AERONAUTICAL ENGINEERING DEPARTMENT

COURSE SYLLABI

Course:	AE 301 – Fundamentals of Flight (3: 3, 1) – Required Core Course

Course Description: History of Flight. Atmosphere. Airplane Anatomy. Nature of Forces on Airplane. Incompressible Fluid Flow. Lift and Drag. Airfoils. Airplane Wings. High Lift systems. Viscosity Effects. Total Incompressible Drag. Compressibility Drag. Aircraft Structures.

Prerequisites: MEP 261, MEP 290.

Textbooks & required Materials:

1. Shevell, R. S., *Fundamentals of Flight*, Prentice – Hall, Inc, 2nd edition, 1988.
2. Anderson, John D., *Introduction to Flight*, McGraw-Hill, 6th edition, 2007.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Classify the different types of vehicles.
2. Recognize the importance of power plants and clean aerodynamic shapes in increasing the aircraft speeds.
3. Describe the main parts of the aircraft.
4. Distinguish the difference between the aircraft control and the aircraft stability.
5. Explain the different types of static stability of the airplane.
6. Classify the different types of power plants.
7. Distinguish the increase in the wing loading and the cruise speeds for the modern airplanes.
8. Identify the forces involving flying airplane.
9. Apply the dimensional analysis to derive the aerodynamic thermodynamic forces and moments.
10. Apply and solve problems related aerodynamic forces of flying airplanes.
11. Recognize the necessity of test.
12. Define the aerodynamic similarity and the conditions required to achieve the aerodynamic similarity.
13. Explain the requirements to minimize wind tunnel corrections.
14. Classify and describe the different types of low speed wind tunnels.
15. Apply and solve problems related to aerodynamic similarity.
16. Recognize the atmosphere as a homogenous gas.
17. Formulate the equations of the troposphere and the stratosphere.
18. Define the pressure and density altitudes.
19. Apply and solve problems of calculations of atmosphere.
20. Classify a flow as uniform, non- uniform, steady, unsteady, incompressible, compressible, 1-D, 2-D & 3-D.
21. Apply continuity equation to calculate mean velocity and volume flow rate.
22. Derive Bernoulli's equation for incompressible one dimensional flow.
23. Apply Bernoulli's equation in a variety of problems including flow velocity measurements and pressure calculations.
24. Define indicated, calibrated, equivalent, and true air speeds
25. Derive Bernoulli's equation for compressible one dimensional flow.
26. Derive compressible flow equations in a variable area streamtube.
27. Apply Bernoulli's equation and compressible flow equations in solving problems including aircraft air speed measurement and wind tunnel air speed measurements.
28. Demonstrate the relationship between circulation and lift.
29. Predict the airfoil pressure distributions using vortex flow.
30. Apply the theory of lift to solve problems including lift determination for airplanes.
31. Explain the relation between the downwash and induced drag.
32. Demonstrate the effect of downwash on slope of the finite wing lift curve and solve problems including determination of lift and induced drag of airplanes.
33. Classify different types of boundary layers and illustrate the effect of viscosity on flows around stream lining and bluff bodies.
34. Illustrate the effect of pressure gradient in the boundary layers on flow separation.
35. Apply equations of skin friction and boundary layer thickness on flat plate to determine drag on airplanes.

36. Predict the total incompressible drag on an airplane and solve related problems.
37. Determine the effect of compressibility on the airplane and solve related problems.
38. Classify the different types of airfoils and compare their main characteristics.
39. Explain the importance of high lift devices.
40. Classify the different types of leading and trailing edges flaps and demonstrate their effects on the maximum lift coefficient and the stall angle.

Course Topics and their Duration:

Course Topics:	**Duration in weeks**
1. History.	1
2. Anatomy of airplane	2
3. Nature of aerodynamic forces	1
4. The atmosphere	1
5. Incompressible one – dimensional Flow	1
6. One – dimensional flow in a compressible fluid	1
7. Compressible flow equations in a variable area stream tube	1
8. Two–dimensional flow: lift and drag	1
9. The finite wing	2
10. Effect of viscosity	1
11. Determination of total incompressible drag	1
12. Compressible drag	1
13. Airfoils and wings - High – lift systems	1

Class Schedule:

- **Lectures:** three 1 hour sessions per week
- **Tutorials:** one 2.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: Non

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	-	-	-	2	-	1	-	1	-	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Maher Said Aly

Last Updated: May 2008

Course:	AE 311 – Low Speed Aerodynamics (3: 3, 1) – Required Core Course

Course Description: Two-Dimensional Inviscid Fluid Flow, Stream Function and Velocity Potential, Superposition of Elementary Flows, Source Panel Methods, Thin airfoil theory, Vortex Panel Methods, Finite Wings. Vortex Lattice Method, Incompressible Boundary Layer, Aerodynamic Design.

Prerequisites: AE 301, EE 300, EE 332.

Textbooks & required Materials:

1. Anderson, John D., *Fundamentals of Aerodynamics,* McGraw-Hill, 4th Edition, 2005.
2. Class Notes

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Derive the general governing equations from the fundamental principles.
2. State the assumptions for incompressible potential flow and use them to simplify the general equations.
3. Define vorticity and circulation and distinguish between rotational and irrotational flows.
4. Define and compute stream function, streamlines, potential function, and equipotential lines for a flow and calculate each, if they exist.
5. State and implement the general approach for the solution of incompressible potential flow.
6. Analyze (i.e., calculate velocities, pressures, stream function, potential function, stagnation points, streamlines, equipotential lines, circulation around bodies, etc.) the elementary flows (uniform, source/sink, doublet, vortex) as well as any combination of them (lifting/non-lifting flow over a circular cylinder, Rankin oval, etc.)
7. Implement the source panel method to compute pressure and velocity on non-lifting surfaces.
8. State Kutta-Joukowski Theorem and use it to compute lift.
9. Explain and apply the Kutta Condition for any sharp edge of a wing (i.e., what it means physically and how it is enforced mathematically.)
10. State Kelvin's theorem and explain how it is implemented to setup the vortex system of an airfoil.
11. Derive the fundamental equation of Thin Airfoil Theory.
12. Use thin airfoil theory to compute aerodynamic characteristics of airfoils (lift and drag at various angles of attack, pitching moment about various points, a.c. location, c.p. location, etc.).
13. Describe and implement the vortex panel method to compute aerodynamic characteristics for thick airfoils.
14. Describe qualitatively and quantitatively both laminar and turbulent boundary layers in terms of their thickness, velocity profiles and shear stress variation along a surface.
15. Use the Boundary Layer Theory to calculate the skin friction drag, estimate the pressure drag of bodies, and predict location on the surface where boundary layer separation is likely to occur.
16. Describe the aerodynamic characteristics of airfoils and their impact on airfoil design.
17. Use software packages (JavaFoil) to investigate the effects of thickness and camber on the aerodynamic characteristics (lift slope, aerodynamic center) of airfoils.
18. Use software packages (JavaFoil) to investigate the effects of airfoil geometrical characteristics and the angle of attack on the boundary layer behavior and how it is related to changes in lift and drag.
19. Describe the flow field around wings of finite span and explain the generation of induced drag.
20. Describe Prandtl's lifting-line theory and state its limitations.
21. Apply the results from Prandtl's lifting-line theory to calculate the aerodynamic characteristics of airplane wings.
22. Identify wing aerodynamic parameters and recognize their impact on wing design.
23. Describe and implement (through the software package TORNADO) the Vortex Lattice Method to compute aerodynamic characteristics of wings and wing-tail-canard configurations (including high-lift device and control surfaces).
24. List several examples of regional, national, and/or global contemporary problems related to aerodynamics (ex. environmental issues, natural resources and energy conservation, etc.) articulate a problem/position statement for each, and explain what makes these issues particularly relevant to the present time.
25. Identify possible solutions to these problems, as well as any limitations of these solutions.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Basic laws	1
2. Potential Flow Theory	4
3. Airfoil and Boundary Layer Theories	4
4. Finite Wing Theory	4
5. Global/Social/Contemporary Problems Related to Aerodynamics	1

Class Schedule:

- **Lectures:** two 80 minutes sessions per week
- **Tutorials:** one 100 minutes session per week

Course Contribution to Professional Component:

- Engineering science: 75%
- Engineering design: 25%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	-	2	-	2	-	2	-	-	2	2

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Ibraheem. M. AL-Qadi

Last Updated: May 2008

Course:	AE 331 - Structure (3: 3, 2) – Required Core Course

Course Description: Introduction: review of CE 271- Strength of material- Aircraft Structural Detail; structural idealization, Aircraft materials, Loads on Aircraft Structures, Shear forces and Moments and Bending and Twisting in Aircraft structural components . Theory of Elasticity. Bending and twisting of thin walled x-sections. Shearing in thin walled beams. Force Analysis in Landing Gears.

