Disciplines PPGPPF

RESEARCH LINE MANUFACTURING PROCESSES

MECM 002 – DESIGN OF EXPERIMENTS - 2 credits
Summary: Topics in experimental statistics. Analysis of variance. Full and fractional factorial design. Response surface. Mixture modeling. Use of computer programs for statistical analysis.

MECM 003 - MANUFACTURING AND AUTOMATION - 2 credits
Summary: Fundamentals of manufacturing and automation; Manufacturing process planning; TG group technology; Computer-aided manufacturing systems (CAD/CAM/CAPP/CNC); Industrial robotics; Automatic material handling and storage; Manufacturing integration systems (CIM/FMS); Lean manufacturing; Clean manufacturing.

MECM 010 - SPECIAL TOPICS IN MANUFACTURING PROCESSES - 2 credits
Summary: This discipline has variable content according to the demand for topics of interest, and is always linked to the area of Manufacturing Processes.

MECM 012 – ADVANCED MACHINING PROCESSES – 2 credits
Summary: Introduction to advanced (non-conventional) machining processes; Abrasive Jet Machining; Ultrasonic Machining; Water Jet Machining; Water Jet Machining with Abrasive; Abrasive Flow Machining; Magneto-Abrasive Finishing; Plasma Arc Machining; Laser Machining; Electron Beam Machining; Electrical Discharge Machining; Electrochemical Machining; Chemical Machining; Hybrid Non-Conventional Machining Processes.

MECM 015 - ADVANCED MANUFACTURING PROCESSES AND TECHNIQUES BY WELDING - 2 credits
Summary: Electric arc physics; Welding metallurgy; Conventional fusion welding processes - SMAW, GTAW, submerged arc; Plasma welding; Tubular electrode welding; GMAW processes; Electric resistance welding; Destructive and non-destructive tests of welded joints; Welding standardization - AWS and ASME; Discontinuities in welding; New technologies applied to welding, Laser welding, Hybrid welding processes and New welding processes.

MECM 018 - ENVIRONMENTAL IMPACT OF THE PRODUCTION PROCESS – 2 credits
Summary: Applied legislation; Management and valuation of solid waste and effluents; Assessment of environmental impacts of products and processes; Analysis of environmental risks; Clean technologies; Case studies.

MECM 023 – SPECIAL TOPICS IN PLASTIC FORMING – 2 credits
Summary: Introduction to forming. Physical and metallurgical aspects. Plasticity theories. Classification and analysis of forming processes. Stresses and deformations in forming. Processes and tools for plastic forming. Friction and wear. CAE topics for plastic forming. Special processes. Market trends and new technologies.

MACHINE AND EQUIPMENT DESIGN RESEARCH LINE

MECM005 - RESISTANCE AND STABILITY OF STRUCTURAL SYSTEMS – 2 credits

Summary: Concepts of the Theory of Elasticity and constitutive relations. Failure theories. Structural models (bars, beams, plates, shells) and their applications. Fundamentals of structural stability. Buckling of columns, beams, plates and thin-walled profiles. Fundamentals of computational structural analysis and direct formulation of single-line elements. Applications in structural analysis software. Plasticity analysis of structural elements. Concepts for the design of metal structures. Introduction to nonlinear and dynamic analysis of single-line structures.

MECM 006 – DYNAMIC AND NONLINEAR ANALYSIS OF STRUCTURES – 2 credits

Summary: Basic nonlinear problems. Geometric nonlinearities – large deflections and deformations: nonlinearity associated with the material; associated with changes in physical properties and large deformations; associated with changes in geometry and large displacements; associated with changes in boundary conditions and contact problems; associated with updating of stiffness. Iterative methods: Newton-Raphson. Dynamic analysis: Static loads. Dynamic loads. Degrees of freedom of a mechanical system. Physical models of the dynamic problem. Formulation of the equations of motion. Matrix techniques. Free and forced vibrations. Eigenvalues and eigenvectors. Sinusoidal, periodic, impact and general dynamic loadings; modal superposition and direct integration. Iterative methods for solving eigenvalues and eigenvectors: Stodola method. Plasticity: yield criteria; plastic stress and strain relations; decomposition law; equations between strains and stresses in plasticity; hardening law. Contact problems. Tensors: deformation gradient tensor and Lagrangian approach; generalization of the deformation gradient tensor; Cauchy polar decomposition theorem. Dynamic nonlinearities and iterative methods: direct integration, explicit methods – central difference; direct integration – implicit methods.

MECM 007 - INSTRUMENTATION OF MECHANICAL SYSTEMS - 2 credits

Summary: Fundamentals of metrology; models of generalized measurement systems; sources of errors, correction and compensation techniques, movement and effort transduction, calibration methods; electronic circuits for measuring and conditioning electrical signals; analog, digital and digital-to-analog conversion; automation of the measurement process; communication protocols between instruments; Strain gages and control of mechanical systems.

MECM 013 - SIMULATION OF MECHANICAL BEHAVIOR – 2 credits

Summary: Theory and application of the Finite Element Method in structural engineering problems. Application of the fundamentals of Solid Mechanics (Theory of Elasticity, constitutive relations, structural models, etc.). Formulation of different types of elements: solid, plane stress or deformation state, beam, shell, axisymmetric, rigid, contact, spring, etc. Isoparametric formulation. Modeling and discretization aspects. Formulation and application of different types of numerical structural analysis. Geometric and material nonlinearity: theory and application in problems involving large displacements and elastoplasticity. Application of the Newton-Raphson method and the arc length method in nonlinear problems. Contact problems. Structural stability problems (linear and nonlinear buckling analysis). Dynamic analysis problems: modal analysis, harmonic analysis, and transient analysis.

