3rd/4th Year

Track 5: Materials

1	55000055	Applied Mathematics
2	55001097	Physical Metallurgy
3	55000502	Ferrous Alloys
4	55000503	Physical Metallurgy
5	55000504	Materials Testing and Analysis
6	55000505	Polymer and Composite Materials
7	55000506	Welding and Forming
8	55000507	Materials Selection
9	55000508	Sintering. Ceramics and Composite Materials.

55000055 - APPLIED MATHEMATICS

CREDITS:	4.5 ECTS
DEPARTMENT:	Industrial and Applied Mathematics (MAT)
COURSE COORDINATOR:	Luis Sanz Lorenzo
TYPE:	Common
YEAR AND SEMESTER:	3rd Year / Spring

LIST OF TOPICS

MODULE 1. Direct Stiffness Method in some engineering problems

- Systems of springs. Static and Dynamic analysis.
- Systems of articulated bars.

MODULE 2. Interpolation

- Polynomial interpolation.
- Nodal Basis functions
- Interpolation using other families of functions.

MODULE 3. Numerical integration and differentiation

- Quadature formulae.
- Newton-Cotes formulae
- Gaussian quadrature.
- Numeric differentiation.

MODULE 4. Numerical solution of Linear Systems

- Direct methods.
- Iterative methods.

MODULE 5. Roots of nonlinear equations and systems of nonlinear equations

- Scalar case.
- Systems of equations.
- Pseudosolutions and equation solving through minimization.

MODULE 6. Approximation of Data

- General Least squares problems.
- Linear least squares.

MODULE 7. Numerical Solution of initial value problems in Ordinary Differential Equations

- Euler implicit and explicit methods.
- Runge-Kutta methods.
- Some notions about stability of schemes.

MODULE 8. The Finite Element Method

- Weak formulation
- Galerkin method
- FEM in 1D problems
- The local approach

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES: Algebra (55000002), Calculus 1 (55000001), Calculus 2 (55000008), Differential equations (55000011), Fundamentals of programming (55000007), Materials Resistance (55000027)

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Basic concepts of elasticity: displacements, strain and stress.
- Basic mathematics: Calculus, algebra and differential equations.
- Fundamentals of programming.

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Programming in Matlab environment.
- Application of numerical methods to problems of mechanical engineering.

STUDENT OUTCOMES

- ABET_1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_6. An ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

OTHER MATERIALS

Class notes, and collection of solved problems available to students through Moodle platform.

55001097 – Physical Metallurgy

CREDITS:	6 ECTS
DEPARTMENT:	Applied Physics and Materials Engineering (P&M)
COURSE COORDINATOR:	Javier Oñoro López
TYPE:	Track (Materials)
YEAR AND SEMESTER:	3rd Year / Spring

LIST OF TOPICS

MODULE 1. Structure and Properties relationship.

MODULE 2. Phase Diagrams and Heat Treatments.

MODULE 3. Solidification, Diffusion and Deformation of Metals

MODULE 4. Recovery and Recrystallization.

MODULE 5. Diffusion and No Diffusion Transformations.

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: Thermodynamic, Materials Resistance.

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Skill for the management of the concepts of stress, strain, resistance and toughness.
- Basic thermodynamic concepts.

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Knowledge of influence of structural and micro-structural changes and defects in the properties of metals.
- Identify the heat treatments to improve or reduce different properties.
- Identify forming and solidification micro-structures.
- Ability to choose the appropriated heat treatment to modify the properties of metals cold forming.

STUDENT OUTCOMES

- ABET_1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
- ABET_5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
- ABET_6. An ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Physical Metallurgy. 4th Edition. Editors: R.W. Cahn P. Haasen.
Fundamentals of Physical Metallurgy. John D. Verhoeven

OTHER MATERIALS

Texts an exercises in Aulaweb

CREDITS:	4.5 ECTS
DEPARTMENT:	Applied Physics and Materials Engineering
COURSE	(P&M) Milagrosa González Fernández de

55000502 - FERROUS ALLOYS

LIST OF TOPICS

MODULE 1. Introduction. Influence of alloying elements in steels

- 1. General information of the course (0.5 h). 2. Introduction (0.5 h) 3. Alloying elements I: Gammagene elements (3 h). 4. Alloying elements II: Alphagene elements (3 h). 5. Alloying elements III: Other elements (1 h).