Prerequisites: AE-301, CE-270

Textbooks & required Materials:

1. Curtis, H.D., *Fundamentals of Aircraft Structural Analysis*, McGraw-Hill, 1996.
2. Bruhn, E.F., *Analysis and Design of flight vehicle structure*, Jacobs Publishing, 3rd edition, 1975.
3. Donaldson, B.C., *Analysis of Aircraft Structures*, Cambridge University Press, 2nd edition, 2008.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Identify the nature and the composition of aircraft structures in order to know the type of loads acting on the aircraft.
2. Define the equilibrium of the force systems in different structures (truss, beam, and frame). Analyse the forces in the landing gear
3. Identify and distinguish between unstable and stable and between determinate and indeterminate structures
4. Find the internal forces in trusses and reactions by applying equilibrium force systems.
5. Sketch the free body diagrams to find the bending moments and shear forces in beams, frames, wing and aircraft.
6. Calculate the centroid and second moment of area, find the principle axis and use the parallel axes theorem.
7. Define the type of loads on aircraft and calculate the inertia loads and load factors
8. Calculate the shear stresses due to torsion for circular , open and thin walled closed sections
9. Calculate the bending stresses due to bending, find normal stress and neutral axis.
10. Calculate the bending shear stresses for closed, open sections and find the shear center.
11. Calculate the shear flow for thin-walled closed sections
12. Formulate the equilibrium equations and find the strain-displacement, stress-strain relationships.
13. Outline the aircraft material and its behavior under different loading.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Aircraft materials	0.5
2. Review of CE270	0.5
3. Equilibrium forces system , landing gear	1
4. Properties of section: centroid, second moment of area…etc	1
5. General load on aircraft	1
6. Moments and shear in beams, frames, wing and Fuselage	1
7. Bending stresses: normal stress and neutral axis	1
8. Torsion: stress and deflections	
a. Circular sections	1.5
b. Open thin walled sections	1
c. Closed thin walled sections	1
9. Bending shear stress	
a. Solid sections	1
b. Open sections	1.5
c. Shear center	1.5
10. Shear flow in closed thin walled sections	1.5
11. Principle of Theory of Elasticity	1

Class Schedule:

- **Lectures:** two 80 minutes sessions per week
- **Tutorials:** one 100 minutes session per week

Course Contribution to Professional Component:

- Engineering science: 75%
- Engineering design: 25%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	-	-	-	2	-	-	2	-	-	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Mohammed Alharbi

Last Updated: May 2008

Course:	AE 361 – Aircraft Performance (3: 3, 1) – Required Core Course

Course Description: Aircraft Performance in steady flight. Straight and level flight. Performance curves in term of thrust. Performance curves in terms of power. Gliding flight. Climbing flight. The hovercraft. Aircraft performance in accelerated flight. Take-off performance. Landing performance. Range and endurance. Climb with allowance for acceleration. Effect of air brakes. Flight in a horizontal circle. Helicopter performance.

Prerequisites: AE 301

Textbooks & required Materials:

1. Anderson, John D., *Introduction to Flight*, McGraw-Hill, 6th edition, 2007.
2. Houghton, E.L.& Caruthers, N.B., *Aerodynamics for Engineering students*, Edward Arnold, Houghton & P.W. Carpenter, 5th edition, 2003.
3. Layton, D.M., *Helicopter Performance*, Matrix Publisher, Inc, 1984.

Course Learning Objectives:

By the completion of this course the students will be able to:

1. Derive the equation of motion for an airplane in straight and level flight.
2. Show the flight limitation for airplane and identify the significance of the equivalent air speed in level flight.
3. Identify the importance of aircraft aspect ratio, zero lift drag coefficient and Oswald efficiency on aircraft performance.
4. Solve problems predict the effect of compressible drag on aircraft performance.
5. Derive the conditions of the minimum drag flight and the minimum power flight.
6. Compute and draw the performance curves in terms of thrust and in terms of power.
7. Show the effect of wing loading, thrust loading, zero lift drag coefficient and altitude on the maximum flight speed.
8. Explain the effect of change of aircraft weight, altitudes and aircraft configurations on performance curves
9. Solve problems related to aircraft performance in straight and level flight.
10. Derive the equation of motion for airplane in gliding flight.
11. Calculate the rate of glide for small and steep angles of glide.
12. Show the conditions of the maximum horizontal covered distance and the maximum duration.
13. Solve problems related to the performance of aircraft in gliding flight
14. Derive the equation of motion for aircraft in climbing flight.
15. Derive the equation to determine the maximum rate of climb for jet aircraft and for propeller driven aircraft.
16. Illustrate the performance curves for climbing flight and the climbing hodograph.
17. Derive the correction equations for steep climbing.
18. Solve problems related to aircraft climbing performance.
19. Explain the effects of altitude on aircraft straight and level performance power curves.
20. Define and calculate the aircraft absolute, service and cruise ceilings
21. Compute the time to climb to certain altitudes.
22. Derive and demonstrate the parameters affected to the fasted climb.
23. Discuss the accelerated rate of climb using the energy height techniques.
24. Derive equations for the range and endurance for propeller driven aircraft and jet aircraft.
25. Show the conditions for maximum range and endurance for different types of aircraft.
26. Solve problems related to range and endurance of aircraft.
27. Derive other method of solution to performance of aircraft having polar drag equation and solve related problems.
28. Solve performance problems of aircraft known its wing lift distribution and the equation of drag is non polar equation.
29. Describe the take- off and landing flight processes and define the related terms for speeds and distances.
30. Calculate the ground roll distance for take off and the braked ground run for landing and estimate the time

corresponding to each case

31. Show the parameters affected to take off and landing ground distances.
32. Define the balanced field length.
33. Derive the equation of motion for aircraft in level turning and study the related parameters affecting turn flight.
34. Solve problems related correctly banked level turning flight.
35. Derive equations of the motion for pull-up and push-down flights.
36. Study the load factor-velocity curve and explain its limitations.
37. Apply momentum theory and blade element theory to study the aerodynamic of helicopter.
38. Predict the power required including flow effects in hover and solve related problems.
39. Derive performance equations of the helicopter vertical climb and solve related problems.

Course Topics and their Duration:

Course Topics	**Duration in weeks**
1. Straight and Level Flight	3
2. Gliding Flight	1
3. Climbing Flight	2.5
4. Range and Endurance	1.5
5. Other Methods of Solution to Performance Problems	1
6. Take off and landing Flight	2
7. Turning Flight	2
8. Helicopter	2

Class Schedule:

- **Lectures:** three 1 hour sessions per week
- **Tutorials:** one 2.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 90%
- Engineering design: 10%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	B	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	-	2	-	2	-	1	-	1	-	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Maher Said Aly

Last Updated: May 2008

Course:	AE 371 – Aircraft Engines (3: 2, 2) – Required Core Course

Course Description: Introduction: review of basic laws, chemical reactions, Engine types, Thermodynamics of gas flow, Thermodynamics and performance of jet engines, Thermodynamics and performance of rocket engines, Thermodynamics and performance of piston engines, Application for engine cycle design.

Prerequisites: AE 301

Textbooks & required Materials:
1. Notes supplied by the instructor.
2. Hill, G.H, and Peterson, C.R, *Mechanics and Thermodynamics of Propulsion,* Prentice Hall, 2^{nd} edition 1991.