MECM 014 - MECHANICS OF FRACTURE AND FATIGUE OF METALS - 2 credits

Summary: Fracture mechanics: Effect of notches and cracks; Failure theories for ductile and brittle materials under static loading. Linear elastic fracture mechanics. Elastoplastic fracture mechanics: IRWIN model, DUGDALE model, R6 criterion. Paris law. Fatigue: Types of loading, Stages of the fatigue process, Factors affecting the fatigue life of materials (microstructural effects, residual stresses).

MECM 016 - METHODS FOR DESIGNING AND DEVELOPING PRODUCTS - 2 credits

Summary: Principles of new product development and strategies for product development. Product development methodologies and models (planning, conception, design and detailing). Product development in the simultaneous engineering environment. Product development considering virtual simulation.

MECM 019 - SPECIAL TOPICS IN MECHANICAL DESIGN - 2 credits

Summary: This discipline has variable content according to the demand for topics of interest, and is always linked to the Mechanical Design area.

MECM 021 – APPLICATION IN PRODUCT DESIGN AND DEVELOPMENT: PLANNING, CONCEPT, DESIGN AND DETAILING – 2 credits

Summary: Integrated project development. Organizational structure for the project. Project planning. Market analysis and business opportunities. Principles of solution and creativity. Generation of alternative solutions. Selection of the best solution (concept). Modeling and analysis of the design. Standardization of the project. Design of modular and serial products. Design for manufacturing and assembly (DFMA); Planning of tests and evaluation of the product. Intellectual property.

RESEARCH LINE SELECTION OF MATERIALS APPLIED TO DESIGN AND MANUFACTURING

MECM 001 - FAILURE ANALYSIS – 2 credits

Summary: Fundamentals of fracture mechanics; defect propagation; common corrosion failures; common fatigue failures; common creep failures; wear processes.

MECM 004 - MATERIAL SELECTION APPLIED TO THE MECHANICAL PROJECT - 2 credits

Summary: Materials engineering and their properties/structure; Property maps; Fundamentals of materials selection; Selection process; Materials and industrial design; Selection of composite, ceramic, metallic and polymer materials.

MECM 008 - CORROSION AND ANTI-CORROSIVE PROTECTION - 2 credits

Summary: Fundamental concepts: Fundamentals of Corrosion, Principles of Electrochemistry Thermodynamics for metals in equilibrium: chemical and electrochemical free energy, equilibrium potential, potential measurements. Electrochemical corrosion: electrochemical reactions, formation of galvanic couples, galvanic and electrolytic cells. Equilibrium Diagrams Applied to Corrosion: potential-pH diagrams Electrochemical Kinetics Applied to Corrosion: kinetic study of electrochemical reactions, types of polarization, polarization curves, metal passivation. General aspects of anticorrosive protection. Protection by metallic coatings and organic coatings. Corrosion inhibitors. Cathodic protection.

MECM 009 – BIOMECHANICS AND BIOMATERIALS – 2 credits

Summary: Engineering applied to the health area. Anatomy and biomechanics of the human body. Biomaterials. Tribology and wear of prostheses and implants. Fatigue failure of prostheses and implants. New biomaterials. Objective: To present concepts of biomechanics and biomaterials and their applications and correlations with engineering.

MECM 011 – EQUIPMENT AND MANUFACTURING 4.0 APPLIED IN THE HEALTHCARE FIELD – 2 credits

Summary: Engineering applied to the health area. Hospital equipment. Additive manufacturing. Prototyping. Finite element method applied to the health area. Devices used in the treatment of fractures. Objectives: To study hospital machines and additive manufacturing equipment for prototyping and other applications in the health area. To present the applications of the finite element method in the health area. To discuss devices used for the treatment of bone fractures.

MECM 017 - METALLURGY OF MATERIALS FOR DESIGN AND MANUFACTURING – Total 2 credits

Summary:

- Concepts of stresses and deformations, flow in ductile materials.
- Plastic deformations in single crystals, dislocation theory.
- Increasing the strength of materials.
- Tensile, hardness, torsion, creep and impact tests.
- Influence of mechanical properties on the conformation of metals.
- Characterization and application of materials.

Mandatory Courses

MECM 020 - SPECIAL TOPICS IN SCIENTIFIC WRITING (Mandatory) – 1 credit
Prerequisits: METHODOLOGY AND SCIENTIFIC WRITING
Summary: Importance of scientific writing; English in scientific writing; Planning, development of experiments and data analysis; Elements of a scientific article; Steps for submitting a scientific article; Review process for scientific articles.

MECM 022 – METHODOLOGY AND SCIENTIFIC WRITING (Mandatory) – 2 credits

Summary: Logical bases of scientific research (types of research and hypotheses, inductive and deductive methods and construction of premises). Writing articles and publishing process. Bibliometrics.

Orientation Disciplines

MECM 024 - Orientation I (Mandatory) – 1 credit
Summary: Individual activity under the supervision of the supervising teacher.

MECM 025 - Orientation II (Mandatory) – 1 credit

Summary: Individual activity under the supervision of the supervising teacher.

MECM 026 - Orientation III (Mandatory) – 1 credit
Summary: Individual activity under the supervision of the supervising teacher.

MECM 027 - Orientation IV (Mandatory) – 1 credit
Summary: Individual activity under the supervision of the supervising teacher.

Teaching Internship

MECM 028 – TEACHING INTERNSHIP I
Summary: Planning of teaching activities. Subject plan, lesson plan. Content taught and content scheduling. Assessment of academic performance.

MECM 029 – TEACHING INTERNSHIP II
Summary: Planning the discipline together with the professor in the undergraduate course. Defining the content and preparing the schedule of activities for the intern student. Supervised teaching activities in the classroom, aiming at training the postgraduate student in university teaching.