAB).
   b. **Prerequisites &/or co-requisites:** None
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student learning outcomes: Students will be able to:
   - Examine and analyze career information from various resources to make informed decisions about which engineering discipline to pursue
   - Explain the critical role of cross-cultural and multidisciplinary teamwork in nurturing diverse perspectives and the creation of innovative engineering solutions that meets the needs of diverse users.
   - Reflect on your teamwork and leadership abilities, recognizing how your behavior impacts the whole team, and making team process adjustments whenever necessary.
   - Explain critical and diverse uses of modeling in engineering to understand problems, represent solutions, compare alternatives, make predictions, etc.
   - Use multiple models, estimation, and logic to triangulate and evaluate information coming from various data sources.
   - Collect, analyze, and represent data to make informative explanations and persuasive arguments.
   - Implement iterative processes, rich information gathering, and multiple modes of modeling when solving complex design problems.
   - Use systematic methods to develop design solutions and compare design alternatives.

- Consider the interconnectedness among social, economic, and environmental factors (in the context of sustainability or systems) when solving engineering problems.

b. Program Outcomes addressed by the course:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

7. Topics:

- Introduction to Engineering; careers in engineering; potential majors in engineering
- Teaming: team roles, teaming skills, team evaluation, diversity
- Information literacy
- Engineering ethics
- Sustainability concepts in Engineering
- Basic Excel skills: interface, calculations, data structures, cell addressing, vectors and arrays, formulas and calculations
- Basic MATLAB skills: interface, calculations, naming conventions, data formatting, functions, vectors and matrices, data structures
- Data handling: descriptive statistics, distributions, histograms, manipulation and calculation in Excel and MATLAB
- Mathematical models: model creation and development skills; use of models for solving engineering problems; generalizability, shareability, reusability, and modifiability of models; reporting and technical communication of designed models
- Design process skills: need-finding, problem scoping and definition, concept generation, concept evaluation, iteration, analysis and evaluation, concept reduction, prototyping
- Feedback, reflection, and iteration in engineering and design work
- Major design project to practice and model skills, including final oral presentation and written communication (full report and executive summary)
- Communications skills: Creating professional charts, figures, and plots in Excel and MATLAB; Oral presentations (with major design project); Written technical communication and executive summary (with mathematical modeling exercises and major design project).

Prepared By: Stephen Hoffmann, Assistant Head for First Year Engineering, 12 April 2013

1. **<u>ENGR 13200 – Transforming Ideas to Innovation II</u>**

2. **Credits and contact hours:**
   2 credits; Studio that meets 2 times per week for 110 minutes per meeting for 16 weeks.

3. **Instructors:** Faculty Course Coordinator: Prof. Heidi Diefus-Dux; Other Faculty Instructors: Brent Jesiek, Bill Oakes, Matt Ohland, Krishna Madhavan, Alice Pawley, Staff Instructional Team: Eric Holloway, Jim Whitford, Lynn Hegewald, Patrick La Petina

4. **Textbook:**
   Ideas to Innovation, 3rd Edition, H. Moore/Purdue; Pearson Education, ISBN 1-256-75227-4

5. **Specific course information**
   a. **Catalog description:** A partnership between Schools and Programs within the College of Engineering continues building on the foundation developed in ENGR 13100. Students take a more in depth and holistic approach to integrating multiple disciplines perspectives while constructing innovative engineering solutions to open-ended problems. Extending skills in project management engineering fundamentals, oral and graphical communication, logical thinking, team work, and modern engineering tools (e.g., Excel and MATLAB).
   b. **Prerequisites:** ENGR 13100 (grade of C or better)
   c. **Course status:** Required

6. **Specific goals for the course**
   a. Student learning outcomes: Successful completion of this course will enable you to use, create, and explore tools, particularly computer tools, in modeling, problem solving, and design. More specifically, this course will enable you to:
   - Develop a logical problem-solving process that includes sequential structures, conditional structures, and repetition structures for fundamental engineering problems
   - Translate a written problem statement into a mathematical model
   - Solve fundamental engineering problems using computer tools
   - Employ design and problem processes in modeling, problem-solving, and design work
   - Work effectively and ethically as a member of a technical team
   - Develop a work ethic appropriate to the engineering profession
   - Evaluate and provide feedback to improve solutions to engineering problems
   - Reflect on personal and team performance to achieve continuous improvement
   - Demonstrate an ability to engage in continuing professional development.