Course Learning Objectives:

By the completion of the course, the students should be able to:
1. Apply basic laws of fluid mechanics and thermodynamics on separate different components of aircraft engines (turbine, compressor and combustors).
2. Apply the compressible flow laws relevant to turbojet and rocket engines (diffusers and nozzles)
3. Evaluate the effects of losses in different engine components (viscous, shocks, incomplete combustion)
4. Calculate the GTE performance parameters (specific thrust and thrust specific fuel consumption Tsfc) as function of the main design parameters(maximum temperature T04, engine pressure ratio EPR, flight M and ambient conditions)
5. Appreciate the rationale for development of specific engine configurations, e.g. turbofans and afterburning.
6. Identify common design constraints and practices for GTE.
7. Explain the performance and design characteristics of rocket engines and predict their effects on the rocket trajectory.
8. Calculate the major design parameters of solid rocket motors thrust chambers, grains and nozzles.
9. Recognize the use of piston engines in aircraft propulsion.
10. Explain the performance and design characteristics of piston engines.
11. Calculate the major design parameters of piston engines.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Introduction,:	
a. Basic laws	1
b. Chemical Reactions	1
c. Engine Types	0.5
2. Thermodynamics of gas flow.	1.5
3. Thermodynamics and performance of jet engines.	5.5
4. Thermodynamics and performance of rocket engines.	1.5
5. Thermodynamics and performance of piston engines.	1.5
6. Design project	1.5

Class Schedule:
- **Lectures:** two 1 hour sessions per week
- **Tutorials:** one 2.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 66%
- Engineering design: 33%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	-	2	-	2	1	-	-	-	1	2

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. I. E. Megahed

Last Updated: June 2008

Course:	**AE 390 – Summer Training (2:0,0) – Required Core Course**

Course Description: 10 weeks of training in industry under the supervision of a faculty member. Students have to submit a report about their achievements during training in addition to any other requirements assigned by the Department.

Prerequisites: AE 301, IE 202

Textbooks & required Materials: None

Course Learning Objectives:

By the completion of the summer training, the student will be able to:

1. Formulate an objective or mission statement that identify the real problem and describe the expected outcomes of the training activity.
2. Break-down a work environment into its units and work functions, and describe how these units are assembled into a whole entity.
3. Describe a professional organizational structure, its size and how it is related to its main products and to market issues.
4. Exhibit integrity, punctuality, and ethical behavior in engineering practice and relationships.
5. Demonstrate enthusiasm and business focusing.
6. Establish successful relationships with team members, advisors, and clients to understand their needs and to achieve or exceed agreed-upon quality standards.
7. Maintain focus to complete important tasks on time and with high quality, amidst multiple demands
8. Relate practical work to previous knowledge from basic sciences, engineering fundamentals, and discipline related courses.
9. Collect and review related data such as technical information, regulations, standards, and operational experiences from credible literature resources
10. Utilize prior knowledge, independent research, published information, and original ideas in addressing problems and generating solutions
11. Monitor achievement, identify causes of problems, and revise processes to enhance satisfaction
12. Communicate, clearly and concisely, training details and gained experience, both orally and in writing, using necessary supporting material, to achieve desired understanding and impact.

Course Topics and their Duration:

Course Topics:	Duration in weeks
1. Acquainting the trainee by the company, its work environment, organizational structure, products, costumers, engineering units, and quality system.	2
2. Familiarizing the trainee of one production or design unit with deep understanding of the work environment, regulations, standards, etc...	1
3. Allocating the trainee to a project team and allowing him to study and collect necessary data about the project using internal and external data sources.	1
4. Working as a team member to execute assigned tasks with the following objectives: 1. Apply engineering practices related to his specialization. 2. Enhance team work skills. 3. Relate practical work to his engineering knowledge. 4. Use modern engineering tools such as equipment and computer software. 5. Use project management techniques. 6. Complete assigned tasks on time with high quality. 7. Develop personal communication skills.	6

Class Schedule:

- Oral Presentation after submitting a written training report; both evaluated by at least 2 faculty members

Course Contribution to Professional Component:

- Engineering science: None
- Engineering design: None
- Others: 100%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	-	-	-	3	-	3	3	-	-	-	3

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Prof. Ali M. Al-Bahi

Last Updated: April 2008

Course:	AE 412 – High Speed Aerodynamics (3: 3, 1) – Required Core Course
Course Description:	Principles from Thermodynamics - Conservation laws governing compressible flow - Generalized flow in Nozzles - Isentropic flow - Normal shock relations - Nozzle flow with shock waves - Oblique shock waves - Expansion waves - Shock reflection - airfoils in supersonic flow - Shock expansion method - Thin airfoil theory - Unsteady gas dynamics - Moving shock waves and expansion waves - Shock tube theory - Aerodynamic facilities – Design of wind tunnels.
Prerequisites:	AE-311.
Textbooks & required Materials:	1. John D. Anderson Jr., Modern Compressible Flow with Historical Perspective, 3rd edition, McGraw-Hill, 2004. 2. H. W. Liepmann and A. Roshko, Elements of Gasdynamics, Dover Publications, 2002. 3. H. Shapiro, the Dynamics and Thermodynamics of Compressible Flow, Vols. 1 and 2, Ronald Press, 1958. 4. Saad, M. A., Compressible Fluid Flow, Prentice Hall, 2nd edition, 1993. 5. Anderson, John D., Fundamentals of Aerodynamics, McGraw-Hill, 4th Edition, 2005.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. To establish the knowledge and understand the need of fluid properties and thermodynamic properties required to describe ideal compressible fluid flow.
2. Demonstrate the difference between compressible and incompressible flow.
3. Demonstrate the ability to apply conservative laws to fluid mechanics problems including one dimensional equation for conservative laws in differential form.
4. Illustrate the implication of compressibility to the area-velocity relationship and the need for a convergent divergent nozzle to obtain supersonic flow
5. Apply isentropic relations to isentropic flow in nozzles.
6. Apply the conservation equations to produce the normal shock wave relations and apply to flows with shock waves
7. Identify the location of a standing shock in a nozzle and select the conditions required to obtain a shock free nozzle
8. Explain the formation of a moving shock wave and oblique shock wave
9. Derive the equations of a moving shock wave, a reflected shock wave, and a moving expansion waves
10. Describe the shock tube, identify the conditions of the shock tube to manipulate the strength of the shock wave
11. Describe the wall deflection to shock angle relationship and the influence of Mach number change.
12. Describe the flow and the waves' pattern over simple 2-dimensional airfoils under variable Mach number conditions.
13. Describe fully the flow field produced by normal reflection and qualitatively by Mach reflection.
14. Explain the occurrence of shock bowing (bow shock wave) and shock detachment (detached shock wave) and describe how they are related.
15. Apply the oblique shock relations, small angle approximation and Prandtl-Meyer function to obtain approximate and exact solutions to flows with waves.
16. Obtain the lift and the drag coefficient of a simple airfoils in supersonic flow using shock expansion method and approximate methods of Prandtle-Meyer function and thin airfoil theory.
17. Describe shock-shock intersection shock-expansion interaction.
18. Design a supersonic nozzle
19. Use modern engineering tools necessary for engineering practice by solving problems using CFD

(FLUENT) and software packages such as KASIMIR.

20. Study an example of regional, national, and / or global contemporary problems related to aerodynamics (ex. environmental issues, natural resources and energy conservation, etc.) articulate a problem / position statement for each, and explain what makes these issues particularly relevant to the present time. Identify possible solutions to these problems, as well as any limitations of these solutions.
21. Demonstrate the ability to engage as a team member in a course capstone design

Course Topics and their Duration:

Course Topics	**Duration in weeks**
1. Introduction to Compressible Flow	1
2. Review of Thermodynamics	1
3. Integral form of the Conservation Equations	0.5
4. One-Dimensional Flow (Normal Shock Wave)	1
5. Oblique Shocks and Isentropic Waves	1.5
6. Lift and Drag in Supersonic Flow	2.5
7. Flow Through Nozzles	2
8. Unsteady One-Dimensional Compressible Flow	1.5
9. Supersonic Wind Tunnels	2

Class Schedule:

- **Lectures:** two 1:20 hour sessions per week
- **Tutorials**: one 3.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 75%
- Engineering design: 25%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	2	2	-	3	2	2	2	2	2	2

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr .K. A. Al JUHANY

Last Updated: May 2008.

Course:	AE 414 – Aerodynamics Lab (2: 1, 3) – Required Core Course

Course Description: Basic concepts and definitions –The generalized measurement system – Experiment planning – Analysis of experimental data: uncertainty analysis, statistical analysis , graphical analysis and curve fitting , method of least squares – Design of Experiments – Wind tunnel testing : types of wind tunnels, similarity parameters, instrumentation of wind tunnel test section,
Corrections of wind tunnel data, selected aerodynamic experiments.

