3rd/4th Year

Track 4: Mechanical Engineering

1	55000054	Applied Mathematics
2	55000401	Automation and Robotics
3	55000402	Road Vehicles Theory
4	55000403	Machine Design
5	55000404	Simulation of Mechanical Systems
6	55000405	Thermal Engines
7	55000406	Structural Analysis
8	55000407	Manufacturing Systems Design
9	55000408	Railway Engineering
10	55000409	Machine Design II

55000054 - 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.

55000401 - AUTOMATION AND ROBOTICS

CREDITS:	6 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE COORDINATOR:	Antonio Vizán
TYPE:	Track (Mechanical Engineering)
YEAR AND SEMESTER:	3rd Year / Spring

LIST OF TOPICS

MODULE 1. Automation of manufacturing processes

- 1) Machining processes
- 2) Automation in manufacturing systems
- 3) Programming of machines and systems

MODULE 2. Robotics in manufacturing

- 4) Development of robotic systems
- 5) Programming of industrial robots
- 6) Assembly systems. Assembly Analysis

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Basic knowledge in manufacturing

SPECIFIC OUTCOMES FOR THE COURSE

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

- Programming of industrial robots
- Analysis and selection of automation technologies for manufacturing processes
- Designing of automated manufacturing processes
- CNC programming of machine tools
- Computer Aided Engineering, Design and Manufacturing

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

OTHER MATERIALS

Recursos propios en las plataformas educativas UPM - ETSII - INGENIERÍA DE FABRICACIÓN:
https://moodle.upm.es/titulaciones/oficiales/login/login.php
http://aulaweb.etsii.upm.es
http://wikifab.dimf.etsii.upm.es/wikifab/index.php/Portada
Ver concreción y detalle en la Guía de Aprendizaje

55000402 - ROAD VEHICLES THEORY

CREDITS:	4.5 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE COORDINATOR:	E. Alcalá
TYPE:	Track (Mechanical Engineering)
YEAR AND SEMESTER:	4th Year / Fall

LIST OF TOPICS

MODULE 1. Purpose, scope and content of the Theory of Motor Vehicle

- 1) Car concept vehicles and technology requirements
- 2) The vehicle in HVM
- 3) Objectives, scope and content of the theory of vehicles. Justification of interest in the subject in the training of Industrial Engineering

MODULE 2. Interaction between vehicle and road surface

- 4) General characteristics of the tires
- 5) Analysis of the stresses generated in the interaction between tire and rolling surface. Influencers
- 6) Simulation models: model and model Dugoff Bakker, Nyburg and Pacejka

MODULE 3. Aerodynamics of cars

- 7) Foundations for understanding the aerodynamic actions on solid
- 8) Aerodynamic actions on motor vehicles. Aerodynamic coefficients and factors of influence
- 9) Vehicle aerodynamic tests

MODULE 4. Longitudinal dynamics. Features

- 10) Resistance to the movement of vehicles
- 11) Limits imposed by adherence to tractors efforts vehicles with different configurations
- 12) Engine and transmission characteristics (mechanical and hydrodynamic) Traction Diagrams
- 13) Calculation of performance: top speed, acceleration, maximum ramp

MODULE 5. Longitudinal dynamics. Braking

- 14) Forces and moments acting on the braking process
- 15) Calculating the optimum distribution of braking. Ideal adhesion utilization curves. Braking two-axle vehicles and tractor-trailer
- 16) Braking process: performance, braking distance and time, power dissipation
- 17) Antilock brake systems

MODULE 6. Lateral dynamics

- 18) Vehicle guidance. Dynamic geometry
- 19) Maneuverability at low speed. Stationary and transient movements
- 20) Speed limit skidding and rollover
- 21) Tipping stability conditions and factors influencing the rollover threshold
- 22) Toner vehicle behavior. Stationary and transient regime. Factors influencing the directional stability

MODULE 7. Dynamic Vertical

- 23) Vibration motor vehicles. Influence on the comfort and safety
- 24) Influence of suspension. Predimensioning suspension system
- 25) Pitch and swing movements
- 26) Profile of the road as random function

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Ability to apply mathematical calculation engineering
- conceptual thinking

