Course name: Advanced Mathematics	**Course code:** MA504

Location in curricular map:
Specialization Axis
Course description: The purpose of this course is to provide the student the methodologies for the analysis, modeling, synthesis and simulation, used for applications in the design of behaviors of mechanical, thermal, fluid, electrical, electromagnetic and electronic systems. Also, energy methods and state variables are studied. The course begins with the formulation of equations, linear system time response, Laplace transform, computational simulations, as well as the kinematics and kinetics of mechanisms for dynamic mechanical systems.

Course learning outcomes:

At the end of the course, the student will:

Know and comprehend the formulation, modeling and simulation of mechanical systems.

Know and apply mathematical modeling software to solve problems.

Analyze the mathematical models of physical systems.

Be able to change any analysis parameter considered in the mathematical formulation.

Course content:

Topics for each unit:	*Hours*
1. Differential Equations	*3*
2. Multivariable calculus	*3*
3. Laplace transform	*3*
4. Introduction to Dynamic Systems	*4*
5. Mechanical Systems	*3*
6. The transfer function: an approximation to the modeling of dynamic systems	*4*
7. State space as an approximation of dynamic systems	*2*
8. Electrical and electromechanical systems	*2*
9. Fluid and thermal systems	*2*
10. Mechanical synthesis	*4*
11. Kinematics of mechanisms	*4*
12. Kinetics of mechanisms	*2*

Learning activities guided by professor:	**Hours 36**
1. Thematic exposition by professor	12
2. Laboratory practices and/or workshops guided by professor	12
3. Discussion and/or presentation plenary guided by professor	8
4. Small group activities guided by professor	2
5. Individual activities guided by professor	2

Independent learning activities:	Hours
1. Presentation of materials selected by professor. • The student must present thematic material. • The student must read an application paper.	12
2. Writing of an article, essay or reading summary. • The student must write a technical article that presents a real technical application.	4
3. Solution of problems selected by professor. • The student must solve 16 total problems.	24
4. Laboratory practices. • The student must solve exercises in a guided workshop, as well as variations of these.	8
5. Integral course project. • This activity consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	4

Evaluation procedures and instruments:

The evaluation procedures and instruments for this course are the following:

1. Presentations.
    - The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic.
2. Deliverables.
    - The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor.
    - The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools.
3. Presentations of the final project prototype.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Technical article 25 points.
    - Solution to 16 problems 30 points.
    - Research and presentation of a topic 15 points.
    - Final project 30 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	System Dynamics	Katsuhiko Ogata,	Prentice Hall	2003
2	Reference	Introduction to Physical Systems	Rosenberg y Karnopp	McGraw Hill	1983
3	Text	Advanced Engineering Mathematics	Erwing Kreyzig	Wiley, John & Sons	2005
4	Reference	Modeling, Analysis, and Control of Dynamic Systems	William J. III Palm	Wiley, John & Sons	1999

Course name: Materials Engineering	**Course code:** MF 506

Location in curricular map:
Specialization Axis

Course description:
The course is focused on the comprehension and knowledge of materials in engineering and the behavior of these when they are subject to work conditions and environments, as well as the processing that allows for them to yield products with diverse degrees of functionality.

Course learning outcomes:
At the end of the course, the student will: Know and comprehend the behavior of materials and their classification. Analyze the specific and combined parameters for the selection of materials.. Know the primary manufacturing processes that exist in the region and be able to detail and calculate them. Do reverse engineering for a product.

Content and specific learning outcomes:

Introduction

- Relationship between the design and manufacturing processes
- Aspects to consider in the selection of materials
- Aspects to consider in the selection of manufacturing processes
- Current design and manufacturing environment

Part I. Fundamentals of Materials: manufacturing behavior and properties.

Learning outcome:

Comprehend and explain the behavior, properties and characteristics of materials, to understand the relationship between these and the manufacturing processes described in part II.

Topics:

- Classification and general aspects of materials
- Mechanical properties
- Physical properties
- Structure, general properties and applications of each category of materials: metals, polymers, ceramic and composite.

Part II. Fundamentals of materials processing: processes and equipment used for product elaboration.

Learning outcome:

Know and comprehend the processing techniques most commonly used for materials transformation into useful products, seeking to manipulate elements of each process and identify the relationships between material variables, form and obtained properties, for each of the studied processes.

