COURSE: Linear Algebra and Analytic Geometry	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 60 h	**Code:** PF.EM.001
Syllabus: Study of analytic geometry; Study of vectors in the plane and space; Analysis of lines and planes; Study of conic sections; Analysis of surfaces and curves in space; Understanding coordinate transformations. Introduction to Matrices and Linear Systems; Investigation of Matrix Inversion; Study of Determinants; Introduction to Vector Spaces; Reflection on Inner Product Spaces; Discussion of Linear Transformations; Construction of Diagonalization.	

Contents

UNIT I – Introduction to Analytic Geometry
        1.1 Point
        1.2 Line
        1.3 Planes
        1.4 Circumference

UNIT II – Vectors in the Plane and Space
        2.1 Vector addition and scalar multiplication
        2.2 Vector product – norm and dot product
        2.3 Orthogonal projection
        2.4 Mixed product

UNIT III – Lines and Planes
        3.1 Equations of lines and planes
        3.2 Angles and distances
        3.3 Relative positions of lines and planes

UNIT IV – Conic Sections
        4.1 Non-degenerate conics – Ellipse
        4.2 Hyperbola
        4.3 Parabola
        4.4 Characterization of conics
        4.5 Polar coordinates and parametric equations – conics in polar coordinates
        4.6 Circumference in polar coordinates

UNIT V – Surfaces and Planes in Space
        5.1 Quadrics – Ellipsoid
        5.2 Hyperboloid
        5.3 Paraboloid
        5.4 Elliptic cone
        5.5 Quadric cylinder
        5.6 Cylindrical and conic surfaces, and revolution surfaces
        5.7 Cylindrical and spherical coordinates

UNIT VI – Coordinate Transformations
        6.1 Rotation and translation
        6.2 Identification of conics
        6.3 Identification of quadrics

UNIT VII – Matrices and Linear Systems
      7.1 Matrix – definition
      7.2 Operations
      7.3 Properties
      7.4 Applications
      7.5 Gauss-Jordan method
      7.6 Row-equivalent matrices
      7.7 Homogeneous linear systems
      7.8 Elementary matrices

UNIT VIII – Matrix Inversion and Determinants
      8.1 Inverse matrix – properties
      8.2 Elementary matrices
      8.3 Matrix inversion method
      8.4 Determinants – properties
      8.5 Elementary matrices
      8.6 Adjoint matrix

UNIT IX – Vector Spaces
      9.1 Definition and examples – $\mathbb{R}^n$ spaces
      9.2 Abstract spaces
      9.3 Subspaces – sum and intersection of subspaces
      9.4 Spanning sets
      9.5 Linear dependence – linear independence of functions
      9.6 Basis and dimension – basis
      9.7 Dimension
      9.8 Applications

UNIT X – Inner Product Spaces
      10.1 Dot product and norm – inner product
      10.2 Norm
      10.3 Orthogonality
      10.4 Orthogonal projection
      10.5 Fourier coefficients
      10.6 Orthonormal bases and orthogonal subspaces – Orthonormal bases
      10.7 Orthogonal complement
      10.8 Distance from a point to a subspace
      10.9 Applications

UNIT XI – Linear Transformations
      11.1 Definition
      11.2 Examples
      11.3 Properties and applications
      11.4 Image and kernel – row space and column space of a matrix
      11.5 Injectivity
      11.6 Surjectivity
      11.7 Composition of linear transformations – matrix of a linear transformation
      11.8 Invertibility
      11.9 Similarity
      11.10 Applications
      11.11 Adjoint – applications

UNIT XII – Diagonalization

12.1 Diagonalization of operators – diagonalizable operators and matrices

12.2 Eigenvalues and eigenvectors

12.3 Invariant subspaces

12.4 Cayley-Hamilton theorem

12.5 Applications

12.6 Self-adjoint and normal operators

12.7 Applications in identifying conics

12.8 Jordan canonical form – Generalized eigenspace

12.9 Cycles of generalized eigenvectors

12.10 Applications

Basic Bibliography

BOLDRINI, José Luiz et al. **Álgebra Linear**. 3. ed. São Paulo: Harper & Row do Brasil, 1980.