SPECIFIC OUTCOMES FOR THE COURSE

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

- Determination of vehicle performance from its initial characteristics, powertrain and characteristics of the road surface: adhesion and geometry
- Analyze and interpret the influence of the tires on the dynamic behavior of the vehicle with special attention to the resistance movement, towing capacity and safety (braking process and lateral behavior)
- Analyze the aerodynamic characteristics of the vehicle and assess the influence of form factors, and other aerodynamic aids in drag and other behaviors that affect safety
- Analysing the braking and conditions that determine the braking distance and directional stability control, braking maneuvers. Calculate stopping distances and other elements that determine the behavior of the vehicle.
- Analyze and evaluate the behavior of the vehicle turning maneuvers at both low and high speed. Terms of skidding, rollover threshold and toner behavior.

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_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

Solved exercises (en Moodle).

Excel spreadsheets for longitudinal dynamics

Links to webs with technical data of the vehicles.

55000403 - MACHINE DESIGN

CREDITS:	6 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE COORDINATOR:	J. Echávarri
TYPE:	Track (Mechanical Engineering)
YEAR AND SEMESTER:	4th Year / Fall

LIST OF TOPICS

MODULE 1. Introduction to the design, calculation and construction of machinery

- 1) Basis of the design, calculation, construction and testing of machine elements
- 2) Materials in machine construction
- 3) Standards for mechanical engineering

MODULE 2. Shafts and bearings

- 4) Criteria for calculating the strength of the mechanical elements
- 5) Design and calculation of shafts
- 6) Bearings: types, features, applications, selection and assembly
- 7) Angular contact bearings

MODULE 3. Couplings, Clutches and Brakes

- 8) Design and calculation of shaft-hub connections
- 9) Design and calculation of bolted joints and screw transmissions
- 10) Shaft-shatf conections: Couplings and clutches. Types, features, applications and selection of commercial elements
- 11) Design and calculation of friction clutches and brakes

MODULE 4. Lubrication and friction bearings

- 12) Lubrication. Lubrication regimes
- 13) Design, calculation and construction of bearings
- 14) Hydrodynamic film bearings

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC: Recommended previous courses: Industrial Drawing I, Science of Materials, Strength of Materials, Theory of Machines and Mechanisms.

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Mechanical spatial sense
- Interpretation of drawings

SPECIFIC OUTCOMES FOR THE COURSE

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

- The modules develop skills and abilities, which are applied during practical sessions, to integrate the acquired knowledge and to develop the project of a machine, comprising:
- Bearing selection. Definition of its layout and assembly.
- Definition of connections between shafts and elements mounted on them.

- Design and calculation of friction clutches and brakes
- Selection of materials for machine building
- Housing design and caps. Selection of other components such as dipsticks, peepholes, etc.
- Application of standars for building machines
- Design and calculation of shafts
- Design and calculation of bolted joints
- Bearing design and selection of the proper lubricant

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

Presentaciones de Diseño y cálculo de elementos de máquinas.
P. Lafont, J. Echávarri, E. Chacón. Editorial Disponible en Aulaweb.

Tratado Teórico Práctico de Elementos de Máquinas.
G. Niemann.

Solved Exercises.
Available online.

Elementos de máquinas.
K.H. Decker.

Manual for the practical contents.
Available online

Principles of Tribology
J. Halling

Engineering Tribology
J.A. Williams

OTHER MATERIALS

Several machines to be analyzed (assembled and disassembled). Machine design software EDIMPO and manuals for the practical sessions.

CREDITS:	4.5 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE	J. Félez

55000404 - SIMULATION OF MECHANICAL SYSTEMS

LIST OF TOPICS

MODULE 1. Computational mechanics

- 1) Simulation of mechanical systems
- 2) Kinematic analysis of multibody systems
- 3) Dynamic analysis of multibody systems. Newton-Euler formulation
- 4) Dynamic analysis of multibody systems. Analytical methods. Lagrange equations

MODULE 2. Multidomain simulation. Bond-Graph technique

- 5) Introduction to the technique of Bond-Graph
- 6) Development of the state equations
- 7) Causality. Dependent and independent variables
- 8) Bond-Graph application for Mechanics
- 9) Bond-Graph application for Hydraulics