- Metal melting processes
- Volumetric deformation of materials
- Metal plate forming processes
- Material removing processes
- Thermal treatments

	Hours

Course content:	**Tema**
Introduction	**2**
Part I	**15**
1. Classification and general aspects of materials	1
2. Mechanical properties	4
3. Physical properties	2
4. Structure, general properties and applications for each category of materials and selection of materials in engineering considering specific properties and design.	8
Part II	**17**
5. Metal melting processes	2
6. Volumetric deformation processes	3
7. Metal plate forming processes	4
8. Material removing processes	4
9. Thermal treatments	4
Final project presentations	**2**

Learning activities guided by professor:	Hours **36**
1. Thematic exposition by professor 2. Discussion and/or presentation plenary guided by professor 3. Small group activities guided by professor 4. Individual activities guided by professor	12 10 6 8

Evaluation procedures and instruments:

The evaluation procedures and instruments for this course are the following:

1. Presentations.
    - The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic.
2. Deliverables.
    - The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor.
    - The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools.
3. Presentations of the final project prototype.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Technical article 25 points.
    - Reading reports 25 points.
    - Research and presentation of a topic 20 points.
    - Final project 30 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Independent learning activities:	Hours
1. Presentation of materials selected by professor. • The student must present thematic material. • The student must read an application paper.	12
2. Writing of an article, essay or reading summary • The student must write a technical article that presents a real technical application.	4
3. Solution of problems selected by professor. • The student must solve 4 process design problems.	4
4. Laboratory practices. • The student must solve exercises in a guided workshop, as well as variations of these.	8
5. Integral course project. • This activity consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	4

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	" Materials Science and Engineering : An Introduction"	Callister, William	John Wiley and Sons	1993
2	Text	“Materials Selection in Mechanical Design”	Michael F. Ashby	Butterworth & Heinemann	2000
3	Reference	“Materials and Design”	Michael F. Ashby	Butterworth & Heinemann	2002
4	Reference	" Introduction to Materials Science for Engineers"	Shackelford, J.	Macmillan Publishing Company	1985
5	Reference	“Manufacturing processes for engineering materials”	Serope Kalpakjian	Prentice Hall	2000
6	Reference	“Metal Forming”	Gegel H. , Altan T. y Soo-Ik	Addison Wesley	1995

Course name:	Course code:
Conceptual Aerospace Design	MF 511

Location in curricular map:
Specialization Axis
Course description: The course focuses on the preliminary dimensioning of an airplane given the appropriate specifications. The design characteristics include the aerodynamic configuration, weight, drag, velocity, propulsion, structural configuration, stability and control. The students develop conceptual designs for an airplane with specific characteristics.

Course learning outcomes:
At the end of the course, the student will: Apply various concepts and tools that allow him or her to design and analyze the initial conditions for conceptualization of a new aircraft, and the practice of design techniques. Analyze specific and combined parameters for materials selection. Know the primary manufacturing processes for the elaboration of a prototype.

Course content:

Topics for each unit:	*Hours*
1. Introduction to aeronautic vehicles	*4*
2. Conceptual design factors for an aircraft	*5*
3. Dimensioning of an aircraft	*5*
4. Types of propulsion	5
5. Aerodynamics, wing design and push	5
6. Materials, structures and loads	5
7. Stability and control	4
8. Security	3

Learning activities guided by professor:	Hours 36
1. Thematic exposition by professor	12
2. Discussion and/or presentation plenary guided by professor	10
3. Small group activities guided by professor	6
4. Individual activities guided by professor	8

Evaluation procedures and instruments:

The evaluation procedures and instruments for this course are the following:

1. Presentations.
    - The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic.
2. Deliverables.
    - The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor.
    - The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools.
3. Presentations of the final project prototype.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Homework 10 points.
    - Lab practices and reports 20 points.
    - Reading reports 10 points.
    - Quizzes 20 points.
    - Final exam 20 points
    - Final project 20 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Independent learning activities:	Hours
1. Reading of materials selected by professor. • The student must do individual reading to know and comprehend in detail the conceptual design of an airplane. • The student must read an application paper relating to the conceptual design of an airplane.	6
2. Writing of an article, essay or reading summary • The student must write a technical article that presents a real technical application.	4
3. Solution of problems selected by professor. • The student must solve 4 problems that involve wing design, conceptual structural design and airplane performance. • The student must present at least 2 exercises for each unit.	16
4. Laboratory practices. • The student must use various materials to construct the principal components of an aircraft. • The student will construct a prototype of an aircraft.	12
5. Laboratory practices with computer. • The student will model the deflection and/or energy behavior of at least 10 problems using maple. Previous definition by professor. • The student will do finite element exercises using specialized software.	20
6. Integral course project. • This activity consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	6

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	‘Aircraft Design: A conceptual Approach’	D. P. Raymer	AIAA Education Series	1999
2	Text	‘Elements of Spacecraft Design’	C. D. Brown	AIAA Education Series	2003
3	Reference	‘Airplane flight Dynamics and Automatic flight	Jan Roskam	Data corporation	2003
4	Reference	Aircraft Conceptual Design Synthesis	Denis Howe	Wiley	2005

Course name: Finite Element for Aerospace Applications	**Course code:** MF 512

Location in curricular map:
Specialization Axis
Course description: The purpose of this course is to study the fundamentals of finite element with emphasis in theory, conditions and characteristics of modeling, so the student may use software that allow the solving of various applications for aerospace components. The emphasis is in aerospace components application, including stress and rigidity analysis, heat transfer and thermal stress, as well as the modes and natural frequencies of vibration problems.