MODULE 2. Structural steel

- 6. Structural steel to be used in delivery state (2 h). 7. Hardenable steels. High-strength steels. Spring steels.

MODULE 3. Tool steels

Maraging steels (4 h). 8. Steels to be thermochemicaly or superficially treated. Cryogenic steels (2 h).

- 9. Tool steels I: Carbon steels, cold working die steels, HSS (4 h). 10. Tool steels II: Hot working die steels. Non deforming steels. Wear resistant steels (4 h).

MODULE 4. Stainless steels and steels for special applications

- 11. Stainless steels I: Martensitic, ferritic, superferritic, austenitic and duplex (4 h). 12. Stainless steesl II:

MODULE 5. Cast irons

Stainless steels for high temperature applications and PH steels (3 h). 13. Steels for special applications (1 h)

- 14. Unalloyed cast irons (4 h). 15. Cast irons with modified graphite (3 h). 16. Alloyed cast irons (3 h)

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Ability to suggest the more convenient metallurgical state for each application.

- Ability to choose the more convenient alloy for each application.
- Ability to perform comprehensive reading of metallurgy literature to delve into the knowledge acquired during the course.

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Compare the properties of steels according to their alloying elements.
- Analyze ferrous alloys to select the appropriate one for each application and its possible failures.
- Communicate orally and in writing the acquired knowledge to specialists and clueless.

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_5. An ability to function effectively on a team whose members together provide leadership,create a collaborative and inclusive environment,establish goals,plan tasks,and meet objectives
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Influencia de los elementos de aleación de los aceros.
Víctor M. Blázquez Martínez Editorial Servicio de Publicaciones de la ETSII de la UPM.

Cast Irons
Editorial ASTM. , 1996

The physical metallurgy of microalloyed Steel.
T. Gladman Editorial The Institute of Materials. , 1997

The book of steel.
G.Béranger G.Henry G. Sanz Editorial Scientific Editors, 1996

Fundiciones férreas aleadas.
Milagrosa Glez. F de Castro. Editorial Servicio de Publicaciones de la ETSII de la UPM, 2006

OTHER MATERIALS

55000503 - PHYSICAL METALLURGY

CREDITS:	4.5 ECTS
DEPARTMENT:	Applied Physics and Materials Engineering (P&M)
COURSE COORDINATOR:	Javier Oñoro
TYPE:	Track (Materials)
YEAR AND SEMESTER:	4th Year / Fall

LIST OF TOPICS

MODULE 1. Module I.

- 1) Properties determined by the structure (4 h)
- 2) Crystal structure (2 h)

MODULE 2. Module II

- 3) Defects in real crystals (2 h)
- 4) Phase thermodynamic principles (2 h)
- 5) Diffusion (4 h)
- 6) Solidification (6 h)
- 7) Recovery and recrystallization (4 h)

MODULE 3. Module III.

- 8) Energy and grain boundary microstructure (2 h)
- 9) Solid phase transformations (6 h)
- 10) Phase diagrams. Microstructure of alloys (8 h)

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: Material Science I.

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Knowledge of atomic structure of metals.
- Understand the elastic and plastic behavior of metals and their correlation with their properties

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Understanding the mechanisms of phase transformations and their relation to the properties.
- Ability to understand and use practically the effect of microstructural changes in the properties of metals.
- Ability for handle phase diagrams

STUDENT OUTCOMES

- ABET_6. An ability to develop and conduct appropriate experimentation, analyse and interpret data, and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Fundamentos de Metalurgia Física
J.D. Verhoeven Editorial Limusa, 1987

Diagramas binarios: Teoria y aplicaciones
Rafael Gamboa Editorial ETSII Madrid , 2011