IEZZI, Gelson. **Fundamentos de matemática elementar** 7: geometria analítica. 5. ed. São Paulo: Atual, 2005.

STEINBRUCH, Alfredo. **Geometria Analítica**. São Paulo: Makron Books, 1987.

Supplementary Bibliography

SWOKOWSKI, Earl William, 1926-. **Cálculo com geometria analítica**. Alfredo Alves de Farias (Trad.). 2. ed. São Paulo: Makron Books, 1994. v.2.

LEITHOLD, Louis. **O cálculo com geometria analítica**. 3. ed. São Paulo: Harbra, 1994. 2 v.

HOFFMAN, K.; KUNZE, R. **Álgebra Linear**. 2. ed. Rio de Janeiro: LTC, 1969.

CAROLI, Alésio de; CALLIOLI, Miguel O. Feitosa. **Matrizes, vetores, geometria analítica**. São Paulo: Nobel, 1984.

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COURSE: Differential and Integral Calculus I	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 150 h	**Code:** PF.EM.057
Syllabus: Study of real functions of a single variable. Description of limits and continuity. Interpretation, calculation, and applications of the derivative. Characterization of indefinite and definite integrals, demonstration of the fundamental theorem of calculus, applications of integrals, and improper integrals.	

Contents

UNIT I – Functions
        1.1 Linear functions
        1.2 Trigonometric functions in Cartesian and polar coordinates
        1.3 Polynomial functions
        1.4 Rational functions
        1.5 Exponential functions
        1.6 Logarithmic function
        1.7 Composite and inverse functions

UNIT II – Limit and Continuity
        2.1 Definition and properties of limits
        2.2 Squeeze theorem
        2.3 Fundamental limits
        2.4 Limits involving infinity
        2.5 Asymptotes
        2.6 Continuity of real functions
        2.7 Intermediate value theorem

UNIT III – Derivative
        3.1 Tangent line
        3.2 Definition of derivative
        3.3 Basic differentiation rules
        3.4 Derivative of elementary functions
        3.5 Partial derivatives and chain rule
        3.6 Derivative of implicit functions
        3.7 Geometric interpretation
        3.8 Higher-order derivatives
        3.9 Rates of change
        3.10 Differential and applications
        3.11 Intermediate value theorem, Rolle's theorem, and mean value theorem
        3.12 Increasing and decreasing functions
        3.13 Concavity and inflection points
        3.14 Maximization and minimization problems
        3.15 Indeterminate forms – L'Hospital's Rule

UNIT IV – Indefinite Integral
        4.1 Concept and properties of the indefinite integral
        4.2 Integration techniques: substitution and integration by parts
        4.3 Integration of rational functions using partial fractions

4.4 Integration using trigonometric substitution

UNIT V – Definite Integral
    5.1 Concept and properties of the definite integral
    5.2 Fundamental theorem of calculus
    5.3 Calculation of areas, arc lengths, volumes, and volumes of revolution
    5.4 Improper integrals
    5.5 Multiple integrals

Basic Bibliography

ANTON, Howard; BIVENS, Irl; DAVIS, Stephen. **Cálculo**. 8. ed. Porto Alegre: Bookman, 2007.
FLEMMING, Diva Marília; GONÇALVES, Mirian Buss. **Cálculo A**: funções, limite, derivação e integração. 6. ed. São Paulo: Pearson prentice hall, 2006.
LEITHOLD, Louis. **O cálculo com geometria analítica**. 3. ed. São Paulo: Harbra, 1994.