Course learning outcomes:

At the end of the course, the student will:

Know and comprehend the techniques and methods for finite element analysis, formulation and evaluation.

Apply the finite element method to structures, armatures and supports.

Calculate stress, strain and security factors in aero structures.

Calculate temperature distribution in molds, modes and frequencies due to vibration of mechanical parts.

Course content:

U	Topics for each unit	Hours.
1	Introduction to rigidity method Definition of the finite element method Derivation of rigidity matrices Boundary conditions Potential energy	6
2	Armatures, structures and supports Derivation of rigidity matrix for armatures and supports	4
3	Development of the stress and strain plane Practical considerations in modeling and results interpretation	4
4	Axis-symmetrical elements Iso-parametric formulation Polynomial stress analysis	4
5	Elements of plate flexion Basic concepts Comparisons	4
6	Heat and fluid transfer Conduction, convection and radiation formulation Heat dissipation in 2D plates such as fins, 3D case, molds Uni-dimensional and bi-dimensional cases formulation	6
7	Structural dynamics Vibrations, modes of vibration, frequencies Effects and calculations on aero structures	4
8	Case study	4

	Total	36

Evaluation procedures and instruments:
The evaluation procedures and instruments for this course are the following: 1. Presentations. • The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic. 2. Deliverables. • The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor. • The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools. 3. Presentations of the final project to group.

Evaluation criteria:
1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities. 2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100. • Technical article 25 points. • Exams 25 points. • Homework and lab practices 20 points. • Final project 30 points. 3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student. 4. The minimum passing grade is 80 points. 5. A student may not obtain a failing grade due to accumulated non attendance.

Independent learning activities:	Hours
1. Presentation of materials selected by professor. • The student must present thematic material. • The student must read an application paper.	12
2. Exams. • The student will do exams during the course.	4
3. Solution of problems selected by professor. • The student must solve 3 problems for each unit.	4
4. Laboratory practices. • The student must solve exercises in a guided workshop, as well as variations of these.	8
5. Integral course project. • This activity consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	4

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	Finite Element Method	Daryl L. Logan	Thomson Learning	2002
2	Text	Concepts and Applications of Finite Element Analysis	Robert D. Cook, et al	Wiley	2001
3	Reference	Finite Element Modeling for Stress Analysis	Robert D. Cook	Wiley	1995
4	Reference	Applied Finite Element Analysis	Larry Segerlind	Wiley	1984
5	Reference	An Introduction to the Finite Element Method	J. N. Reddy	Mc GRAW HILL	1994
6	Reference	Finite Element Analysis	Saeed Moaveni	Pearson	2003
7	Reference	Finite Element Modeling for Stress Analysis	Robert D. Cook	Wiley	1995
8	Reference	The Finite Element Method for Engineers	Kenneth H. Huebner, et al	Wiley	2001

Course name:	Course code:
Aerospace Prototype Design	MF 513

Location in curricular map:
Specialization Axis
Course description: This course is oriented towards studying the various methodologies for computer aided parts design, design for assembly as well as the various techniques to generate rapid prototypes and also that these may be evaluated under laboratory conditions and verified using computer data acquisition systems.

Course learning outcomes:
At the end of the course, the student will:
Select and improve manufacturing operations involved in the fabrication of metal-mechanical products, via the selection of materials, the modification of mechanical properties, the selection of processes relating to fabrication, creation and assembly of rapid prototypes of special materials, with modern fabrication techniques that allow the visualization in a better context of the functionality of the product and implement methodologies of higher quality.

Course content::	Hours
1. Introduction to the development of an aero-part.	3
2. Tools for the product development process.	3
3. Dimensional requirements and functional properties.	3
4. Establishing the functionality of the aero-part.	3
5. Engineering specifications.	3
6. Computer aided design.	3
7. Good and bad designs.	3
8. Interoperability of design formats.	3
9. Conceptual rapid prototype modelers.	3
10. Generators and modelers of physical prototypes.	3
11. Secondary physical generators.	3
12. Robust design.	2
The course contemplates the development of a design or redesign project for a product or component.	1

Learning activities guided by professor:	**Hours 36**
1. Thematic exposition by professor	12
2. Thematic exposition by student.	12
3. Discussion and/or presentation plenary guided by professor.	4
4. Lab work designing virtual prototypes.	4
5. Lab work with physical modelers.	4

Independent learning activities:	Hours
1. Presentation of materials selected by professor. • The student must present thematic material • The student must read an application paper	12
2. Writing of an article, essay or reading summary • The student must write a technical article that presents a real technical application	4
3. Solution of problems selected by professor. • The student must solve 4 problems relating to the improvement of an aero-part.	4
4. Laboratory practices. • The student must solve exercises in a guided workshop, as well as variations of these.	8
5. Integral course project. • This activity consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	4

Evaluation procedures and instruments:
The evaluation procedures and instruments for this course are the following: 1. Presentations. • The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic. 2. Deliverables. • The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor. • The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools. 3. Presentations of the final project prototype.