Physical Metallurgy
Peter Hansen Editorial 3Th Cambridge University Press, 1996

Physical Metallurgy and Advanced Materials
R.E. Smallman and A.H.W. Ngan Editorial 7Th Ed. Elsevier, 2007

OTHER MATERIALS

AulaWeb, Lab Metallurgy

55000504 - MATERIALS TESTING AND ANALYSIS

CREDITS:	6 ECTS
DEPARTMENT:	Applied Physics and Materials Engineering (P&M)
COURSE COORDINATOR:	García Ruiz, Ana M.
TYPE:	Track (Materials)
YEAR AND SEMESTER:	4th Year / Fall

LIST OF TOPICS

MODULE 1. Chemical and microscopic analysis

- Microscopic techniques
- Spectroscopic techniques
- High-temperature combustion and fusion inert gas techniques
- Thermal analysis techniques

MODULE 2. Mechanical testing

- Tensile testing
- Impact toughness testing
- Hardness testing
- Creep and fatigue testing
- Other mechanical and technological tests

MODULE 3. Non-destructive testing

- Introduction to non-destructive testing
- Surface non-destructive testing
- Volumetric non-destructive testing
- Other methods of non-destructive testing

MODULE 4. Quality management

- Quality in the laboratory of analysis and testing of materials
- Standardization and Certification
- Accreditation

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: Metallic Materials Science, Structure and Properties of Non-Metallic Materials

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

• The students will practice chemical, mechanical, and non-destructive testing that will help strengthen their theoretical knowledge. They will learn how to prepare specimens for mechanical tests of tensile, resilience, and hardness, which they will then carry out. They will be able to heat treat both carbon and stainless steels to provide them different properties. At the end of the course, the students will also be able to realize and interpret non-destructive testing.

• Additionally, students will be able to prepare and defend work related to the content of the course.

• After completing the course, the students will know how technical analysis or type of testing should be applied at all times to the material under study and will have acquired sufficient criteria to establish which procedures are relevant in which cases. They will also be able to correctly interpret the standards of analysis and testing used for materials.

STUDENT OUTCOMES

• ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics

• ABET_3. An ability to communicate effectively with a range of audiences

• ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions

• ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Principios de Análisis Instrumental.
D.A. Skoog, F. J. Holler, S.R. Crouch, Editorial Cengage Learning, 2011

Ciencia e Ingeniería de la Superficie de los Materiales Metálicos.
AJ Vázquez, JJ de Damborenea Editorial Consejo Superior de Investigaciones Científicas, 2000

Métodos Instrumentales de Análisis.
H.H. Willar, L.L. Merrit, J.A. Dean, F.A, Settle, Ed. Compañía editorial Continental, 1990

Métodos de Ensayos No Destructivos. Tomos I y II
F Ramírez Rodríguez y otros Editorial INTA Publicaciones, 1996

Mechanical Testing and Evaluation. ASM Handbook, Volumen 8 Editorial ASM Internacional, 2000

Materials Characterization. ASM Handbook, Volumen 10, Ed. ASM Internacional, 1998

UNE-EN ISO 6892-1: 2016. Materiales metálicos. Ensayo de tracción. Parte 1: Método de ensayo a temperatura ambiente. Febrero 2017, versión corregida en abril 2017

UNE-EN ISO 148-1:2016. Materiales metálicos. Ensayo de flexión por choque con péndulo Charpy. Parte: 1 Método de ensayo. Abril 2017.

UNE-EN ISO 6507-1:2018. Materiales metálicos. Ensayo de dureza Vickers. Parte 1: Método de ensayo. Octubre 2018

OTHER MATERIALS

The following laboratories will be available in the Department of Applied Physics and Materials Engineering:
-Materials Testing and Analysis Laboratory, including ovens for heat treatment, tensile testing machines, pendulum for the Charpy V-notch impact test, durometers and microdurometers, Carbon / Sulfur analyzer, etc.
-Non-Destructive Testing Laboratory, including ultrasound and induced currents equipments.