Prerequisites: AE-311.

Textbooks & required Materials:

1. Holman, J.P., *Experimental Methods for Engineers*, 7th Edition, McGraw Hill, 2001.
2. Rae, W.H., Jr. and Pope, A., *Low-Speed Wind Tunnel Testing*, John Wiley and Sons, 3rd edition, 1999.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Define the technical terms used in the course
2. Communicate the details of an experimental procedure clearly and completely
3. Identify different types of wind tunnels and recognize their characteristics
4. Design and select main components of wind tunnels such as contractions, diffusers, screens etc
5. Design an experiment to study or investigate technical fluid dynamic problem, propose a solution taking into account safety measures
6. Conduct or simulate an experiment to validate/check the feasibility of the proposed solution
7. Develop a mathematical model or computer simulation to correlate or interpret experimental results that may be real data from a laboratory experiment or simulated data given to students by their lecturer
8. List and discuss several possible reasons for deviations between predicted and measured results from an experiment, choose the most likely reason and justify the choice
9. Demonstrate knowledge of contemporary issues in experimental aerodynamics
10. Work effectively in a team

Course Topics and their Duration:

Course Topics:	Duration in weeks
Flow properties and basic principles Forces, stresses and the continuum hypothesis, Measurable properties, Flow velocity and velocity fields, Analytical description of flows, The choice of analytical approach, Similarity, Patterns of fluid motion	1
Towards a sound experiment Planning the experiment, Safety, Qualitative assessment, Record keeping, Scientific ethics	1
Fluid mechanical apparatus Producing the desired flow, Changing the flow area, Flow management, Wind tunnels, Turbulence and shear generation, Model testing	1
Measurement of flow pressure What exactly is pressure, Pressure measuring instrumentation, Wall pressure measurements, In-flow pressure measurements	1
Flow Visualization techniques Overview, Marker techniques, Optical techniques	1
Measurements of local flow velocity Pressure impact devices, Thermal anemometer, Measurements of wind velocity	1
Analysis of Experimental Data Measurements errors, Accuracy and precision, Resolution, sensitivity and Dynamic range, Accuracy /Systemic errors of measuring systems	1
Selected Aerodynamic Experiments Flow visualization using smoke tunnel, Flow around circular cylinder, Flow around airfoil, High lift airfoils, Smooth and rough-wall turbulent boundary layer, Calibration of a normal hot-wire anemometer, Design an experiment to study or investigate technical fluid, dynamic problem, proposed by team of students and approved by their lecturer	7

Class Schedule:

- **Lectures:** 1 hour per week.
- **Tutorials:** 1 hour per week.
- **Aero Lab:** 2 hours per week

Course Contribution to Professional Component:

- Engineering science: 80%
- Engineering design: 20%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	3	2	2	3	2	2	2	-	2	3

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Salah Hafez

Last Updated: May 2008

Course:	**AE 432 - Structure II (3: 3, 2) – Required Core Course**

Course Description: Deflection of statically determinate structures-Load analysis of statically indeterminate structures- Deflection of statically indeterminate structures- matrix method of structural analysis: stiffness equations of spring structures, general stiffness equations of a structural element, matrix analysis of beam, matrix analysis of frames , matrix analysis of thin walled structures-matrix analysis of thin walled structures- structural stability : primary buckling of columns, buckling of thin plates , local buckling of thin walled columns, crippling strength of thin walled columns, buckling of stiffened panels, tension filled web beams.

Prerequisites: AE 331.

Textbooks & required Materials:

1. Curtis, H.D., *Fundamentals of Aircraft Structural Analysis*, McGraw-Hill, 1996.
2. Bruhn, E.F., *Analysis and Design of flight vehicle structure*, Jacobs Publishing, 3rd edition, 1975.
3. Donaldson, B.C. Analysis of Aircraft Structures, Cambridge University Press, 2nd edition, 2008.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Calculate the deflections of statically determinate structures.
2. Analyze the statically indeterminate structures to find their internal loads
3. Calculate the deflections of statically indeterminate structures.
4. Derive the stiffness equations of spring structures.
5. Derive the stiffness equations of a structural element.
6. Use the stiffness method to calculate the deflections and internal loads of truss structures
7. Apply the matrix method to find the deflections and internal loads of beams
8. Use the matrix method for structural analysis of frames.
9. Apply the stiffness method to find the deflections and internal loads of thin-walled structures
10. Calculate the primary buckling loads of columns.
11. Find the buckling loads of thin plates in compression , shear , bending and under combined systems of loading
12. Predict the local buckling load of a thin-walled column and compare it with the primary buckling load of the column
13. Calculate the crippling strength of thin-walled columns.
14. Design the stiffened panels to avoid buckling and crippling.
15. Design the tension-filled web beams.

Course Topics and their Duration:

Course Topics	Duration in weeks
Deflection of aircraft structures: 1. Deflections of statically determinate structures. 2. Load analysis of statically indeterminate structures 3. Deflections of statically indeterminate structures.	5
Matrix Method of structures analysis 4. Stiffness equations of spring structures. 5. General Stiffness equations of a structural element. 6. Matrix analysis of truss structures 7. Matrix analysis of beams 8. Matrix analysis of frames. 9. Matrix analysis of thin-walled structures.	6
Structural stability 10. Column primary buckling. 11. Thin plates Buckling 12. Local buckling load of a thin-walled column. 13. Crippling strength of thin-walled columns. 14. Stiffened panels in compression. 15. Tension-field web beams.	4

Class Schedule:

- **Lectures:** 3 hours per week
- **Tutorials**: 2.0 hours per week

Course Contribution to Professional Component:

- Engineering science: 80%
- Engineering design: 20%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	-	-	-	3	-	2	-	-	2	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Mostafa Bourchak

Last Updated: May 2008

Course:	AE 433 – Flight Vehicles Materials (3: 3, 1) – Required Core Course

Course Description: Imperfections in solids - Requirements from aerospace structural materials, Design philosophy (safe-life and damage-tolerant design), Aerospace applications of fracture mechanics, Airframe fatigue, Creep, Oxidation, Composite materials, Computer applications.

Prerequisites: AE-331.

Textbooks & required Materials:
1. Notes by Instructor
2. Dieter, G. E., "Engineering Design: A Materials and Processing Approach", McGraw-Hill, 3rd edition, 2000.
3. Bruhn, E.F., Analysis and Design of flight vehicle structure, Jacobs Publishing, 3rd edition, 1975.

Course Learning Objectives:

By the completion of the course, the students should be able to:
1. Describe the behavior of engineering materials, particularly alloys of iron, aluminum, ceramics, plastics, and composites.
2. Describe criteria for material selection (Ashby chart).
3. Analyze the stress strain curves
4. Explain types of fracture modes.
5. Define airframe design philosophy (i.e. safe life & damage tolerant design philosophies)
6. Classify imperfections and explain their effects on the properties of materials. Define the different Non Distractive methods.
7. Calculate the expected life of a material with a given creep rate.
8. Calculate fracture toughness.
9. Apply materials selection and processing for aerospace related design project.
10. Communicate effectively in a team environment, negotiate and resolve conflict, motivate and coach other team members, organize meetings, delegate work tasks, develop a team vision, set team goals, and manage resources.
11. Write high quality design reports using correct language and terminology, correct technical information, and professionally prepared graphs and tables.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Introduction to aircraft materials.	1
2. Class of sold materials alloys, ceramics, plastics, and composite.	1
3. Material selection criteria (Ashby chart).	1
4. Stress strain curves	1
5. Types of fracture modes.	1
6. Airframe design philosophy (i.e. safe life & damage tolerant design philosophies)	1
7. Imperfections and their effect on the properties of materials.	1
8. Methods of Non Destructive Testing.	1
9. Creep and Creep rate	2
10. Fracture toughness.	2
11. Materials selection and processing for aerospace related design project.	2

Class Schedule:

- **Lectures:** three 1-hour sessions per week
- **Lab:** one 3-hour session each 2 weeks

Course Contribution to Professional Component:

- Engineering science: 75%
- Engineering design: 25%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	2	3	2	2	-	2	-	-	2	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Wail Harasani

Last Updated: May 2008

Course:	**AE 434 – Structures lab (2: 2) – Required Core Course**

Course Description:

Bending of simply supported beams. Bending of cantilever beams. Unsymmetrical bending of beams. Shear center. Deflections of simply supported portal frame. Deflections of simply supported S frame. Deflections of statically indeterminate portal frame. Deflections of closed frames. Buckling of struts. Buckling of thin plates. Local buckling of thin-walled columns.