Evaluation criteria:
1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities. 2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100. • Technical article 25 points. • Solution of 4 problems 30 points. • Research and presentation of a topic 15 points. • Final project 30 points. 3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student. 4. The minimum passing grade is 80 points. 5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	Rapid Prototyping: Principles and Applications	Rafiq I. Noorani	Wiley	2005
2	Reference	Rapid and Virtual Prototyping and Applications	C. E. Bocking, Allan Rennie, David Jacobson	Wiley	2003
3	Reference	Rapid Prototyping: Theory and Practice	Ali K. Kamrani, Emad Abouel Nasr	Springer	2006

Course name: Aerospace Structural Analysis.	**Course code:** MF 514

Location in curricular map::
Aerospace Engineering Masters, Specialization: Structural

Course description:
The course covers the introduction to design and analysis of plane structures, including: configuration, design criteria, design concept, wing and fuselage sections properties, bending of supports and plates, wall torsion, fault mechanisms and predictions, asymmetric flexion, energy methods, introduction to composite structures, material selection, tolerance of durability and fatigue.

Course learning outcomes:
At the end of the course, the student will:
Know the relationship between designs based on mathematical and experimental models.
Use software for the design verification.
Use experimental equipment for information acquisition like unitary deformation in quarter, half and full bridges, as well as the use of rosettes with gauges as well as compensation for temperature and other effects.

Course content:	Hrs.

1. BASIC CONSIDERATIONS FOR STRESS AND STRAIN. 1.1 Stress and strain concepts 1.2 Principal types of stress, planes and directions	4
2. ELASTIC RELATIONSHIP AND STRAIN. 2.1 Hook's generalized law, stress vs. strain 2.2 Mohr circle for stress and strain 2.3 Polar diagram for stress and strain	4
3. FAULT THEORIES. 3.1 Tresca criteria 3.2 Maximum primary stress theory 3.3 Moh'rs fault theory	4
4. STRESS CONCENTRATION FACTORS. 4.1 Due to dimensional changes because of machining, drilling for screws, filet radius, manufacturing like soldering, superficial scratches, etc.	3
5. CONTACT STRESS. 5.1 Stress by external or internal cylindrical contact. 5.2 Stress by external or internal spherical contact. 5.3 Other types of contact.	3
6. EXPERIMENTAL STUDY OF PHOTO ELASTICITY, FRAILTY AND GAUGES. 6.1 Photo elasticity, principles and materials. 6.2 Theoretical considerations in stress and strain. 6.3 Relationship between strain and change in resistance 6.4 Analysis of rectangular and equiangular rosettes. 6.5 Installation of gauges and rosettes and construction of load cell. 6.6 Temperature compensation.	8
7. ELASTICITY AND PLASTICITY 7.1 Elastic properties, Modules: Young, Poisson, Cedencia, etc. 7.2 Plastic properties, hardening constant and exponent. 7.3 Ramberg-Osgood equation.	4
8. ELASTIC DEFLECTION – CASTIGLIANO METHOD. 8.1 Castigliano theorem 8.2 Strain energy due to: - Axial load. - Torsion load. - Flexional load. - Transversal load. 8.3 Determination of deflection via the Castigliano method.	6
Total	36

Learning activities guided by professor:	Hours 36
1. Thematic exposition by professor	12
2. Discussion and/or presentation plenary guided by professor	10
3. Small group activities guided by professor	6
4. Individual activities guided by professor	8

Evaluation procedures and instruments:

The evaluation procedures and instruments for this course are the following:

1. Presentations.
    - The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic.
2. Deliverables.
    - The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor.
    - The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools.
3. Presentations of the final project prototype.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Homework 10 points
    - Lab practices and reports 20 points.
    - Presentation of reading reports 10 points.
    - Quizzes 20 points
    - Final Exam 20 points
    - Final project 20 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Independent learning activities:	Hours

1. Reading of materials selected by professor. • The student must do individual reading to know and comprehend in detail the concepts relating to mechanical properties and their behavior with loads. • The student must read an application paper relating mechanical properties.	6
2. Writing of an article, essay or reading summary • The student must write a technical article that presents a design problem application as well as the tools and methodologies to solve it.	4
3. Solution of problems selected by professor. • The student must solve 4 problems that involve stress states, strain, dimensioning, fault theory and stress concentration factors. • The student must present at least 2 exercises for each unit.	16
4. Laboratory practices. • The student will test mechanical parts. • The student will make transversal cuts to photo-elastic material. • The student will use equipment to measure unitary strain.	12
5. Laboratory practices with computer. • The student will model the deflection and/or energy behavior of at least 10 problems using maple. Previous definition by professor. • The student will do finite element exercises using specialized software.	20
6. Integral course project. • Optional activity that consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	6