Supplementary Bibliography

BOULOS, Paulo. **Cálculo diferencial e integral** - Volume 1. São Paulo: Pearson Makron Books, 1999.
DEMANA, Franklin D. et al. **Pré-Cálculo**. São Paulo: Pearson Addison Wesley, 2009.
GUIDORIZZI, Hamilton Luiz. **Um curso de cálculo**. 5. ed. Rio de Janeiro: LTC, 2001.
WEIR, Maurice D.; HASS, Joel; GIORDANO, Frank R. **Cálculo**: George B. Thomas. Volume 1. 11. ed. São Paulo: Pearson, 2009.
SIMMONS, George Finlay. **Cálculo com Geometria Analítica**. Volume 1. São Paulo: Makron Books, 1987.

COURSE: Introduction to Technical Drawing	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 120 h	**Code:** PF.EM.076
Syllabus: Study of Descriptive Geometry and dihedral representation. Reading and interpretation of mechanical technical drawings, preparation of freehand sketches and drawings using technical drawing instruments.	

Contents

UNIT I – Introduction to Descriptive Geometry
      1.1 Historical background
      1.2 Basic concepts
      1.3 Projection systems
      1.4 Monge's double-projection method

UNIT II – Study of the Point
      2.1 Point projections
      2.2 Point coordinates
      2.3 Special positions of the point
      2.4 Points on the bisector plane
      2.5 Point symmetry

UNIT III – Study of the Line
      3.1 Projections
      3.2 Special positions of lines in relation to the projection planes
      3.3 Belonging of point and line
      3.4 Line traces
      3.5 Relative positions of two lines

UNIT IV – Study of the Plane
      4.1 Plane traces
      4.2 Special positions
      4.3 Belonging of line and plane
      4.4 Belonging of point and plane
      4.5 Lines of maximum slope and maximum inclination
      4.6 Geometric elements that define a plane

UNIT V – Introduction to Technical Drawing
      5.1 Importance of technical drawing
      5.2 Classification of technical drawing
      5.3 Types of paper
      5.4 Paper formats (ABNT – A series)
      5.5 Technical lettering
      5.6 Scales

UNIT VI – Two-Dimensional Geometric Representation
        6.1 Universal projection system
        6.2 North American projection system
        6.3 Auxiliary views

UNIT VII – Three-Dimensional Geometric Representation
        7.1 Cavalier perspective
        7.2 Isometric perspective
        7.3 Circular elements in isometric perspective

UNIT VIII – Dimensioning in Technical Drawing
        8.1 Dimensioning elements
        8.2 General rules for dimensioning

UNIT IX – Sections and Cuts
        9.1 Types of cuts
        9.2 Sections
        9.3 Omission of cuts
        9.4 Breaks

Basic Bibliography

PRÍNCIPE JÚNIOR, A. dos R. **Noções de geometria descritiva**. V.1. São Paulo: Nobel, 1983.
SILVA, Arlindo; RIBEIRO, Carlos Tavares; DIAS, João; SOUSA, Luís. **Desenho Técnico Moderno**. 4. ed. Rio de Janeiro: Editora LTC, 2006.
FRENCH, Thomas E.; VIERK, Charles J. - **Desenho Técnico e Tecnologia Gráfica**. 8. ed. São Paulo: Editora Globo, 2005. 1093 p.

Supplementary Bibliography

LEAKE, James M.; BORGERSON, Jacob L. – **Manual de Desenho Técnico para Engenharia.** 2. ed. Rio de Janeiro: Editora LTC, 2015.
MONTENEGRO, G. **Geometria descritiva**. V.1. São Paulo: Edgard Blücher, 2004.
PROVENZA, Francesco - PRO-TEC - **Projetista de Máquinas**. 46. ed. São Paulo: Editora F. Provenza, 1991.
CUNHA, Luis Veiga da. **Desenho Técnico**. 7. ed. Lisboa: Fundação C. Guibenkian, 1989.
RIBEIRO, Antônio Clélio; PERES, Mauro Pedro; NACIR, Izidoro. **Curso de desenho técnico e AutoCAD**. 1. ed. São Paulo: Editora Pearson, 2013.