Prerequisites: AE 331, AE 432, CE 270.

Textbooks & required Materials:

1. Curtis, H.D., *Fundamentals of Aircraft Structural Analysis*, McGraw-Hill, 1996.
2. Bruhn, E.F., *Analysis and Design of flight vehicle structure*, Jacobs Publishing, 3rd edition, 1975.
3. Donaldson, B.C., *Analysis of Aircraft Structures*, Cambridge University Press, 2nd edition, 2008.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Define the simplicity of beam bending
2. State the assumptions in beam bending
3. State the strain-displacements relationships
4. Define the Bernouli's-Euler assumption
5. Derive the stress-strain relationships
6. Derive the 4th order equation of beam bending
7. Set up the experiment for cantilever beam
8. Calculate and measure the deflections at certain point
9. Write down the discussion in experiment sheet
10. Define the centroid, principle and neutral axes
11. Calculate the 2nd moment of area and product of inertia
12. set up the experiment for L-section
13. Define the shear center
14. Set up the experiment for different sections
15. calculate and locate the shear center
16. Explain the difference between theory and experimental results
17. Define SIS, SDS in frames
18. Derive the shear force and the bending moments diagrams
19. Define the total strain and complementary energy methods
20. Calculate the deflections using total complementary method
21. Solve the statically indeterminate frame.
22. Set up the experiment for different frames
23. Define the struts
24. Derive the Euler's equation for critical loads
25. Calculate and measure the critical loads
26. Set up the experiment for different lengths

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Review of CE270, AE331 and AE432	1
2. Experiment 1: Simple bending	1
3. Experiment 2&3: unsymmetrical bending	2
4. Experiment 4&5 : Shear center and shear flow	2
5. Experiment 6 &7: Elastic Frame	2
6. Experiment 8 &9: stability of struts	2
7. Term Project: Design of an experiment	4

Class Schedule:

- **Lectures:** two 1 hour sessions per week
- **Tutorials:** one 3.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 70%
- Engineering design: 30%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	2	3	2	2	-	-	2	-	2	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Mohammed Alharbi

Last Updated: May 2008

Course:	AE 435 – Aircraft Design (4: 3, 3) – Required Core Course

Course Description: Introduction: Review of AE361, Aircraft Sizing, Determination of takeoff, empty, and fuel weight, sensitivity analysis to takeoff weight, selection of the overall configuration, discussion of the aircraft systems, cost prediction.

Prerequisites: AE-361.

Textbooks & required Materials:

1. Roskam, J., Airplane Design Parts I through VIII, Darcorporation, 2nd edition, 2003.
2. Roskam, J., Airplane Aerodynamics and Performance, Darcorporation, 3rd reprint, 2000.
3. Howe, D., Aircraft Conceptual Design Synthesis, Wiley, 2005.

Course Learning Objectives: By the completion of the course, the students should be able to:

1. Define an appropriate set of mission requirements and sketch the mission profile of an airplane.
2. Perform a literature search and collect data to show the need for a particular airplane.
3. Identify the critical mission requirements of an airplane.
4. Evaluate the configuration of airplanes and describe the connection between configuration choices (ex. High wing, tandem landing gear) and mission requirements.
5. Describe the pros and cons of the various conventional aircraft configurations.
6. Describe the pros and cons of unconventional aircraft configuration such as canards, 3-surface, swept-forward wings, flying wings, tailless, V/STOL, stealth, etc.
7. Select an appropriate configuration for an airplane with a specified mission.
8. Estimate the takeoff weight of an airplane based on the mission requirements using the weight fraction method.
9. Calculate the takeoff weight sensitivity of an airplane to change of critical parameter such as L/D, SFC, etc.
10. Construct a matching graph based on specific performance constraints, such as stall speed, cruise speed, takeoff distance, and landing distance and used it to predict the required thrust / power and wing area for an airplane.
11. Prepare CAD drawing of the cockpit and fuselage of an airplane based on the specific payload requirements.
12. Design the wing, empennage and the landing gear of an airplane using tip-over and ground clearance criteria.
13. Discuses selected systems applied to the design of the airplane.
14. Calculate the direct operating cost for the designed airplane.

Teamwork and project management

15. Communicate effectively in a team environment, negotiate and resolve conflicts, motivate and coach others in your team, organized and delegate and resolve as needed, develop a team vision and set team goals, manage resources.
16. Develop a milestone schedule (timeline) for an engineering project.

Communication

17. Write high quality design reports (i.e. using correct language and terminology, correct technical information, and professionally prepared graphs and graphs and tables).
18. Give clear information, technically correct oral presentations using professionally prepared visual aids.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Determination of the takeoff weight, empty weight, and fuel weight from a given mission specification. Derivation and discussion of takeoff weight sensitivities to range, endurance, lift-to-drag ratio specific fuel consumption, and empty weight.	2
2. Derivation and discussion of performance constraints for: stall speed, takeoff and landing field length, carrier compatibility, climb to altitude, climb with all-engines-operational and one-engine-out, specific excess power, cruise speed, maximum speed. The performance constraint plot and selection of takeoff wing landing and takeoff trust-to-weight ratio. Preliminary method for determining drag polar. Civil and military regulation.	2 2
3. Selection of the overall configuration. Example of airplane design as a non –unique and iterative process. Preliminary design decision making for: cockpit and fuselage, wing, high lift devices, propulsion system, empennage, landing gear. Preparation of a preliminary three-view.	2
4. Detailed discussion of why's and how's of the design of cockpit and fuselage, wing, high lift devices, propulsion system, empennage, landing gear. Procedures for analysis, design, and re-design of airplanes so that all mission, airworthiness and environmental regulations are met.	2
5. Discussion of the design of systems. Reversible and irreversible fuel systems. Hydraulic systems. Electrical and Avionics systems. Water and waste system. Anti- and de-icing system.	2
6. Airplane cost analysis and prediction. RDTE cost (through certification), manufacturing cost, operating cost for civil aircraft, indirect operating cost for civil aircraft, life cycle cost. The design-to-cost problem. Estimation of aircraft net worth. Design guides for low cost. Factors in airplane program decision making. Typical cost breakdown for aircraft. Factors in aircraft program decision making.	1
7. Alternative schools of aircraft design, and why, the master equation.	1
8. Technique for Order Preference by Similarity to Ideal Solution TOPSIS	

Class Schedule:

- **Lectures:** three 1 hour sessions per week
- **Tutorials**: one 3.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 75%
- Engineering design: 25%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	-	3	3	-	3	3	3	-	3	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Wail I. Harasani

Last Updated: May 2008

Course:	AE 436 – Aircraft Structural Design (4: 3, 3) – Required Core Course
Course Description:	Structural design of wing, fuselage, tail-plane, fin, and landing gear - Design of ribs, frames, stiffeners, webs, and skins - Spar design - Diagonal semi tension field beams - Optimum design – Computer applications.
Prerequisites:	AE 432.
Textbooks & required Materials:	1. Nahas, M.N, *Stress Analysis in Aircraft Structures,* King Abdulaziz University Press, 2002. 2. Moaveni, S. *Finite Element Analysis, Theory and Application with ANSYS*, 2nd Edition, Pearson Education, Inc., 2003.

Course Learning Objectives:

By the completion of the course, the students should be able to:

Design – Load Assessment

1. Define limit and ultimate loads on an aircraft.
2. Calculate the inertia forces acting on an aircraft during maneuver.
3. Define the aerodynamic forces acting on an aircraft.
4. Identify all forces acting on a plane in flight.
5. Calculate maneuver and gust load factor.
6. Apply the equations of equilibrium in steady or accelerated flight.
7. Prepare the V-N diagram for a conventional airplane with a specified mission.

Design – Finite Element Analysis

8. List the basic steps of the Finite Element (FM) method.
9. Analyze 2Dand 3D trusses using the FE method.
10. Analyze 2D and 3D trusses using ANSYS software.
11. Analyze 2D and 3D beams using the FE method
12. Analyze 2D and 3D beams and frames using ANSYS software.
13. Analyze isotropic flat plates using ANSYS software
14. Analyze curved shells structures using ANSYS software
15. Develop a landing gear structure concept
16. Develop a wing structure concept with skin, spars, ribs and stringers
17. Analyze the suggested structure using ANSYS software and calculate margin of safety distributions in the different components.