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	"Advanced Mechanics of Materials",	Boresi Arthur P. and SideBottom Omar M.	Wiley	1993
2	Reference	"Stress, Strength & Strain"	Robert C. Juvinall,	McGraw-Hill	1983
3	Reference	"Engineering Design"	Joseph H. Faupel, Franklin e. Fisher	Wiley	1981
4	Reference	"Elasticity in Engineering"	Boresi and Chong,	Interscience	1999
5	Reference	"Mechanics of Materials"	Higdon Archie, Ohlsen Edward, et al	Wiley	1993
6	Reference	"Advanced Strength & Applied Elasticity"	Ugural Ansel	Prentice Hall	2003
7	Reference	"Experimental Stress Analysis"	Daily & Riley	McGraw-Hill	1978
8	Reference	"The gage Primer"	Perry, Lissner	McGraw-Hill	1962
9	Reference	., "Advanced Strength & Applied Stress Analysis"	Budynas, R.G.	McGraw-Hill	1977
10	Reference	"Formulas for Stress and Strain"	Raymond Roark	McGraw-Hill	1975
11	Reference	"Stress Concentration Factors"	Walter D. Pilkey	Wiley	1997
12	Reference	"Manufacturing Processes for Engineering Materials"	Serope Kalpakjian.	Addison Wesley	1997

Course name: Materials Resistance and Fatigue	**Course code:** MF 515

Location in curricular map:
Aerospace Engineering Masters, Specialization: Structural

Course description:
Plane structures and their components are submitted to fluctuating stress that modifies the internal structure of the materials used, diminishing their resistance to fatigue, ultimately producing fractures. This diminishing of resistance to fatigue, not only produces structural modifications but also other factors such as corrosion, structural defects due to the fabrication of the element in service. The existence of a fissure and the growth of it originated by the workings of the element, or due to a defect in the fabrication of its geometry and mostly due to drastic changes in the section, corresponding to the mechanics of the fracture, ultimately contribute to the failure of the component. It is deduced that the fracture, as well as the fatigue constitute factors to take into account in the design of any mechanical or structural component in engineering.

Course learning outcomes:
At the end of the course, the student will: Aplicación de los diferentes conceptos y herramientas que permitan al estudiante comprender la importancia de la selección de los materiales, los fundamentos de la fatiga, los fundamentos de la fractura tanto dúctil como frágil, la propagación de las grietas, las evidencias superficiales de las fracturas, los factores que contribuyen a la corrosión de los elementos, y las formas de protección de los mismos.

Course content:

1. Historical cases of faults in aircraft a) Materials selection. b) The process of joints between elements. c) Forming process. d) Superficial treatment process. e) The importance of various factors that contribute to faults in aircraft elements.	***Hours*** 5
2. Fundamentals of factors that contribute to a fault a) Fundamentals of fracture b) Ductile fracture. c) Fragile Fracture. d) Mechanical principles of fracture. e) Stress concentration. f) Griffith fragile fracture theory. g) Irwin ductile fracture theory. h) Combined stress. i) Fracture tenacity. j) Design based on the mechanics of the fracture. k) Fatigue l) Cyclic stress m) S-N curve.	***Hours*** 20

n) Initiation and propagation of fissure. o) Stress marks. p) Fissure propagation velocity. q) Fault cycle prediction. r) Fatigue factors that affect life span. s) Life span under fatigue improvement methods.	
3. Fundamentals of corrosion a) Electrochemical considerations. b) Electrode potential. c) FEM standard series. d) Galvanic series. e) Corrosion velocity. f) Passivity. g) Environmental factors. h) Forms of corrosion. i) Environmental corrosion. j) Cathode protection. k) Corrosion prevention. l) Oxidation.	***Hours*** *5*
4. Parts design details and consideration of material selectivity	***Hours*** 6

Learning activities:	**Hours:**
• **In-class activities:** - Presentation of topic by professor. - Presentations by guest speakers. - Case and topic discussions. - Final project presentations. • **Independent activities:** - Reading of applied research case studies. - Homework tasks. - Exercises and lab practices. - Research.	**60**

Evaluation criteria and procedures:
The evaluation instruments are as follows: • Final exam. • Homework tasks and research homework. • Final research project. • Participation. The weight in points for each of these instruments will be established between the group and the professor in the first class session.