COURSE: Applied Physics to Mechanical Engineering I	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 180 h	**Code:** PF.EM.003
Syllabus: Foundations and development of Unit Systems and dimensional analysis, physical measurements, and error theory. Study of kinematics, statics and dynamics of a particle and rigid body, Newton's laws, energy conservation, particle systems, collisions, rotational motion, and conservation of angular momentum. Definitions and foundations of gravitation, oscillations; mechanical waves; temperature; fluid mechanics; first law of thermodynamics; kinetic theory of gases; second law of thermodynamics. Theoretical analysis of geometric optics. Laboratory activities included.	

Contents

UNIT I – Measurements and Units
      1.1 Physical quantities, standards, and units
      1.2 International system of units
      1.3 Standards of time, length, and mass
      1.4 Significant figures; dimensional analysis

UNIT II – One-Dimensional Motion
      2.1 Particle kinematics
      2.2 Motion description
      2.3 Average velocity
      2.4 Instantaneous velocity
      2.5 Accelerated motion and constant acceleration
      2.6 Free fall and gravity measurement

UNIT III – Two- and Three-Dimensional Motion
      3.1 Vectors and scalars
      3.2 Vector algebra
      3.3 Position, velocity, and acceleration
      3.4 Projectile motion
      3.5 Circular and relative motion

UNIT IV – Newton's Laws of Motion
      4.1 Newton's first law – inertia
      4.2 Newton's second law – force
      4.3 Newton's third law – interactions
      4.4 Weight and mass
      4.5 Types of forces

UNIT V – Particle Dynamics
      5.1 Friction forces
      5.2 Properties of friction
      5.3 Drag force
      5.4 Uniform circular motion
      5.5 Galilean relativity

UNIT VI – Work and Energy
   6.1 Work done by a constant force
   6.2 Work done by variable forces
   6.3 Kinetic energy of a particle
   6.4 Work-energy theorem
   6.5 Power and efficiency

UNIT VII – Energy Conservation
   7.1 Conservative and dissipative forces
   7.2 Potential energy
   7.3 Conservative systems
   7.4 Potential energy curves
   7.5 Energy conservation in a particle system

UNIT VIII – Particle Systems and Collisions
   8.1 Two-particle systems and linear momentum conservation
   8.2 Multi-particle systems and center of mass
   8.3 Center of mass of solids
   8.4 Linear momentum of a particle system
   8.5 Collisions and impulse
   8.6 Energy and momentum conservation in particle systems
   8.7 Elastic and inelastic collisions
   8.8 Variable mass systems

UNIT IX – Rotational Kinematics and Dynamics
   9.1 Rotational motion and variables
   9.2 Constant angular acceleration
   9.3 Scalar and vector rotational quantities
   9.4 Rotational kinetic energy
   9.5 Moment of inertia
   9.6 Torque
   9.7 Newton's second law for rotation
   9.8 Work and rotational kinetic energy

UNIT X – Angular Momentum
   10.1 Rolling and combined motion
   10.2 Kinetic energy of rolling objects
   10.3 Angular momentum
   10.4 Conservation of angular momentum
   10.5 Angular momentum in particle systems
   10.6 Angular momentum of a rigid body

UNIT XI – Equilibrium
   11.1 Conditions for equilibrium
   11.2 Center of gravity
   11.3 Solving equilibrium problems of rigid bodies

UNIT XII – Temperature
   12.1 Temperature concept
   12.2 Thermal equilibrium
   12.3 Temperature measurement
   12.4 Temperature scales
   12.5 Thermal expansion

UNIT XIII – Heat
>13.1 Energy
>13.2 Quantity of heat
>13.3 Specific heat
>13.4 Heat conduction
>13.5 Mechanical equivalent of heat
>13.6 Work – First Law of Thermodynamics

UNIT XIV – Kinetic Theory of Gases
>14.1 Ideal gas
>14.2 Pressure
>14.3 Temperature
>14.4 Intermolecular forces
>14.5 Energy equipartition – mean free path
>14.6 Velocity distribution in a gas
>14.7 Brownian motion
>14.8 Equation of state