MODULE 3. Numerical simulation

- 10) Bond-Graph application to Electricity
- 11) Numerical methods with MatLab
- 12) Systems of nonlinear equations
- 13) ODE and DAE systems

MODULE 4. Application Project

- 14) Computational Mechanics and integration with Bond-Graph
- 15) Development of a project working in a team

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: Mechanics, Theory of circuits, Fluid mechanics

TOPIC: Mechanics, Theory of circuits, Hydraulics

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Knowledge and basic use of MatLab

SPECIFIC OUTCOMES FOR THE COURSE

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

• • Analyze and relate the fundamental components of a mechanism or a system belonging to mechanical, electrical or hydraulic domains, or combinations thereof, being able to model, interpret and define correctly the system

• • Analyze the results of simulations and understand the possibilities and limitations of the simulations

• • Incorporate the use of technical terms in the language

• • Use computer simulation tools to address the simulation of the previous model

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 for 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

OTHER MATERIALS

moodle.upm.es / ? Mis cursos / ? E.T.S. DE INGENIEROS INDUSTRIALES / ? Grado en ingeniería en tecnologías industriales / ? 4º /
? SIMULACION_DE_SISTEMAS_MECANICOS

55000405 - THERMAL ENGINES

CREDITS:	4.5 ECTS
DEPARTMENT:	Energy Engineering (ENE)
COURSE COORDINATOR:	R. Abbas
TYPE:	Track (Mechanical Engineering)
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Definitions, classification and application of thermal machines and heat engines

- 1) DEFINITIONS, classification and application of thermal machines and heat engines
- 2) Thermodynamic cycles of heat engines
- 3) Fundamentals of combustion and emissions

MODULE 2. Internal Combustion Engines (ICE)

- 4) Classification, general structure and p-V cycles of ICE
- 5) Energy balance of ICE Heat and mechanical losses
- 6) Gas exchange processes and mixture formation
- 7) ICE combustion

MODULE 3. Positive displacement compressors

- 8) Fundamentals and classification of positive displacement compressors

MODULE 4. Thermal Turbomachinery

- 9) General structure of the flow in Compressors and Turbines
- 10) Bimensional analysis of flow in axial Turbomachinery
- 11) Off-design in Turbomachinery
- 12) Radial Turbomachinery

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Multidisciplinary phenomenological reasoning capacity
- Critical interpretation of results

SPECIFIC OUTCOMES FOR THE COURSE

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

- Development and abstract reasoning ability in the field of heat engines apply multiple fields of technology
- Develop critical thinking regarding the consistency of numerical results obtained for application in the field of heat engines
- Ability to understand the operating principles of the different heat engines and their applications in industry and transportation
- Connect and properly apply multiple skills fundamental branches of science and engineering to reciprocating internal combustion engines and turbomachinery temic

STUDENT OUTCOMES

- ABET_1. An ability to identify,formulate,and solve complex engineering problems by applying principles of engineering,science,and mathematics
- ABET_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions

BIBLIOGRAPHY

TEXT BOOKS

Motores de Combustión Interna Alternativos
Varios Editorial Reverté, 2011

Máquinas Térmicas
M. Muñoz Domínguez y A. Rovira Editorial UNED, 2011

OTHER MATERIALS

Presentations, support texts and application problems specific to each topic or module will be available in Moodle.

55000406 - STRUCTURAL ANALYSIS

CREDITS:	4.5 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE COORDINATOR:	Alberto Fraile de Lerma
TYPE:	Track (Mechanical Engineering)
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Introduction.

1) Scope of the course
2) Modeling assumptions and limitations of linear models and numerical methods.
3) Examples of numerical solutions. Commercial programs

MODULE 2. FEM analysis for linear steady state problems. Part I.- Thermal analysis

4) Weak and strong formulation. Conservation of energy and Fourier's Law. Energy minimization.
5) Boundary conditions
6) Shape functions
7) Force vector and stiffness matrix
8) Examples of numerical solutions.

MODULE 3. FEM analysis for linear steady state problems. Part II.- Bars and Beams

9) Weak and strong formulation. Energy minimization.
10) Boundary conditions
11) Shape functions
12) Force vector and stiffness matrix. Matrix formulation
13) Examples of numerical solutions.