   b. Program outcomes addressed by the course:
   (b) an ability to design and conduct experiments, as well as to analyze and interpret data
   (d) an ability to function on multidisciplinary teams
   (e) an ability to identify, formulate, and solve engineering problems
   (f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

7. Topics:

- More advanced MATLAB skills: Vector and array manipulations, relational and logical operators, decision and repetition structures, user-defined functions, graphical-user interfaces (GUIs)
- Mathematical modeling: model creation, model development, model communication, use of models for solving engineering problems, generalizability, shareability, reusability, modifiability
- Making evidence-based decisions
- Flowcharting and logical decision-making
- Conversion of flowchart logic to MATLAB programs: if structures, for loops, while loops, complex loops, nested loops
- Data handling: descriptive statistics (histograms, cumulative distributions), regression (theory, regression to various types of functions in Excel and MATLAB), function forms (linear, power, exponential, logarithmic) and function discovery
- Major design project using MATLAB and GUIDE (for creating GUIs) to design a deliverable for an external client; design skills and design process (need-finding, problem scoping and definition, concept generation, concept evaluation, iteration, analysis and evaluation, concept reduction, prototyping and storyboarding, peer evaluation and feedback) embedded in project activities.

Prepared By: Stephen Hoffmann, Assistant Head for First Year Engineering, 16 April 2013

1. **<u>MA 16500 – Analytic Geometry and Calculus I</u>**

2. **Credits and contact hours:**
   4 credits
   Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.
   Recitation that meets once per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:**
   N. K. Yip, Chair, Calculus Committee

4. **Textbook:** *Calculus - Early Transcendentals,* 7th EDITION (Purdue University
5. Edition with 3-term EWA Card ISBN 1-133-16646-6), Stewart, Brooks Cole.
   a. **Other supplemental materials:** none

6. **Specific course information**
   a. **Catalog description:** Introduction to differential and integral calculus of one variable, with applications. Conic sections. Designed for students who have had at least a one-semester calculus course in high school, with a grade of "A" or "B", but not qualified to enter MA 16200 or MA 16600, or the advanced placement courses MA 17300 or MA 27100, or the honors calculus course MA 18100.
   b. **Prerequisites:** Demonstrated competency in college algebra, trigonometry at the level of MA 15100.
   c. **Course status:** Required

7. **Specific goals for the course**
   a. Student learning outcomes
      On completing this course the student shall be able to:
   - obtain the skills necessary to deal with models in engineering and science involving *differential calculus of one variable*.
   - gain a familiarity with the *elementary special functions* (e.g. exponential, log, and trigonometric functions) which arise in engineering and science.
   - learn the basic calculus concepts concerning *growth* and *decay* which are pursued in later courses.
   - learn the notion of Riemann sums in order to understand the development of many models in engineering and science which arise this way.

   b. Relationship of course to program outcomes
      (a) an ability to apply knowledge of mathematics, science, and engineering.

Topics

1. Functions and Models.
1.1 Four Ways to Represent a Function.
1.3 New Functions from Old Functions.
1.5 Exponential Functions.
1.6 Inverse Functions and Logarithms.
2. Limits and Derivatives.
2.2 The Limit of a Function.
2.3 Calculating Limits Using the Limit Laws.
2.5 Continuity.