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	" Materials Science and Engineering : An Introduction"	Callister, William	John Wiley and Sons	1993
2	Reference	“Dual Element Analysis of crack Growth”	Portela A.	Computational Mechanics, Publication.	1993
3	Reference	. “Fracture and Fatigue Control in structures”.	Rolfe, Stanley, Barson John	Prentice Hall	1977
4	Reference	" Introduction to Materials Science for Engineers"	Shackelford, J.	Macmillan Publishing Company	1985
5	Reference	“Fracture Mechanics Fundamentals and Application”	Anderson, T. L.	CRC	1995

Course name: Composite Materials Mechanics	**Course code:** MF 516

Location in curricular map: Aerospace Engineering Masters, Specialization: Structural

Course description: This course covers the analysis and design of composite materials structures, which are more complex than those of metallic parts. This is due, of course, to the anisotropic nature of typical composite laminate materials. This course provides basic knowledge and comprehension of composite materials mechanics and allows for their efficient use in aerospace design applications.

Course learning outcomes: At the end of the course, the student will: Develop a strong understanding for the role of the primary components of composites in behavior under low loads. Comprehend and calculate how orientations affect the resistance of laminates. Apply concepts to analyze and design composites of reinforced fibers for engineering applications. Analyze stress and strain in isotropic and anisotropic materials with continuous and discontinuous reinforcements.

Course content:

	Topics for each unit:	***Hours***
1	Introduction, application and fabrication processes	*3*
2	Reinforcement principles	*3*
3	Unitary stress-strain relationship in anisotropic materials	*4*
4	Orthotropic materials analysis	*4*
5	Resistance of reinforced laminates with continuous fibers	*4*
6	Mechanical tests for composites	*3*
7	Hydro-thermal behavior of plates	*2*
8	Resistance of reinforced laminates with discontinuous fibers	*3*
9	Laminated supports	*3*
10	Theory of laminated plates	*4*
11	Resistance, deflection, bending of laminates	*3*

Learning activities guided by professor:	Hours 36
1. Thematic exposition by professor	12
2. Discussion and/or presentation plenary guided by professor	10
3. Small group activities guided by professor	6
4. Individual activities guided by professor	8

Evaluation procedures and instruments:

The evaluation procedures and instruments for this course are the following:

1. Presentations.
    - The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic.
2. Deliverables.
    - The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor.
    - The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools.
3. Presentations of the final project prototype.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Homework 10 points
    - Lab practices and reports 20 points.
    - Presentation of reading reports 10 points.
    - Quizzes 20 points
    - Final Exam 20 points
    - Final project 20 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Independent learning activities:	Hours
1. Reading of materials selected by professor. • The student must do individual reading to know and comprehend in detail the concepts relating to mechanical properties and their behavior with loads. • The student must read an application paper relating mechanical properties.	6
2. Writing of an article, essay or reading summary • The student must write a technical article that presents a design problem application as well as the tools and methodologies to solve it.	4
3. Solution of problems selected by professor. • The student must solve 4 problems that involve stress states, strain, dimensioning, fault theory and stress concentration factors. • The student must present at least 2 exercises for each unit.	16
4. Laboratory practices. • The student will use composite materials for tension tests. • The student will construct a parts sampler of parts made of composites. • Build a prototype made of composite materials.	12
5. Laboratory practices with computer. • The student will model the deflection and/or energy behavior of at least 10 problems using maple. Previous definition by professor. • The student will do finite element exercises using specialized software.	20
6. Integral course project. • Optional activity that consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	6

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	Principles of Composite Materials Mechanics	R. F. Gibson	McGraw-Hill	1994
2	Reference	Mechanics of Composite Materials	R. M. Jones	Taylor and Francis	1990
3	Reference	Mechanics of Composite Materials	R. M. Christensen	Wiley	1991
4	Reference	Introduction to Composite Materials	Tsai and Haln	Technomic	1980
5	Reference	An Introduction to Composite Materials	D. Hull	Cambridge Univ.	1996
6	Reference	Analysis and Performance of Fiber Composites	D. Agarwal and L. J. Broutman	Wiley	1990

Course name: Aerodynamics.	**Course code:** MF 517

Location in curricular map::
Specialization Axis

Course description:
Basic relationships that describe the flow surrounding the wings and fuselages at subsonic and supersonic velocities. Thin wing theory. Formulation of theories to evaluate forces and moments in geometries of aircrafts. Applications to high speed aircraft.

Course learning outcomes:
At the end of the course, the student will:
Comprehend the principles of aerodynamics and the capacity to apply analysis principles to formulate and solve engineering problems.
Demonstrate familiarity with design principles of the components of the aircraft.