MODULE 4. FEM analysis for linear steady state problems. Part III.- Elasticity

14) Weak and strong formulation. Energy minimization.
15) Plane strain and plane stress models.
16) Boundary conditions
17) Shape functions
18) Force vector and stiffness matrix.
19) Examples of numerical solutions.

MODULE 5. FEM analysis for linear transitory problems

20) Modal and direct methods.
21) Mass matrix
22) Direct integration
23) Modal integration
24) Examples of numerical solutions.

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE: 3rd Course Fall and Spring

TOPIC: Strength of Materials and Strength of Materials Extension

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):

- Criteria to apply assumptions and define the model of the structure in a computer program
- Use properly (critically) a computer program.
- Quality control of work: check the units of the different variables, the order of magnitude of the results using 3 or 4 digits
- Know the different structural types, assumptions and magnitudes of each.
- Handle basic relationships (balance compatibility and law behavior) to perform scores
- Knowing the basics (GDL element stiffness matrix.) Of the numerical method (matrix calculation - finite element) that is used and the differences between them
- Comprehensive analysis of monitoring results and limitations of numerical methods.
- Use the basic relationships to check the numerical results (balance ...)

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 for 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

BIBLIOGRAPHY

TEXT BOOKS

- Cervera, M., Blanco, E. (2002). Mecánica de estructuras. Libro 2. Métodos de análisis. Barcelona: Ediciones UPC
- Hughes, T. J. R. (1987). The finite element method. Englewood Cliffs, New Jersey: Prentice-Hall Inc.
- Cook, R. D. (1995). Finite element modeling for stress analysis. John Wiley & Sons.

OTHER MATERIALS

- Blackboard
- Computer equipment
- Theoretical Notes and Solved Problems
- Bibliography
- Software used for practical applications: ANSYS Academic.

55000407 - MANUFACTURING SYSTEMS DESIGN

CREDITS:	6 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE COORDINATOR:	José Rios
TYPE:	Elective - Track Mechanical Engineering
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Manufacturing systems

- 1) Types of manufacturing systems.
- 2) Concept of Computer Integrated Manufacturing - CIM.
- 3) Concept of computer aided manufacturing - CAM.
- 4) Modeling of manufacturing systems. Types of computer aided systems - CAX.

MODULE 2. Digital Manufacturing

- 5) Conception of the structure of the manufacturing process. Planning processes. Selection of tools and machining conditions.
- 6) Geometric and technological information.
- 7) Modeling and simulation of manufacturing systems. Machining program generation.
- 8) Product data management, processes and resources. PLM systems.

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Computer literate:

SPECIFIC OUTCOMES FOR THE COURSE

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

- Model and simulate a manufacturing system.
- Define manufacturing process documentation
- Apply systematic design methodologies and manufacturing
- Using tools in manufacturing

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_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

Recursos propios: http://aulaweb.etsii.upm.es

55000408 - RAILWAY ENGINEERING

CREDITS:	6 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE COORDINATOR:	Francisco Javier Páez
TYPE:	Elective - Track Mechanical Engineering
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Railway infrastructure

- 1) Introduction
- 2) Railway line description
- 3) Track geometry

MODULE 2. Railway rolling stock

- 4) Wheels and axles
- 5) Bogie
- 6) Suspension
- 7) Traction technologies
- 8) Braking technologies

MODULE 3. Railway dynamics

- 9) Resistance to motion
- 10) Tractor and braking efforts
- 11) Safety, comfort and driving stability

MODULE 4. Railway Electrification

- 12) Contact line technologies and pantograph interaction
- 13) Electrical models in use under DC and AC

MODULE 5. Detection, Protection and Train Control

- 14) Detection systems: track circuit and axle counters
- 15) Interlocking and block
- 16) Protection systems: ASFA, ATP/ATO/ATC,CBTC
- 17) Railway Interoperability and ERTMS
- 18) Rail Safety
- 19) Traffic control and management
- 20) Level Crossings
- 21) Safety auxiliary systems

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Conceptual thinking
- Ability to apply mathematical calculation engineering
- Specific management software