2.6 Limits at Infinity; Horizontal Asymptotes.
2.7 Derivatives and Rates of Change.
    Writing Project: Early Methods for Finding Tangents.
2.8 The Derivative as a Function.
3. Differentiation Rules.
3.1 Derivatives of Polynomials and Exponential Functions.
    Applied Project: Building a Better Roller Coaster.
3.2 The Product and Quotient Rules.
3.3 Derivatives of Trigonometric Functions.
3.4 The Chain Rule.
    Applied Project: Where Should a Pilot Start Descent?
3.5 Implicit Differentiation.
    Laboratory Project: Families of Implicit Curves
    3.6 Derivatives of Logarithmic Functions.
3.7 Rates of Change in the Natural and Social Sciences.
3.8 Exponential Growth and Decay.
3.9 Related Rates.
3.10 Linear Approximations and Differentials.
    Laboratory Project: Taylor Polynomials.
    3.11 Hyperbolic Functions.
4. Applications of Differentiation.
4.1 Maximum and Minimum Values.
    Applied Project: The Calculus of Rainbows.
4.2 The Mean Value Theorem.
4.3 How Derivatives Affect the Shape of a Graph.
4.4 Indeterminate Forms and L'Hospital's Rule.
    Writing Project: The Origins of L'Hospital's Rule.
4.5 Summary of Curve Sketching.
4.7 Optimization Problems.
    Applied Project: The Shape of a Can.
4.9 Antiderivatives.
5. Integrals.
5.1 Areas and Distances.
5.2 The Definite Integral.
    Discovery Project: Area Functions.
5.3 The Fundamental Theorem of Calculus.
5.4 Indefinite Integrals and the Total Change Theorem.
    Writing Project: Newton, Leibniz, and the Invention of Calculus.
5.5 The Substitution Rule
10. Parametric Equations and Polar Coordinates
    10.5 Conic Sections
Appendix A – Numbers, Inequalities, and Absolute Values
Appendix B – Coordinate Geometry and Lines
Appendix C – Graphs of Second-Degree Equations

- Prepared by: N. K. Yip, July 12, 2012

1. **<u>MA 16600- Analytic Geometry and Calculus II</u>**

2. **Credits and contact hours:**
   4 credits
   Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.
   Recitation that meets once per week for 50 minutes per meeting for 15weeks.

3. **Instructor's or course coordinator's name:**
   N. K. Yip, Chair, Calculus Committee

4. **Textbook:** *Calculus - Early Transcendentals,* 7th EDITION (Purdue University Edition with 3-term EWA Card ISBN 1-133-16646-6), Stewart, Brooks Cole.
   a. **Other supplemental materials:** none

5. **Specific course information**
   a. **Catalog description:** Continuation of MA 16500. Vectors in two and three dimensions. Techniques in integration, infinite series, polar coordinates, surfaces in three dimensions. Not open to students with credit in MA 16200.
   b. Prerequisites: MA 16500 Analytic Geometry and Calculus I.
   c. Course status: Required

6. **Specific goals for the course**
   a. Student learning outcomes
   On completing this course the student shall be able to:
   - Learn the basic notions used in vector algebra which are needed in their early courses in engineering and science, and which are also needed later in the development of vector calculus.
   - Learn techniques of integration which are needed to compute basic integrals in engineering and science.
   - Apply integration to compute geometric and physical quantities of importance in science and engineering.
   - Learn the basic ideas in sequences and series which will be needed in later studies of Fourier analysis and signal processing.

   b. Relationship of course to program outcomes
   (a) an ability to apply knowledge of mathematics, science, and engineering.

7. **Topics**

- Vectors and the Geometry of Space
  - Vectors
  - The Dot Product
- Applications of Integration
  - Areas Between Curves

    - Volumes
    - Volumes by cylindrical shells
    - Work
    - Average value of a function
- Techniques of Integration
    - Integration by Parts
    - Trigonometric Substitution
    - Integration of Rational Functions by Partial Fractions
    - Integration Using Tables and Computer Algebra Systems
    - Approximate Integration
    - Inproper Integrals
- Further Applications of Integration
    - Arc Length
    - Area of a Surface of Revolution
    - Applications to Physics and Engineering
- Infinite Sequences and Series
    - Sequences
    - Series
    - The Integral Test and Estimates of Sums
    - Alternating Series
    - Absolute Convergence and the Ratio and Root Tests
    - Strategy for Testing Series
    - Representations of Functions as Power Series
    - Taylor and Maclaurin Series
- Parametric Equations and Polar Coordinates
    - Curves Defined by Parametric Equations
    - Calculus with Parametric Curves
    - Polar Coordinates
    - Conic Sections

- Prepared By: **N. K. Yip**
- Date : **July 12, 2012**

1. **<u>MA 26100 – Multivariate Calculus</u>**

2. **Credits and contact hours:**
   4 credits
   Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.
   Recitation that meets once per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:**
   N. K. Yip, Chair, Calculus Committee