55000505 - POLYMER AND COMPOSITE MATERIALS

CREDITS:	4.5 ECTS
DEPARTMENT:	Chemical and Environmental Engineering (CHE)
COURSE COORDINATOR:	M. Laso
TYPE:	Track (Materials)
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Methods / Background

- 1) Background (review methodology addressed in course 'Structure and Properties of Non-Metallic materials')

MODULE 2. Properties of composite materials - Homogenization

- 2) Representation surfaces
- 3) Homogenization - simple cases
- 4) Homogenization - general case
- 5) Homogenization -effective medium theory
- 6) Homogenization for polycrystalline and semicrystalline materials

MODULE 3. Membranes and laminated composite materials.

7) Membranes and textiles
8) Curvature and deformability of membranes
9) Description of laminated materials
10) Micromechanics of laminated materials
11) Macromechanics of laminated materials

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: Structure and Properties of non-Metallic Materials

TOPIC: materials science

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Spatial vision for identifying symmetry elements to classify crystalline structures to appropriate crystallographic class
- General physics (static and dynamics, electromagnetism)
- Miller indices
- Calculate linear, surface and volumetric densities
- General chemistry, adjustment reactions and stoichiometric calculations
- Matrix algebra (operations with vectors and matrices, diagonalization, determinants

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Design and advanced composite applications
- Rational design of composite materials

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments,which must consider the impact of engineering solutions in global,economic,environmental,and societal contexts
- ABET_5. An ability to function effectively on a team whose members together provide leadership,create a collaborative and inclusive environment,establish goals,plan tasks,and meet objectives
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Apuntes de Materiales Poliméricos y Compuestos
M. Laso / N. Jimeno , 2013

OTHER MATERIALS

55000506 - WELDING AND FORMING

CREDITS:	4.5 ECTS
DEPARTMENT:	Applied Physics and Materials Engineering (P&M)
COURSE COORDINATOR:	A. Portolés
TYPE:	Track (Materials)
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Special welding processes

- 1) Welding processes. New developments
- 2) Robotic welding processes

MODULE 2. Welding metallurgy. Weldability

- 3) Welding metallurgy
- 4) Weldability of advanced high strength steels
- 5) Weldability of stainless steels
- 6) Weldability of non-ferrous alloys
- 7) Dissimilar welds

MODULE 3. Procedures

- 8) Quality requirements for welded joints.
- 9) . Welding procedures. Qualification

MODULE 4. Forming by plastic deformation

- 10) Basic principles. Plastic state general equation
- 11) Deformation instability
- 12) Plastic deformation mechanisms
- 13) Superplasticity
- 14) Thermomechanical treatments

MODULE 5. Forming by deposition

- 15) Hardfacing by welding
- 16) Thermal spraying
- 17) Electroplating
- 18) Vapor phase deposition
- 19) Ion Implantation

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: 4th year / Fall

TOPIC: Materials Technology, Ferrous Alloys and Non-Ferrous Alloys

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Knowing how to relate the structure of materials and their properties.
- Knowing to reason about the elastic and plastic behavior of materials

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Ability to understand the phenomena that occur during the welding and forming processes
- Ability to select manufacturing processes of materials for behavior in service.
- Ability to evaluate and get the proper quality of welded constructions for behavior in service

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_5. An ability to function effectively on a team whose members together provide leadership,create a collaborative and inclusive environment,establish goals,plan tasks,and meet objectives
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Automating the welding process
James M. berge Editorial Industrial press

Metals Handbook, 10th Edition, Vol 06, 07, 14 y 15
Editorial ASM

Heat effects of welding
D. Radaj, Editorial Editorial Springer-Verlag

Fundamentos de Manufactura Moderna.
M.P. Groover Editorial Editorial Prent

Conformado de los metales. .
G.W. Rowe Editorial Ed. Urmo

Advanced welding processes.Technology and process control
John Norris Editorial Woodhead publishing

Aluminum welding
N.R. Mandal Editorial ASM International

Welding Hanbook
Editorial Ed AWS

OTHER MATERIALS

Written notes of the subject

Welding, Mechanical Testing and Metallurgy Laboratories. Audiovisual and computer media.