Course content:

Topics for each unit:	***Hours***
1. Aerodynamic principles and fundamentals.	*4*
2. Uncompressible flow.	*3*
3. Viscous flow.	*3*
4. Uncompressible flow in sustentation layers.	*4*
5. Uncompressible flow on finite wings.	*4*
6. Compressible flow dynamics through injectors, diffusers and wind tunnels.	*4*
7. Subsonic compressible flows.	*3*
8. Linear supersonic flow.	*3*
9. Introduction to non-linear supersonic flow techniques.	*3*
10. Hypersonic flow.	*3*
11. Special flow cases.	*2*
Total	*36*

Evaluation procedures and instruments:

The evaluation procedures and instruments for this course are the following:

1. Presentations.
    - The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic.
2. Deliverables.
    - The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor.
    - The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools.
3. Presentations of the final project prototype.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Technical article 25 points.
    - Exams 25 points.
    - Homework tasks and lab practices 20 points.
    - Final project 30 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Independent learning activities:	Hours
1. Presentation of materials selected by professor. • The student must present thematic material. • The student must read an application paper.	12
2. Exams. • The student will do exams during the course.	4
3. Solution of problems selected by professor. • The student must solve 3 problems for each unit.	4
4. Laboratory practices. • The student must solve exercises in a guided workshop, as well as variations of these.	8
5. Integral course project. • This activity consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	4

Bibliography

	Type	Title	Author	Publisher	Year
1	Reference	Fundamentals of Aerodynamics	John D. Anderson	McGraw-Hill	2005
2	Reference	Aerodynamics for Engineers	John J. Bertin	Prentice Hall	2001
3	Reference	Aerodynamics of Wings and Bodies	Ashley and Landahl	Dover	1985
4	Reference	Aerodynamics of Turbo machinery	ASME	ASME Press	2000
5	Reference	Aerodynamics, Aeronautics and flight mechanics	Barnes, Mc Cormick	Wiley and Sons	1994
6	Reference	Classical Aerodynamic Theory	NASA	University Press of the Pacific	2005

Course name:	Course code:
Thermo-fluids Fundamentals	MF 507

Location in curricular map:
Specialization Axis

Course description:

This course has the objective to introduce the first year graduate student to the fundamental aspects of fluid mechanics, heat transfer and thermodynamics. The emphasis of the course is in the application of fundamental principles of these sciences and the practical understanding of the operation of various devices, processes and systems in industry. During class sessions, the basic theory will be accompanied by multiple practical problems.

During the course the student will do reading and homework independently. At the end of the course the student will do a final project that applies the principles studied throughout the course.

Course learning outcomes:

At the end of the course, the student will:

Know and comprehend the fundamentals of fluid mechanics, heat transfer and thermodynamics.

Solve industrial application problems using the principles of fluid mechanics, heat transfer and thermodynamics.

Solve various thermal energy consumption systems and various energy conversion systems.

Identify areas of opportunity for the improvement of industrial systems.

Course content:	Hours
1. Fundamentals of heat transfer 1.1 Introduction 1.1.1 Conduction 1.1.1.1 Heat conduction in 1D, 2D y 3D 1.1.1.2 Transient heat conduction 1.1.2 Convection 1.1.2.1 Forced convection 1.1.2.2 Free convection 1.1.2.3 Heat transfer with phase change 1.1.3 Radiation	12
2. Fundamentals of thermodynamics 2.1 Basic concepts, definitions, pure substance properties 2.2 Heat, work and energy 2.3 First law of thermodynamics 2.4 Second law of thermodynamics	12
3. Fundamentals of fluid mechanics 3.1 Introduction 3.2 Fluid statics 3.3 Fluid dynamics 3.4 Viscous fluid flow 3.5 Flow of submerged bodies .4. Fundamentals of psychrometrics 4.1 Properties of wet air 4.2 Psychrometric processes and applications	12

Learning activities guided by professor:	Hours **36**
1. Thematic exposition by professor	28
2. Laboratory practices and/or workshops guided by professor	4
3. Discussion and/or presentation plenary guided by professor	4
4. Small group activities guided by professor	OP
5. Individual activities guided by professor	OP

Independent learning activities:	Hours 60
1. Reading of materials selected by professor.	15
2. Writing of an article, essay or reading summary	OP
3. Solution of problems selected by professor.	25
4. Field practices.	OP
5. Research and development of a topic assigned by professor.	OP
6. Integral course project.	20

Evaluation procedures and instruments:

The evaluation procedures and instruments are the following:

1. Oral or written exam.
   - The student must prove to the professor via an oral or written exam, the knowledge of the primary course topics.
2. Deliverables.
   - The student will deliver a report for each of the selected problems, which must be solved individually.
   - The student will deliver a report of the final project.
3. Presentations.
   - All students must present the final project, on the day and hour that is established by the group and professor.
4. Participation in discussion sessions.
   - This will not be subject to evaluation.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Written or oral exam 30 points.
    - Solution and implementation of 4 problems 40 points.
    - Final project 30 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Bibliography

	Type	Title	Author	Publisher	Year
	Reference	Heat transfer a practical approach 2nd Edition	Cengel Y.A.	McGraw-Hill	2003
	Reference	Thermodynamics an Engineering approach 4th Edition	Cengel Y.A., Boles M.A.	McGraw-HIll	2002
	Reference	Fluid Mechanics 5th Edition	White F.M.	McGraw-HIll	2003

Course name: Advanced Thermodynamics.	**Course code:** MF 519

Location in curricular map::
Specialization Axis

Course description:
The course is based on the application of the first law of thermodynamics for the conversion of thermo mechanical energy in propulsion systems. Also, given the basic geometry and ideal component performance the specific push and impulse of a gas turbine may be estimated using the principles of fluids and thermodynamics.