4. **Textbook:** *Calculus - Early Transcendentals* (Purdue University Edition with 3-term EWA Card ISBN 0538781122) , 7th edition, Stewart, Brooks Cole
   a. **Other supplemental materials:** none

5. **Specific course information**
   a. **Catalog description:** Planes, lines, and curves in three dimensions. Differential calculus of several variables; multiple integrals. Introduction to vector calculus. Not open to students with credit in MA 17400 or 27100.
   b. Prerequisites: MA 16200 or MA 16600 or MA 17300 or MA 18100 or MATH 16400 or MA 17100 or MA 16400 or MATH M2160 or MA 16900.
   c. Course status: Required

6. **Specific goals for the course**
   b. Student learning outcomes
   On completing this course the student shall be able to:
   - develop the concepts of vector calculus which are needed in the studies of many areas of engineering and science such as dynamics and electromagnetic field theory. These include properties of the gradient of a scalar field, line and surface integration, and Green's Theorem.

   - apply calculus techniques in elementary problems of optimization in several variables.

   b. Relationship of course to program outcomes
   (a) an ability to apply knowledge of mathematics, science, and engineering
   (e) an ability to identify, formulate, and solve engineering problems

7. **Topics**
   Vectors and the Geometry of Space
   - Three-Dimensional Coordinate Systems
   - Vectors
   - The Dot Product
   - The Cross Product
   - Equations of Lines and Planes
   - Cylinders and Quadric Surfaces

   Vector Functions
   - Vector Functions and Space Curves

- Derivatives and Integrals of Vector Functions
- Arc Length and Curvature
- Motion in Space: Velocity and Acceleration

Partial Derivatives

- Functions of Several Variables
- Limits and Continuity
- Partial Derivatives
- Tangent Planes and Linear Approximations
- The Chain Rule
- Directional Derivatives and the Gradient Vector
- Maximum and Minimum Values
- Lagrange Multipliers

Multiple Integrals

- Double Integrals over Rectangles
- Iterated Integrals
- Double Integrals over General Regions
- Double Integrals in Polar Coordinates
- Applications of Double Integrals
- Surface Area
- Triple Integrals
- Triple Integrals in Cylindrical Coordinates

Vector Calculus

- Vector Fields
- Line Integrals
- The Fundamental Theorem for Line Integrals
- Green's Theorem

Curl and Divergence

- Parametric Surfaces and Their Areas
- Surface Integrals
- Stokes' Theorem
- The Divergence Theorem

- Prepared By: **N. K. Yip**
- Date________: **July, 12, 2012**

1. **<u>MA 26500 - Linear Algebra</u>**

2. **Credits and contact hours:**
   3 credits
   Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's:**
   N. K. Yip, Chair, Calculus Committee

4. **Textbook:** *Elementary Linear Algebra and Applications*, B. Kolman and D. Hill, 9th ed., Prentice Hall, 2008. (Purdue Custom Edition, includes Matlab Workbook and WebAssign Access Card).
   a. **Other supplemental materials:** none

5. **Specific course information**
   a. **Catalog description:** Introduction to linear algebra. Systems of linear equations, matrix algebra, vector spaces, determinants, eigenvalues and eigenvectors, diagonalization of matrices, applications. Not open to students with credit in MA 26200, MA 27200, MA 35000 or MA 35100.
   b. Prerequisites: MA 16200, or MA 16600 of MA 17300.
   c. Course status: Option for Required Course

6. **Specific goals for the course**

   a. Student learning outcomes
   On completing this course the student shall be able to:
   - develop the algebra skills necessary to solve linear algebraic systems and linear systems of differential equations.
   - develop the matrix algebra skills necessary to do computational linear algebra.
   - obtain an understanding of the linear algebra structure underlying the theories of differential equations, Fourier analysis, and other areas of applied mathematics.

   b. Relationship of course to program outcomes
   - (a) an ability to apply knowledge of mathematics, science, and engineering