55000507 – MATERIALS SELECTION

CREDITS:	3 ECTS
DEPARTMENT:	Applied Physics and Materials Engineering (P&M)
COURSE COORDINATOR:	L.Sánchez
TYPE:	Track (Materials)
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1.

1) properties of materials (2h)
2) Factors of influence (2h)
3) Selection criteria (2h)
4) Performance and efficiency of materials (2h)
5) Efficiency ratios. Methods of obtaining (8h)

MODULE 2.

6) Selection methods. Maps of properties (6h)
7) Primary constraints. Maximization criteria (2h)
8) Multiple restrictions (2h)
9) Factors of influence (2h)

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Namely manufacturing processes relate to the structure and properties obtained
- Reasoning about material properties and parameters of influence

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Ability to choose and select a particular material which meets the specified quality requirements for conditions of service

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments,which must consider the impact of engineering solutions in global,economic,environmental,and societal contexts
- ABET_5. An ability to function effectively on a team whose members together provide leadership,create a collaborative and inclusive environment,establish goals,plan tasks,and meet objectives
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Diseño en Ingenieria Mecánica
Joseph Edward Shigley; Charles R.Mischke Editorial Mac Graw Hill, 1998
Materials selection and design
Volumen 20 Editorial ASM
Engineering materials 1 y 2
M.F Asbhy, D.R.H. Jones , 2002
Materials selection in mechanical design.
M.F. Asbhy Editorial Pergamon Press, 2000

OTHER MATERIALS

55000508 - SINTERING. CERAMICS AND COMPOSITE MATERIALS

CREDITS:	3 ECTS
DEPARTMENT:	Applied Physics and Materials Engineering (P&M)
COURSE COORDINATOR:	María Fe
TYPE:	Laguna Track
YEAR AND SEMESTER:	(Materials) 4th

LIST OF TOPICS

MODULE 1. CHARTS TERNARY AND QUATERNARY

- 1) Introduction to the ternary diagrams both partial solid solubility and total insolubility in the same
- 2) Formation of a solid solution
- 3) Binary reactions
- 4) Main ternary reactions
- 5) Binary and ternary compounds
- 6) Binary and ternary solvus volumes. precipitation and dissolution
- 7) Microconstituents
- 8) Other ternary reactions
- 9) Introduction to quaternary systems

MODULE 2. SINTERING.CERAMICS AND COMPOSITES MATERIALS.

- 10) Properties of ceramic materials.
- 11) Tribological properties of ceramic materials.
- 12) Ceramic Manufacturing Process.
- 11) Silicon nitride. Sialon
- 12) Silicon carbide. Alumina and Mullite based ceramics
- 13) High performance Ceramics.
- 14) Ceramic Matrix Composites.

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: Metallic Materials Science

COURSE: Structure and Properties of non-metallic materials

COURSE: Physical Metallurgy

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Capacity to understand the binary diagrams
- Capacity to understand the microstructures
- Capacities to address tenacity studies

SPECIFIC OUTCOMES FOR THE COURSE

At the end of the course, the student will be able to (or will have ability for):

- Extensive Knowledge of ceramic materials.
- Understanding of their problems and the possibilities of their use

- Ability to select these materials
- Opportunities to improve their toughness properties
-

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_2. An ability to apply engineering design to produce solutions that meet specified needs with consideration fo public health,safety,and welfare,as well as global,cultural,social,environmental,and economic factors
- ABET_3. An ability to communicate effectively with a range of audiences
- ABET_4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments,which must consider the impact of engineering solutions in global,economic,environmental,and societal contexts
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions
- ABET_7. An ability to acquire and apply new knowledge as needed using appropriate learning strategies

BIBLIOGRAPHY

TEXT BOOKS

Diagramas ternarios: Teoría y aplica. Introd. a siste. cuaternar
Rafael Gamboa Editorial ETSII. Madrid, 2011

ENGINEERED MATERIALS HANDBOOK. Vol. 4. CERAMICS AND GLASSES
Editorial ASM International

OTHER MATERIALS

Recursos propios docentes y laboratorios