Course learning outcomes:
At the end of the course, the student will:

1. Establish the first law of thermodynamics and define heat and thermal efficiency, as well as the difference between various forms of engineering.
2. Identify and describe energy exchange processes in aerospace systems.
3. Apply steady state energy equations of the first law of thermodynamics to components of thermodynamic systems (heaters, coolers, pumps, turbines, pistons, etc.) to estimate balances required for heat, work and energy flow.
4. Apply the ideal cycle, analyze simple machine thermal cycles, to estimate thermal efficiency and work as a function of pressure and temperature in various points of the cycle.
5. Apply volume control analysis and the integral moment equation to estimate the forces produced by propulsion systems.
6. Calculate the required power for range and capacity of flight, given the weight, geometry, aerodynamics and propulsion.

Course content:

Unit	**Topics for each unit:**	Hours
1	Basic relationships of the first law of thermodynamics.	*2*
2	Second law of thermodynamics.	*3*
3	Availability analysis.	*3*
4	Cycle availability analysis.	*4*
5	State equations.	*3*
6	Relationships between thermodynamic properties.	*4*
7	Third law of thermodynamics.	*3*
8	Homogeneous mixes and thermodynamic properties.	*3*
9	Multi-component and multiphase systems.	*3*
10	Chemical reactions.	*3*
11	Chemical availability.	*3*
12	Chemical availability of fuels.	*2*
	Total	*36*

Evaluation procedures and instruments:

The evaluation procedures and instruments for this course are the following:

1. Presentations.
    - The student must prove to the professor and group that he or she has prepared for the presentation of the specific topic.
2. Deliverables.
    - The student must deliver a technical article that is derived from a professional inquiry or a topic assigned by the professor.
    - The student must deliver reports and files of the virtual designs in the formats of the physical prototype modeling tools.
3. Presentations of the final project prototype.

Evaluation criteria:

1. The evaluation instruments and procedures will be centered on the guided and non guided learning activities.
2. The professor will evaluate and assign a grade to each of the evaluation instruments. The grade must be within 0 and 100.
    - Technical article 25 points
    - Exams 25 points.
    - Homework tasks and lab practices 20 points.
    - Final project 30 points.
3. The professor will report to the Graduate College the grade average for all the evaluation instruments obtained by each student.
4. The minimum passing grade is 80 points.
5. A student may not obtain a failing grade due to accumulated non attendance.

Independent learning activities:	Hours
6. Presentation of materials selected by professor. • The student must present thematic material. • The student must read an application paper.	12
7. Exams. • The student will do exams during the course.	4
8. Solution of problems selected by professor. • The student must solve 3 problems for each unit.	4
9. Laboratory practices. • The student must solve exercises in a guided workshop, as well as variations of these.	8
10. Integral course project. • This activity consists of the implementation of the solution presented in the technical article. However, hours can be exchanged with those of activity 3, with previous approval by the professor.	4

Bibliography

	Type	Title	Author	Publisher	Year
1	Text	Advanced Thermodynamics for Engineers	Kenneth Wark, Kenneth Wark	McGraw-Hill	1994
2	Reference	Advanced Engineering Thermodynamics	Adrian Bejan	Wiley and sons	2006
3	Reference	Advanced Thermodynamics Engineering	Kalyan Annamalai, Ishwar K. Puri	CRC Press	2001
4	Reference	Advanced Thermodynamics for Engineers	Desmond E. Winterbone	Elsevier Science & Technology	1996

Course name: Application Project	**Course code:** CS 501

Location in curricular map: Terminal Axis

Course description: Throughout the course, the student will develop pan application project that demonstrates the capacity for analysis, team work, interpretation and application of knowledge and tools acquired throughout the masters program

Course learning outcomes: The student will be capable of applying the knowledge and abilities acquired throughout the courses of the masters program, contributing to the development of practical solutions that benefit the community.

Course Content	**Hours**
1. Definition of application pre-project.	**16**
2. Ethics in professional services.	**4**
3. Project presentation.	**4**
4. Follow up by professor.	**4**
5. Presentation of pre results.	**4**
6. **Presentation of final results.**	**4**

Learning activities:	
• **Guided activities:** - Presentation of subject by professor. - Presentation by guest researchers. - Discussions of subjects and cases. - Final project presentation.	**36**
• **Independent activities:** - Applied research case reading. - Information gathering. - Research reports. - Problem analysis. - Solution design.	**60**

Evaluation criteria and procedures:

The evaluation instruments are the following:

Homework and research work
Final project research
Participation

The points distribution for each instrument will be established in accordance with the group in the first class session.

Bibliography

	Type	Title	Author	Publisher	Year
1	None				