7. **Topics:**
   1 - Linear Equations and Matrices
   2 - Solving Linear Systems
   3 - Determinants
   4 - Real Vector Spaces
   5 - Inner Product Spaces
   6 - Linear Transformations and Matrices
   7 - Eigenvalues and Eigenvectors
   8 - Applications of Eigenvalues and Eigenvectors (Optional)
   9 - MATLAB for Linear Algebra

10 - MATLAB Exercises
APPENDIX B Complex Numbers

- Prepared By: **N. K. Yip**
- Date : **July 12, 2012**

1. **<u>MA 26600 – Ordinary Differential Equations</u>**

2. **Credits and contact hours:**
   3 credits
   Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:**
   N. K. Yip, Chair, Calculus Committee

4. **Textbook:** *Elementary Differential Equations and Boundary Value Problems*, by Boyce and DiPrima,
   9th Edition, Wiley, 2006.
   b. **Other supplemental materials:**
      None
5. **Specific course information**
   a. **Catalog description:** First order equations, second and n-th order linear equations, series solutions, solution by Laplace transform, systems of linear equations. It is preferable but not required to take MA 26500 either first or concurrently. Not open to students with credit in MA 26200, 27200, 36000, 36100, or 36600.
   b. **Prerequisites:** MA 26100 Multivariate Calculus
   c. **Course status:** Option for Required Course or Required *(School choice)*

6. **Specific goals for the course**
   c. Student learning outcomes
      On completing this course the student shall be able to:
      - learn the standard methods of solving differential equations of the type which occur in many areas of engineering and science.
      - learn transform methods which are used in numerous engineering problems such as mechanical systems and circuit theory.
      - learn the standard theory of solving basic linear systems of differential equations such as those arising in fluid flow.
   d. Relationship of course to program outcomes
      - (a) an ability to apply knowledge of mathematics, science, and engineering

7. **Topics**

Introduction
1.1 Some Basic Mathematical Models; Direction Fields
1.2 Solutions of Some Differential Equations
1.3 Classification of Differential Equations

First Order Differential Equations
2.1 Linear Equations; Method of Integrating Factors
2.2 Separable Equations

2.3 Modeling with First Order Equations
2.4 Differences Between Linear and Nonlinear Equations
2.5 Autonomous Equations and Population Dynamics
2.6 Exact Equations and Integrating Factors
2.7 Numerical Approximations: Euler's Method

Second Order Linear Equations
3.1 Homogeneous Equations with Constant Coefficients
3.2 Fundamental Solutions of Linear Homogeneous Equations; The Wronskian
3.3 Complex Roots of the Characteristic Equation
3.4 Repeated Roots; Reduction of Order
3.5 Nonhomogeneous Equations; Method of Undetermined Coefficients
3.6 Variation of Parameters
3.7 Mechanical and Electrical Vibrations
3.8 Forced Vibrations

Higher Order Linear Equations
4.1 General Theory of nth Order Linear Equations
4.2 Homogeneous Equations with Constant Coefficients
4.3 The Method of Undetermined Coefficients

The Laplace Transform
6.1 Definition of the Laplace Transform
6.2 Solution of Initial Value Problems
6.3 Step Functions
6.4 Differential Equations with Discontinuous Forcing Functions
6.5 Impulse Functions
6.6 The Convolution Integral

Systems of First Order Linear Equations
7.1 Introduction
7.2 Review of Matrices
7.3 Systems of Linear Algebraic Equations; Linear Independence, Eigenvalues, Eigenvectors
7.4 Basic Theory of Systems of First Order Linear Equations
7.5 Homogeneous Linear Systems with Constant Coefficients?
7.6 Complex Eigenvalues
7.7 Fundamental Matrices
7.8 Repeated Eigenvalues
7.9 Nonhomogeneous Linear Systems

- **Prepared By: N. K. Yip, July 12, 2012**

1. **<u>MA 30400 – Differential Equations and Analysis of Nonlinear Systems for Engineering and the Sciences</u>**

2. **Credits and contact hours:**
   3 credits
   Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:**
   P. Stefanov, Chair, Advanced Services Committee

   Q. Textbook: *Elementary Differential Equations and Boundary Value Problems* (Binder Ready with Wiley Plus, ISBN 978-9-470-40421-8) 9th edition, Boyce and DiPrima, 2006.