Teamwork and Project Management

18. Work and communicate effectively in a team to solve engineering problems.

Engineering Ethics

19. Identify different scenarios related to structural design that require a decision with an ethical implication.

Communication

20. Prepare a complete design report.
21. Give clear, informative, and technical oral presentations.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Basic steps of the Finite Element (FE) method	1
2. 2D and 3D trusses using FE method and ANSYS software	1
3. 2D and 3D beams using FE method and ANSYS software	1
4. Frames using ANSYS software	1
5. Landing structure	1
6. Isotropic flat plates using ANSYS software	1
7. Curved shells structures using ANSYS software	1
8. Wing structure (skin, spars, ribs and stringers)	1
9. Limit and ultimate loads on an aircraft. Inertia and aerodynamic forces acting on an aircraft.	1
10. Maneuver and gust load factors. Equations of equilibrium in steady and accelerated flight	1
11. V-N diagram for a conventional airplane with a specified mission	1
12. Design Project	3

Class Schedule:

- **Lectures:** two 1.5 hour sessions per week
- **Tutorials**: one 3.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 50%
- Engineering design: 50%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	-	3	3	3	3	3	-	-	-	3

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Dr. Belkacem Kada

Last Updated: June 2008

Course:	AE 462 – Aircraft Stability & Control (4: 3, 3) – Required Core Course
Course Description:	Static longitudinal stability. Neutral point. Longitudinal control. Hinge moments. Control surface balancing. Stick free stability. Stick force. Stick force gradient. Maneuverability. Maneuver point. Center of gravity limits. Directional static stability. Directional control. Rolling static stability. Rolling control. Aircraft equations of motion. Small disturbance theory. Longitudinal dynamic stability. Lateral dynamic stability. Stability derivatives. Flying qualities
Prerequisites:	AE 361, MATH 204.
Textbooks & required Materials:	Nelson, Robert C., *Flight Stability and Automatic Control,* 2nd edition, 1998, McGraw-Hill Science.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Define the concepts of static and dynamic stability and distinguish between different modes of stability.
2. Define the concepts of degrees of freedom for a dynamical system, and classify aircraft motion variables, forces, moments,
3. Classify control surfaces (primary and secondary surfaces) and define their functions.
4. Derive the contributions of different aircraft components to longitudinal stability and derive the elevator control power.
5. Determine the stick fixed neutral point and describe the effect of changing the center of gravity location on the aircraft longitudinal static stability.
6. Compute the stick free lift curve slope, longitudinal static stability derivative, neutral point & static margin.
7. Define the stick force gradient, state the condition for aircraft speed stability, and explain the use of trim tabs on the elevator.
8. Estimate the contributions of aircraft components for the directional static stability and derive the rudder control power.
9. State and describe the conditions of roll static stability and trim, discuss the dihedral, the wing-fuselage interaction effect, and the sweep effects, and derive expressions for the wing dihedral derivative and the aileron control power.
10. Define axes systems and transformations, Euler's angles of rotation, orientation matrices and wind reference frame.
11. Derive aircraft kinematical equations of motion and illustrate longitudinal and lateral-directional modes
12. Employ Taylor series expansion for multivariable functions to Linearize functions about equilibrium points and steady reference conditions,
13. State assumptions of the small disturbance theory and the longitudinal/lateral motion decoupling assumptions.
14. Study the dynamic longitudinal and lateral stabilities and derive their response characteristics.
15. Define the effect of the effect of stability derivatives, the centre of gravity and mass distribution on the dynamic stability
16. Define the longitudinal, lateral and directional flying quality requirements
17. Define the characteristics of flight control systems and clarify the relations between flying quality requirements and design
18. State and obtain first and second order linear system characteristics, and infer stability and transient response from the complex plane root representation.
19. Derive state space models for linear multivariable systems, and reproduce the linear system characteristic equation from its state space model.
20. Study the controllability and observability of flight control system
21. Construct state space models for longitudinal and lateral dynamics and perform modal analysis on state

space models.

22. Construct reduced state space models for Phugoid mode and short period mode approximations
23. Construct reduced state space models for Dutch roll mode, spiral mode, and roll mode approximations and estimate the motion characteristics of each mode
24. Apply linear optimal control theory to aircraft control
25. Design and apply different linear regulators

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Introduction to Aircraft Stability and Control	1
2. Longitudinal Static Stability	3
3. Longitudinal Static Control	1
4. Lateral-Directional Static Stability and Control	2
5. Equation of Motion and Stability Derivatives	3
6. Dynamic Stability and Response Characteristics	1
7. Classical Design techniques and Flying Qualities	2
8. Introduction to Modern Control Theory	2

Class Schedule:

- **Lectures:** three 1 hour sessions per week
- **Tutorials**: one 3 hours session per week

Course Contribution to Professional Component:

- Engineering science: 60%
- Engineering design: 40%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	-	2	-	2	2	-	-	2	-	2

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Belkacem Kada

Last Updated: June 2008

Course:	AE 472 – Aircraft Propulsion (4: 3, 3) – Required Core Course

Course Description: Introduction: review of AE 371- Preliminary aero-thermodynamic design of the different gas turbine engine fixed components: inlets, combustors and afterburners, and exhaust nozzles, Preliminary aero-thermodynamic design of the different gas turbine engine turbo-machinery: axial and centrifugal compressors and axial turbines, Engine components matching, acceleration and stresses, Application to the design of gas turbine engine components.

Prerequisites: AE-371.

Textbooks & required Materials: Hill, G.H, and Peterson, C.R, *Mechanics and Thermodynamics of Propulsion,* Prentice Hall, 2nd edition 1991.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Explain the internal mechanism of various fixed GTE components (inlet, combustors, and nozzles) in order to describe the factors that impose practical limits on performance.
2. Explain conditions required for high performance of those fixed components.
3. Perform experiments to demonstrate the nozzle flow characteristics and analysis of results.
4. Apply Euler equation for turbomachines on axial and centrifugal compressors and axial turbines.
5. Explain the internal mechanisms of energy transfer and conversion inside turbomachines to find out sources of losses and methods to reduce these losses for high performance.
6. Relate the required performance to the rotor and stator blade shapes and angles.
7. Explain factors that impose limits on performance.
8. Explain the new trends in GTE designs, turbine blade cooling, new blade materials, use of composite materials, wide chord blades and their effect on engine performance.
9. Recognize the importance of components matching and its effect on the overall engine performance.
10. Proposing the optimum design (main shape and dimensions) of high performing GTE components to meet specified design requirements.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Review of AE371	1
2. Aerothermodynamics of fixed components	
a. Inlets	1.5
b. Combustion chambers and afterburners	2
c. Exhaust nozzles	1
3. Turbomachines	
a. Single and multistage axial compressors	3
b. Centrifugal compressor	1.5
c. Axial turbine	2
4. General engine topics	1
5. Laboratory	1
6. Design project	1

Class Schedule:

- **Lectures:** three 1 hour sessions per week
- **Tutorials**: one 3.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 75%
- Engineering design: 25%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	2	2	2	2	1	-	-	-	-	2

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. I. E. Megahed

Last Updated: June 2008

Course:	AE 499 – BS Project (4: 2, 4) – Required Core Course

Course Description:

Selection of topic, Literature review, Project design planning, Arranging for data collection and experimental work, Interim report, Experimental work and data collection or field study (if any), Data processing analysis and results, Preparation of a first draft of the final report, Presentation of the project.

Prerequisites: MENG-410.

Textbooks & required Materials:

1. Notes by: Dr. Bahattin karagözoğlu, A Guide to Engineering Design Methodologies and Technical Presentation, KAU, faculty of engineering, department of electrical and computer engineering, 2007
2. AE Assessment Rubrics for BS Projects, available from the BS Project Committee.