UNIT XV – Thermodynamics
>15.1 Reversible and irreversible transformations
>15.2 Thermodynamic cycles – Second Law of Thermodynamics
>15.3 Heat engines
>15.4 Thermodynamic temperature
>15.5 Entropy

UNIT XVI – Mechanical Waves
>16.1 Wave concept
>16.2 Wave propagation equation
>16.3 Wave interference
>16.4 Complex waves
>16.5 Standing waves
>16.6 Power and intensity of wave propagation

UNIT XVII – Sound Waves
>17.1 General characteristics of sound waves
>17.2 Sound speed in solids, liquids, and gases
>17.3 Beats
>17.4 Doppler effect for sound

UNIT XVIII – Electromagnetic Waves
>18.1 General characteristics of electromagnetic waves
>18.2 Poynting vector
>18.3 Speed of electromagnetic waves
>18.4 Doppler effect for light

UNIT XIX – Geometrical Optics
>19.1 Laws of reflection and refraction
>19.2 Study of mirrors and thin lenses

Basic Bibliography

Halliday, D.; Resnick, R. ; Walker, J. **Fundamentos de Física**. 8. ed. V1. Rio de Janeiro: Editora Livros Técnicos e Científicos, 2008.
Halliday, D.; Resnick, R. ; Walker, J. **Fundamentos de Física**. 8. ed. V3. Rio de Janeiro: Editora Livros Técnicos e Científicos, 2008.

Tipler, P. A.; Mosca, G. **Física**: para cientistas e engenheiros. 6. ed. V1. Rio de Janeiro: Editora Livros Técnicos e Científicos, 2009.

Supplementary Bibliography

NUSSENZVEIG, H. M. **Curso de física básica**. 4. ed. São Paulo: Editora Edgard Blucher, V1, 2002.
NUSSENZVEIG, H. M. **Curso de física básica**. 4. ed. São Paulo: Editora Edgard Blucher, V2, 2002.
SERWAY, R.A.; JEWETT, Jr., JOHN, W. **Princípios de Física Vol. 1** - Mecânica Clássica. 3. ed. São Paulo: Editora Thomson Pioneira, V1, 2003.
SERWAY, R. A. **Física I**. Vol. 1, 3. ed. Rio de Janeiro: LTC Editora, 1996.
TIPLER, P. A.; MOSCA, G. **Física**: para cientistas e engenheiros. 6. ed. V2; Rio de Janeiro: Editora Livros Técnicos e Científicos, 2009.

COURSE: Applied Portuguese	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 60 h	**Code:** PF.EM.008
Syllabus: Development of vocabulary and application of the standard form of the language. Reading, production and presentation of technical-scientific texts. Introduction to scientific knowledge: classification, research methods and techniques.	

Contents

UNIT I – Linguistic Practices
      1.1 Linguistic variation
          1.1.1 Levels of language
          1.1.2 Spoken language and written language
      1.2 Study and practice of standard written language
          1.2.1 Spelling and accentuation
          1.2.2 Verbal and nominal agreement
          1.2.3 Verbal and nominal government (regency)
          1.2.4 Use of punctuation marks
          1.2.5 Use of relative, demonstrative and object pronouns
          1.2.6 Homonyms and paronyms in technical-scientific writing

UNIT II – Study and Production of Texts
      2.1 Reading, analysis and textual interpretation
          2.1.2 Text typology
          2.1.3 Characterization and purpose of textual genres
      2.2 Text production
          2.2.1 Letter (e-mail)
          2.2.2 Technical report, visit report and internship report
          2.2.3 Abstract
          2.2.4 Critical review
          2.2.5 Curriculum vitae

UNIT III – Fundamentals of Scientific Methodology
      3.1 Scientific knowledge and research
          3.1.1 Concepts
          3.1.2 Types of research
          3.1.3 Research methods and techniques
      3.2 Ethics in research work
          3.2.1 Ethical aspects in research
          3.2.2 Relationship between advisor and student in academic research production