   a. **Other supplemental materials:** None

   R. Specific course information

   a. **Catalog description:** This is a differential equations course designed to follow MA 26500-26600. Same description as MA 30300 except that material on the qualitative behavior of solutions to nonlinear systems is substituted for material on Laplace transforms and numerical methods. Not open to students with credit in MA 30300.
   b. **Prerequisites:** MA 26200 and MA 27200
   c. Course status: Required

   S. Specific goals for the course

   c. Student learning outcomes

   On completing this course the student shall be able to:

   - use more advanced techniques for solving differential equations and systems. These include series solutions and applications to Bessel's equation.
   - use Fourier series and learn how to apply the theory to solving partial differential equations.
   - use standard numerical methods to solve differential equations.
   - determine the stability of solutions to nonlinear systems.

   d. Relationship of course to program outcomes
   (a) an ability to apply knowledge of mathematics, science, and engineering

   T. Topics

   Systems of First Order Linear Equations

   7.1 Introduction
   7.2 Review of Matrices
   7.3 Systems of Linear Algebraic Equations; Linear Independence, Eigenvalues, Eigenvectors
   7.4 Basic Theory of Systems of First Order Linear Equations
   7.5 Homogeneous Linear Systems with Constant Coefficients?
   7.6 Complex Eigenvalues

7.7 Fundamental Matrices
7.8 Repeated Eigenvalues
7.9 Nonhomogeneous Linear Systems
Numerical Methods
8.1 The Euler or Tangent Line Method
8.2 Improvements on the Euler Method
8.3 The Runge-Kutta Method
Nonlinear Differential Equations and Stability
9.1 The Phase Plane: Linear Systems
9.2 Autonomous Systems and Stability
9.3 Locally Linear Systems
9.4 Competing Species
9.5 Predator-Prey Equations
Partial Differential Equations and Fourier Series
10.1 Two-Point Boundary Value Problems
10.2 Fourier Series
10.3 The Fourier Convergence Theorem
10.4 Even and Odd Functions
10.5 Separation of Variables; Heat Conduction in a Rod
10.6 Other Heat Conduction Problems
10.7 The Wave Equation: Vibrations of an Elastic String
10.8 Laplace's Equation
Boundary Value Problems and Sturm-Liouville Theory
11.1 The Occurrence of Two-Point Boundary Value Problems
11.2 Sturm-Liouville Boundary Value Problems

- Prepared By: **P. Stefanov**
- Date : **July, 12, 2012**

1. **<u>ME 20000 – Thermodynamics I</u>**

2. **Credits and contact hours:**3 credits, Lecture that meets 3 times per week for 50 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:** E. A. Groll

4. **Textbook(s):**
   Fundamentals of Engineering Thermodynamics, 7th edition, M. J. Moran, H. N. Shapiro, D. D. Boettner, and M. Bailey, Wiley and Sons.
   a. Other supplemental materials: none

5. **Specific course information**
   a. **Catalog description:** First and second laws, entropy, reversible and irreversible processes, properties of pure substance. Application to engineering problems.
   b. **Prerequisites:** CHM 11500; **Concurrent Prerequisite:** MA 26100 and ENGR 13200
   c. **Course status:** Required

6. **Specific goals for course**
   a. Student learning outcomes
   On completing this course the student shall be able to:
   - Provide a thorough understanding of the basic concepts of thermodynamics (i.e., 1st and 2nd law).
   - Apply the basic concepts of thermodynamics to the solution of practical problems in a social context.
   - Develop a systematic approach to problem-solving skills.

   b. Specific goals for the course
   (a) an ability to apply knowledge of mathematics, science and engineering
   (e) an ability to identify, formulate, and solve engineering problems
   (g) an ability to communicate effectively