Course Learning Objectives:

By the completion of the BS Project, the students should be able to:

1. Analyze a project statement, brief, or proposal to identify the real problem and the most relevant needs and operational constraints.
2. Identify potential costumers, their needs, and their operational constraints.
3. Collect and review related data such as technical information, regulations, standards, and operational experiences from credible literature resources.
4. Integrate previous knowledge from mathematics, basic sciences, engineering fundamentals and discipline related courses to address the problem.
5. Discuss all applicable realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
6. Define design objectives, measures of design viability, and the evaluation criteria of the final project, and reformulate the problem based on collected data.
7. Generate possible solutions; compare alternatives, and select one alternative based on evaluation criteria and feasibility analysis.
8. Plan an effective design strategy and a project work plan, using standard project planning techniques, to ensure project completion on time and within budget.
9. Implement a planned design strategy for an Experimental Design Project, if applicable:
   - 9.1 Identify experimental variables and parameter with ranges and desired accuracies.
   - 9.2 Select appropriate experimental tools such as sensors, instruments, and software.
   - 9.3 Explain a reliable experimental setup and experimental procedure that solves the problem.
   - 9.4 Explain efficient measures to deal responsibly with safety issues and environmental hazards.
   - 9.5 Use appropriate measurement techniques to ethically collect and record data.
   - 9.6 Analyze experimental data using appropriate tools such as data reduction and statistical analysis.
   - 9.7 Perform uncertainty analysis.
   - 9.8 Judge, verify, and validate the experimental result by comparing them with theory and/or previous experimental works.
10. Implement a planned design strategy for a Product-Based Design Project, if applicable:
    - 10.1 Identify design parameters as well as assumptions.
    - 10.2 Carry out initial design calculations using modern engineering tools.
    - 10.3 Use modern engineering tools to estimate the performance parameters of the initial design.
    - 10.4 Use constraint analysis and trade-off studies of the design parameters to refine the initial design and obtain a final optimized design.
    - 10.5 Evaluate the project related environmental, social, health and safety issues, as well as hazards anticipated by the project.

10.6 Evaluate project success in satisfying customer's needs, design criteria, and operational constraints.

11. Communicate design details and express thoughts clearly and concisely, both orally and in writing, using necessary supporting material, to achieve desired understanding and impact.
12. Demonstrate ability to achieve project objectives using independent, well organized, and regularly reported multidisciplinary team management techniques that integrate, evaluate, and improve different skills of team members.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Project selection and team formation	1
2. Problem Definition	2
3. Literature review and data collection	3
4. Problem formulation:	3
a. Knowledge integration	
b. Operational and realistic constraints	
c. Design objectives	
d. Evaluation criteria	
5. Design options and initial layout	2
6. Work plan and budgeting	1
7. Progress report and oral presentation	1
8. Implementation phase	7
9. Design refinement	3
10. Final report and oral presentation	3

Class Schedule:

- 2 general audience oral presentations of 30 minutes each

Course Contribution to Professional Component:

- Engineering science: Non
- Engineering design: 100%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	-	3	3	3	3	3	3	3	3	3

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Prof. Ali Al-Bahi

Last Updated: June 2008

Course:	AE 452 – Aircraft Systems & Instruments (3: 3, 1) – Elective Course

Course Description: Instrument display and panels. Air data instrument. Attitude Indicating Instruments. Heading indicating instruments. Flight director systems. Power-plant related instruments. Hydraulic and pneumatic systems.

Prerequisites: AE 462: **Aircraft Stability and Control**

Textbooks & required Materials:

1. Al-Bahi, A.M.; *Introduction to Aircraft Instruments and Systems*, KAU, Jeddah, 2006, Course notes (available from AE Dept.)
2. Goodwin, A.B.; *Fluid Power Systems*, McMillan Press Ltd., London, 1976.
3. Gracey, W.; *Measurement of Aircraft Speed and Altitude*, John Wiley & Sons, New York, 1981.

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Identify main elements of aircraft hydraulic systems
2. Analyze basic fluid power components
3. Analyze pressure measurement techniques as related to air data systems
4. Describe attitude indicating instruments
5. Analyze attitude indicating systems
6. Analyze heading indicating systems
7. Demonstrate ability to life-long learning skills
8. Access information from a variety of sources and critically assess their quality, validity, and accuracy.
9. Analyze new content by breaking it down, comparing, contrasting, and interpreting information.
10. Prepare correctly formatted and technically correct written documents that contain few, if any, typographical or grammatical errors.
11. Deliver well-organized oral presentations that maintain audience interest and, make effective use of visual aids during oral presentations.

Course Topics and their Duration:

Course Topics	Duration in weeks
1. Aircraft hydraulic & pneumatic systems; Main hydraulic elements	1
2. Analysis of hydraulic systems: Basic fluid power components	1
3. Analysis of hydraulic systems: Transmission systems	1
4. Analysis of hydraulic systems: Valve controlled systems, Accumulator systems.	1
5. Analysis of hydraulic systems: Accumulator systems, Block diagrams & signal flow diagrams.	1
6. Air data systems: Instrument systems and errors, Standard atmosphere, Speed equations, Total pressure measurement	1
7. Air data systems: Static pressure measurement, Static pressure tubes, using air data tables.	1
8. Attitude indicating instruments: Introduction, Airworthiness requirements, Instrument panels and layout, the gyroscope and its properties, free gyro, Steady precession gyro.	1
9. Attitude indicating instruments: References established by gyroscopes, free gyroscope limitations, apparent drift & transport wander, Real drift, Control of drift and transport wander.	1
10. Attitude indicating instruments: Displacement gyroscope limitations, Gimbal lock, Gimbal error, Gyro horizon.	1
11. Attitude indicating instruments: Gyro Horizon, Erection rate, Erection errors.	1
12. Heading indicating instruments: Direct reading magnetic compass, Terrestial magnetism, Compass construction, Acceleration and turning errors, Gyro compass, Compass construction.	1

13. Heading indicating instruments: Gyro compass, Erection devices, Gimbal errors, Remote indicating compass.	1
14. Presentation of term paper	1

Class Schedule:

- **Lectures:** two 1:20 hour sessions per week
- **Tutorials**: one 1 hour session per week

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: None

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	-	-	-	3	-	3	-	3	-	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Prof. Ali Al-Bahi

Last Updated: June 2008

Course:	AE 463 – Aircraft Automatic Control (3: 3, 2) – Elective Course
Course Description:	Aircraft transfer functions. Open loop response. Aircraft response to atmospheric disturbances. Automatic control. Conventional control theory. Modern control theory. Gyrodynamics. Stability augmentation systems. Longitudinal Autopilots. Lateral Autopilots. Design project.
Prerequisites:	AE 462, MATH 204.
Textbooks & required Materials:	Norman S. Nise, *Control Systems Engineering*, John Wiley & Sons, 2004, (4th edition).

Course Learning Objectives:

By the completion of the course, the students should be able to:

1. Model first and second-order LTI systems by differential operator method and state space method and by Laplace transform.
2. Transform linear equations of motion to the Laplace domain and solve differential equations using Laplace transforms
3. Derive transfer functions and characteristic equations for dynamical systems, state and apply initial and final value theorems.
4. Convert from state space to transfer function system representation and vice versa.
5. Infer the relation between pole-zero locations and time response, derive the impulse response function of first-order, second-order and higher order systems.
6. Identify the system type, and obtain impulse, step, ramp, and acceleration response.
7. Find time and frequency domain solutions of state equations.
8. Define the concepts of the transfer function and the block diagram, and obtain block diagram reductions for open loop systems.
9. Perform closed loop analysis of second order systems, and obtain closed loop transfer functions and the corresponding time response characteristics.
10. Analyze root loci, design closed loop systems using the magnitude and angle criteria, and plot the root locus.
11. Recognize the role frequency response techniques in linear system identification, plot Bode plots for open loop transfer functions, and reconstruct transfer functions from available Bode plots.
12. Derive and state the Nyquest stability criterion, and plot Nyquist diagram.
13. Obtain stability and gain/phase margins via the Nyquist diagram, and relate the concepts to robustness.
14. Design closed loop systems via frequency response to meet closed loop stability and robustness requirements
15. Design aircraft stability augmentation, attitude hold, altitude hold, and Mach hold control systems
16. Use state space analysis of dynamical systems to assess system controllability and observability, and design multivariable control systems via pole placement methodology.