SPECIFIC OUTCOMES FOR THE COURSE

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

- Determine the basic characteristics of geometry and rail sector
- Identify areas of railway technology
- Determine the status of railway rolling stock
- Identify electric traction installations (substations and overhead contact line
- Basic and advanced train control functions such as traffic safety, and the management and planning of railway operations
- Determine the specific characteristics of the high-speed rail

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_6. An ability to develop and conduct appropriate experimentation,analyse and interpret data,and use engineering judgment to draw conclusions

BIBLIOGRAPHY

TEXT BOOKS

- ANDREWS, H. I. RAILWAY TRACTION. THE PRINCIPLES OF MECHANICAL AND ELECTRI¬CAL RAILWAY TRACTION. Netherlands : Elsevier Science Publishers. 1986.
- Esveld, Coenraad. Modern Railway Track. Edit. MRT – Productions. 2001.
- FERNÁNDEZ GONZÁLEZ, F.J. Y FUENTES LOSA, J. INGENIERÍA FERROVIARIA, Edit. Uned. 2008.
- GARG, V. K. DYNAMICS OF RAILWAY VEHICLE SYSTEMS .Canada : Academic Press. 1984.
- GARCÍA DÍAZ-DE-VILLEGAS, J.M. FERROCARRILES. Publicaciones de la E.T.S. Ingenieros de Caminos, Santander. 2007.
- HAY, W. W. RAILROAD ENGINEERING .USA : John Wiley & Sons. 1982.
- IWNICKI, SIMON. HANDBOOK OF RAILWAY VEHICLE DYNAMICS. 2006.
- MAYNAR, M. APUNTES DE INTRODUCCIÓN A LA DINÁMICA VERTICAL DE LA VÍA Y A LAS SEÑALES DIGITALES EN FERROCARRILES. Edición Ingeniería De Ferrocarriles, Metros Y Túneles, S.l. 2008.
- OLIVEROS, F.; LOPEZ PITA, A.; MEGIA PUENTE, M. J. TRATADO DE FERROCARRILES I. VIA .Madrid: Rueda. 1977.
- Wickens, Alan. Fundamentals of Rail Vehicle Dynamics. 2003.

OTHER MATERIALS

- Notes and tests in AULAWEB server

55000409 - MACHINES DESIGN II

CREDITS:	6 ECTS
DEPARTMENT:	Mechanical Engineering (MEC)
COURSE COORDINATOR:	Enrique Chacón Tanarro
TYPE:	Elective - Track Mechanical Engineering
YEAR AND SEMESTER:	4th Year / Spring

LIST OF TOPICS

MODULE 1. Wheelgears for parallel shafts

- 1) Mechanical transmissions. Types, characteristics and applications
- 2) Cylindrical gears. Kinematics and Dynamics
- 3) Design and calculation of cylindrical gears

MODULE 2. Manufacturing and gear lubrication

- 4) Gear manufacturing
- 5) Types and classification of gear lubricants
- 6) Lubrication methods
- 7) EHD lubrication. Application to gear lubrication
- 8) Influence of lubrication in the occurrence of failures in gear

MODULE 3. Wheelgears for intersecting and crossing shafts

- 9) Design and calculation of bevel gears
- 10) Hypoid gears
- 11) Worm gears

RECOMMENDED COURSES OR KNOWLEDGE

RECOMMENDED PREVIOUS COURSES:

COURSE:

TOPIC:

RECOMMENDED PREVIOUS KNOWLEDGE OR ABILITIES:

- Interpretation of drawings
- Mechanical spatial sense

SPECIFIC OUTCOMES FOR THE COURSE

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

- Ability to design and select a mechanical transmission, according to specifications.
- Ability to design and calculate a gear, applying ISO standards, taking into account the surface fatigue on the flanks (Pitting and micropitting), bending fatigue of the teeth, wear, efficiency and possible scuffing.

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_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

Ejercicios resueltos
Editorial Disponibles en Moodle

Engranajes de ejes que se cortan o se cruzan
P. Lafont, J. Echávarri, E. Chacón Editorial Disponible en Aulaweb

Engranajes paralelos
P. Lafont, A. Diaz, J. Echávarri Editorial Publicaciones de la ETSII- UPM

OTHER MATERIALS

For practical sessions:

• Student's guide

• Teacher's guide

• Solid Edge - CAD Software

• EDIMPO - Design program