7. **Topics**

Lecture		**Reading**	**Problems**
1	Syllabus, systems, definitions	1.1-1.3	SP1; 1.5, 1.6, .16
2	Units, specific volume, pressure	1.4-1.6	SP2; 1.31, 1.36
3	Temperature, problem solving	1.7-1.9	SP3; 1.45, 1.51
4	Mechanical concepts of energy, work	2.1-2.2.2	SP4; 2.10, 2.21
5	Expansion/compression work, other examples of work	2.2.3-2.2.8	SP5; 2.33, 2.34, 2.35
6	Total energy, internal energy, heat transfer	2.3-2.4	SP6; 2.30, 2.42
7	Energy balance for closed systems	2.5	SP7; 2.58, 2.63
8	Energy analysis of cycles	2.6	SP8; 2.77, 2.82
9	Evaluating properties	3.1-3.3	SP9; 3.8,3.12
10	Property tables	3.4-3.5	SP10; 3.24, 3.37
11	Internal energy and enthalpy, energy balance	3.6,3.8	SP11; 3.40, 3.44, 3.53

12	Specific heats, incompressible substances	3.9-3.10	SP12; 3.83,3.87
13	**Exam 1: Covers lectures 1-10**		
14	Compressibility chart and factors, ideal gas model	3.11-3.12	SP14; 3.101, 3.108
15	Ideal gas properties, polytropic processes	3.13-3.15	SP15; 3.123, 3.128
16	Control volume analysis (steady-state); mass conservation	4.1-4.3	SP16; 4.6, 4.11
17	Conservation of energy for control volume	4.4-4.5	SP17; 4.23, 4.27
18	Nozzles, diffusers	4.6	SP18; 4.31, 4.39
19	Turbines, compressors, pumps	4.7-4.8	SP19; 4.41, 4.53, 4.65
20	Heat exchangers, throttling devices	4.9-4.10	SP20; 4.70, 4.77
21	System Integration	4.11	SP21; 4.91, 4.97
22	Introducing the second law, irreversibilities	5.1-5.4	SP22; 5.3, 5.6, 5.8
23	Thermodynamic cycles and second law	5.5-5.7	SP23; 5.20, 5.35
24	Temperature scales, maximum performance measures	5.8-5.9	SP24; 5.51, 5.61
25	Carnot cycle, Clausius inequality and significance	5.10-5.11	SP25; 5.77, 5.83
26	**EXAM 2: Covers Lectures 1 - 22,**		
27	Entropy as a property	6.1-6.2	SP27; 6.1, 6.2
28	T-ds relations, incompressible substances	6.3-6.4	SP28; 6.11, 6.17
29	Entropy change of ideal gases	6.5	SP29; 6.21, 6.27
30	Internally reversible processes, closed system balance	6.6-6.7	SP30; 6.47, 6.64, 6.65
31	Entropy increase principle, open system balance	6.8-6.10.1	SP31; 6.82, 6.88
32	Applications of rate balance to open systems	6.10.2	SP32; 6.99, 6.103, 6.109
35	Isentropic processes	6.11	SP33; 6.125, 6.129
33	Isentropic efficiencies	6.12	SP34; 6.132, 6.140
35	Heat transfer and work in reversible flow processes	6.13	SP35; 6.174, 6.180
36	Vapor power systems; Rankine cycle	8.1-8.2	SP36; 8.10, 8.14
37	Superheat and reheat	8.3	SP37; 8.28, 8.33
38	**EXAM 3: Covers Lectures 1 - 34,**		
39	Vapor-compression refrigeration systems	10.1-10.2	SP39; 10.6, 10.18
40	Heat pump systems	10.6	SP40; 10.39, 10.42
41	Air standard cycle, I.C. engines, Otto cycle	9.1-9.2	SP41; 9.6, 9.12
42	Diesel cycle, Dual Cycle	9.3-9.4	SP42; 9.22, 9.31
43	Brayton cycle	9.5-9.6	SP43; 9.44, 9.54
44	Course review		
	Final exam		

- **Prepared By:**
- **Date :**

1. **PHYS 17200 – Modern Mechanics**

2. **Credits and contact hours:**
   4 credits
   Lecture – 2 times per week for 50 minutes per meeting for 15 weeks.
   Recitation – 1 day per week for 50 minutes per meeting for 15 weeks.
   Laboratory – 1 day per week for 100 minutes per meeting for 15 weeks.