Course Topics and their Duration:

Course Topics:	**Duration in weeks**
1. Review of LTI systems and differential equations solution by Laplace transform	2
2. Transfer functions, zeros, poles, initial/final value theorems, block diagram reduction	2
3. System types, response to impulse, step, ramp, and acceleration inputs	1
4. State space modeling, time and frequency solution to state equations	1
5. Closed loop response and transfer functions, time response characteristics of first and second order systems	1
6. Root locus analysis and design	1
7. Frequency response, Bode plots, phase and gain margins	1
8. Nyquest stability criterion, Nyquist diagram, stability robustness via the Nyquist diagram.	1
9. Closed loop design by frequency response	1
10. MATLAB computer applications on aircraft stability and control augmentations	2
11. Introduction to modern control theory, controllability, observability, pole placement	2

- **Class Schedule:**
  - **Lecture:** three 1 hour sessions per week
  - Tutorials: one 2.0 hours session per week

Course Contribution to Professional Component:

- Engineering science: 60%
- Engineering design: 40%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes											Program Criteria	
	a	b	c	d	e	f	g	h	i	j	k	l	m
Highest Attainable Level of Learning*	2	3	1		2			1	1		1	2	

*1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)

Prepared by: Dr. Balkacem Kada

Last Updated: June 2008

Course:	**AE 482 – Aircraft Maintenance Systems (3:3,1) – Elective Course**

Course Description:

Introduction. Reliability theory. Life testing. Maintained systems. Integrated logistic support (ILS). Aircraft handling. Repair station requirements. Quality systems. Inventory control. Structural repair. Engine maintenance and overhaul. Maintenance of aircraft systems and instruments.

Prerequisites:

IE 331: Probability and Engineering Statistics
AE 361: Aircraft Performance

Textbooks & required Materials:

1. Al Bahi, A.M.; *Introduction to Aircraft Maintenance Engineering and Practices – Part 1 & 2*, KAU, Jeddah, 2006, Course notes (available from AE Dept.)
2. Lewis, E.E.; *Introduction to Reliability Engineering*, John Wiley & Sons, New York, 1987.

Course Learning Objectives:

By the completion of the course, the student will be able to:

1. Define reliability and mathematically formulate failures as a stochastic, age related, random process.
2. Calculate analytic reliability parameters for components as well as redundant and non redundant systems.
3. Use life testing to estimate reliability parameters of systems and components.
4. Plan optimal preventive/corrective maintenance policies for engineering systems.
5. Plan inspection/repair interval for both revealed and unrevealed failures.
6. Analyze maintainability, availability, and integrated logistic support parameters to ensure safe and economic life cycle operation of complex systems.
7. Use simple birth-death processes and queuing theory to measure the effectiveness of maintenance facilities.
8. Analysis inventory control systems including demand models, replenishment, inventory costs, and control policies.
9. Identify aircraft handling and servicing operations and their ground support equipments.
10. Describe aircraft repair station requirements and associated FAA regulations, certifications and publications.
11. Discuss inspection fundamentals applied in aircraft maintenance environment.
12. Evaluate non-destructive testing and crack detection techniques used for aircraft and engine components.
13. Identify load carrying components of the aircraft and their typical structural repair procedures.
14. Identify maintenance and overhaul policies for aircraft engines including fixed time between overhauls, on condition maintenance, cold/hot section inspection, and troubleshooting of malfunctioning.
15. Describe the main elements of aircraft hydraulic systems.
16. Demonstrate ability to achieve objectives of assigned tasks using independent, well organized, ar regularly reported multidisciplinary team management techniques that integrate, evaluate, and improv different skills of team members.
17. Communicate details of personal and team assignments and express thoughts clearly and concisely, bo orally and in writing, using necessary supporting material, to achieve desired understanding and impact.
18. Perform professionally and ethically by demonstrating punctuality, behaving honestly, acceptin responsibility, taking initiative, and providing leadership.

Course Topics and their Duration:

Course Topics:	**Duration in weeks**
1. Introduction, Reliability definitions and function, Mortality curve	1
2. Component mortality, Mean time to failure (MTTF), Useful life, Wearout, Early life, System Mortality.	1
3. Series systems, Parallel systems, Stand-by systems, Multi-mode systems, De-rating.	1
4. Reliability testing; Parametric and non-parametric methods, Censoring and acceleration, Maximum likelihood method, Weibull and exponential reliability papers.	1
5. Maintained systems; Preventive maintenance (P.M.), Idealized P.M. Imperfect P.M., Replacement policy, Corrective maintenance, Revealed failures, Unrevealed failures.	1
6. Maintainability, availability and integrated logistic support (ILS); Down time, Design for maintainability, Life cycle, Maintenance Eng. Analysis (MEA), Level of spare protection.	1
7. Queuing theory; Queuing characteristics, Poisson Process, Birth-Death process.	1
8. Queuing theory; Queuing models, M/M/1 model, M/M/C model, Machine interference model, Measures of effectiveness.	1
9. Aircraft handling; Handling operations, Engine starting, Taxiing, Towing, Jacking, Tying down, Aircraft servicing, Lubrication, Ground support equipment.	1
10. Repair station requirements; FAA regulations, Organization chart, Certification requirements, Storage, Publications, Cleaning operations.	1
11. Inspection fundamentals; Regular inspections, Special inspections. Crack detection and Non Destructive Testing (NDT); Visual inspection, Magnetic Particle Inspection (MPI), Dye Penetrating Inspection (DPI), Radiography, Ultrasonic, Eddy current.	1
12. Structural repair of load carrying components; Fuselage, Wing, Tail and control surfaces, Landing gear, Typical structural repairs.	1
13. Engine maintenance & overhaul; Maintenance policy, Fixed Time Between Overhauls (TBO), on condition maintenance, Engine maintenance and repair, Cold section inspection, hot section inspection (HSI), Engine overhaul, troubleshooting.	1
14. Aircraft hydraulic systems; Main hydraulic elements; Pumps, valves, Pressure regulators, Pressure reducers, Accumulators, Actuators. Oral presentation of a selected subject by each student.	1
15. Inventory control systems; Demand models, Replenishment, Inventory costs, Control policies, some inventory models.	1

Class Schedule:

- **Lectures:** two 1:20 hour sessions per week
- **Tutorials**: one 1.0 hour session per week

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: None

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	3	-	2	3	3	3	3	-	3	-	-

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Prof. Ali M. Al-Bahi

Last Updated: April 2008

Course:	AE 492 – Computer Applications in Aeronautical Engineering (3: 3, 1) – Elective Course
Course Description:	Introduction to CFD, Navier Stokes Equatios, Partial Differential Equations (PDE's) Basics Of numerical methods for solving PDE's, Finite difference Methods for Hyperbolic, Parabolic, and Elliptic PDE's, Finite Volume Methods, Numerical Grid Generation, Applied CFD using Fluent commercial Package.
Prerequisites:	AE 412.
Textbooks & required Materials:	Kalus Hoffmann & Steve T. Chiang, *Computational Fluid Dynamics for Engineers* – Volume I, EES Publications, 2000.

Course Learning Objectives:

By the completion of the course, the students should be able to:

Introduction

1. State the basics steps in a CFD analysis.

Navier Stokes Equations

2. Derive Navier-Stokes equations from the fundamental principles.

Finite Difference Methods

3. State the basics steps in a CFD analysis.
4. Classify partial differential equations (PDE's)
5. Formulate Finite Difference approximations for different types of PDE's
6. Analyze the stability of finite difference approximation.
7. Assess the accuracy of finite difference approximation using benchmark problems.
8. Solve fluid dynamics and heat transfer problems in one and two dimensions for simple domains.

Finite Volume Methods

9. Formulate Finite Volume approximations for different types of PDE's.

Fluent

10. Use the CFD package FLUENT to study and analyze fluid engineering problems.

Course Topics and their Duration:

Course Topics	Duration in weeks
6. Introduction	1
7. Navier-Stokes Equations	1
8. Finite Difference Methods	5
9. Finite Volume Methods	1
10. Fluent	6

Class Schedule:

- **Lecture:** two 80 minutes sessions per week
- **Tutorials**: one 100 minutes session per week

Course Contribution to Professional Component:

- Engineering science: 100%
- Engineering design: 0%

Course Relationship to Program Outcomes:

Program Outcomes	ABET Outcomes										
	a	b	c	d	e	f	g	h	i	j	k
Highest Attainable Level of Learning*	2	1	-	-	2	-	2	-	-	-	2

***1: Low level (knowledge & Comprehension), 2: Medium (Application & Analysis), 3: High (Synthesis & Evaluation)**

Prepared by: Dr. Ibraheem Al-Qadi

Last Updated: May 2008