3. **Instructor's or course coordinator's name:**
   Andrew Hirsch

4. **Textbook(s):** R. Chabay and B. Sherwood, Matter & Interactions – Volume 1 – Modern Mechanics, Wiley.
   Lab Manual: J. Yeazell, Physics 17200 Laboratory Manual
   a. **Other supplemental materials:** iClicker

5. **Specific course information**
   d. **Catalog description:** Introductory calculus-based physics course using fundamental interactions between atoms to describe Newtonian mechanics, conservation laws, energy quantization, entropy, the kinetic theory of gases, and related topics in mechanics and thermodynamics. Emphasis is on using only a few fundamental principles to describe physical phenomena extending from nuclei to galaxies. 3-D graphical simulations and numerical problem solving by computer are employed by the student from the very beginning.
   e. **Prerequisites:** Co-requisites: MA 16500. Authorized equivalent courses or consent of instructor may be used in satisfying course pre- and co-requisites.

   f. **Course status:** Required

6. **Specific goals for the course**
   a. Student learning outcomes
      - On completing this course the student shall be able to:
      - understand and describe a wide range of physical phenomena using only a few fundamental principles of physics.
      - Learn a unified approach that relates microscopic behavior to macroscopic behavior, such as the combination of traditional mechanics, a modern view of quantized atomic levels and statistics leading to basic thermodynamics from mechanics.
      - apply this unified approach to a broad array of applications including asteroids, black holes, nuclear fission and fusion, quantization in atoms and molecules, and heat capacity.
      - model natural phenomena, enabling quantitative studies such as computer simulations describing specific physical behaviors using a programming language called VPython, with little or no prior programming experience.
   b. Relationship of course to program outcomes
      - This course contributes to:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data

7. Topics

1. Interactions and Motion
2. The Momentum Principle: Impulse and Momentum Change
3. The Momentum Principle: Non-constant Forces
4. Contact forces and the Momentum Principle
5. The Energy Principle
6. Energy in Macroscopic Systems
7. Energy Quantization
8. Multiparticle Systems
9. Collisions
10. Angular Momentum
11. Entropy: Limits on the Possible

Prepared By: Hisao Nakanishi
Date: August 22, 2012

1. **<u>PHYS 24100 – Electricity and Optics</u>**

2. **Credits and contact hours:**
   3 credits
   Lecture – 2 days per week at 50 minutes for 15 weeks.
   Recitation – 1 day per week at 50 minutes for 15 weeks.

3. **Instructor's or course coordinator's name:**
   Laura Pyrak-Nolte

4. **Textbook:** *Physics for Scientists and Engineers*, R. Tipler and G. Mosca, Volume 2, 6th ed., Freeman & Co.
   a. **Other supplemental materials:** iClicker

5. **Specific course information**
   g. **Catalog description:** Electrostatics, current electricity, electromagnetism, magnetic properties of matter. Electromagnetic waves, geometrical and physical optics.
   h. **Prerequisite:** PHYS 17200; **Co-requisite:** MA 166 or authorized equivalent
   i. **Course status:** Required

6. **Specific goals for the course**
   By completing this course, the student will:
   - Learn that a relatively small number of fundamental physics concepts form the basis of a wide variety of complex physical phenomena.
   - Learn that conceptual understanding can invariably be raised to the level of analytic and quantitative understanding by use of suitable mathematics.
   - Learn that the quantitative formulations so achieved can be used for problem solving and predicting outcomes of experiments.
   - Apply these processes to solving problems that involve various natural phenomena, such as those encountered in electrostatics, dc and ac currents and circuits, magnetostatics, magnetic induction, electromagnetic waves, light and optics including both geometric and physical optics, light spectra and lasers.
   - Relate the basic understanding and problem solving skills to concrete and practical examples.
   - Develop an elementary understanding of Maxwell's Equations.

   a. Relationship of course to program outcomes
      (a) an ability to apply knowledge of mathematics, science, and engineering

7. **Topics:**
   - The Electric Field I: Discrete Charge Distributions
   - The Electric Field II: Continuous Charge Distributions
   - Electric Potential
   - Electrostatic Energy and Capacitance
   - Electric Current and Direct-Current Circuits

- The Magnetic Field
- Sources of the Magnetic Field
- Magnetic Induction
- Alternating-Current Circuits
- Maxwell’s Equations and Electromagnetic Waves
- Properties of Light
- Optical Images, Mirrors, Thin lenses
- Optical Instruments
- Interference and Diffraction

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