UNIT IV – Preparation and Presentation of Scientific Papers

    4.1 Techniques for scientific writing

        4.1.1 Reading, note-taking and paraphrasing

        4.1.2 Literature review

    4.2 Presentation of academic works

        4.2.1 Oral presentation techniques

        4.2.2 Study and application of standards for the preparation of academic works (ABNT)

    4.3 Structure of Scientific Works

        4.3.1 Research project: structure and description of its elements

        4.3.2 Scientific article: concept, typology and structure

        4.3.3 Final Course Project (TCC): concept, typology and structure

Basic Bibliography

MARCONI, Marina de Andrade; LAKATOS, Eva Maria. **Metodologia do trabalho científico**: procedimentos básicos, pesquisa bibliográfica, projeto, relatório. Publicações e trabalhos científicos. 7. ed. São Paulo: atlas, 2007.

MARTINS, Dileta Silveira; ZILBERKNOP, Lúbia Scliar. **Português instrumental**: de acordo com as atuais normas da ABNT. 28. ed. São Paulo: Atlas, 2009.

MEDEIROS, João Bosco**. Redação científica**: a prática de fichamentos, resumos, resenhas. 10. ed. São Paulo: Atlas, 2008.

Supplementary Bibliography

BECHARA, Evanildo. **Moderna gramática da língua portuguesa**. 37. ed. Rio de Janeiro: Editora Lucerna, 2003.

CEGALLA, Domingos Paschoal. **Novíssima gramática da língua portuguesa**. 46. ed. São Paulo: Companhia Editora Nacional, 2005.

FRANÇA, Júnia Lessa; VASCONCELLOS, Ana Cristina. **Manual para normalização de publicações técnico-científicas**. Belo Horizonte: UFMG, 2007.

FURASTÉ, Pedro. **Normas técnicas para o trabalho científico**: elaboração e formação. 14. ed. Porto Alegre: s. n., 2007.

MEDEIROS, João Bosco. **Português instrumental**. 8. ed. São Paulo: Atlas, 2009.

COURSE: Introduction to Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 30 h	**Code:** PF.EM.007
Syllabus: Introduction to the Mechanical Engineering program. Study of the organizational structure of the Federal Institute of Education, Science and Technology Sul-rio-grandense. Analysis of the main laboratory practices of the Mechanical Engineer.	

Contents

UNIT I – Introduction
        1.1 General presentation
        1.2 The course
        1.3 Objectives
        1.4 Program
        1.5 Assessment system

UNIT II – Structure of IFSul
        2.1 Centers
        2.2 Departments
        2.3 Coordination Office
        2.4 Regulations and statute

UNIT III – The Mechanical Engineering Program
        3.1 Curriculum
        3.2 Areas of study
        3.3 Internship
        3.4 Prerequisites
        3.5 Elective courses

UNIT IV – Entering the University
        4.1 Study methods

UNIT V – Technological Research
        5.1 Science, technology and society
        5.2 Scientific methodology

UNIT VI – Communication
        6.1 Writing
        6.2 Technical reports

UNIT VII – Design
        7.1 Design morphology
        7.2 Problem approach
        7.3 Case analysis

UNIT VIII – Models
  8.1 Modeling
  8.2 Classification
  8.3 Simplifying assumptions
  8.4 Simulation
  8.5 Experimentation

UNIT IX – Optimization
  9.1 The optimum
  9.2 Variables
  9.3 Examples

UNIT X – Creativity
  10.1 Creative process
  10.2 Requirements
  10.3 Barriers
  10.4 Stimuli

UNIT XI – Historical Overview of Technology and Engineering
  11.1 Landmark facts
  11.2 Formal education
  11.3 Engineering in Brazil

UNIT XII – Engineer Profile
  12.1 Functions
  12.2 Professional attributions
  12.3 Areas of practice
  12.4 Labor market

UNIT XIII – Engineering Qualifications and Concepts
  13.1 Areas of practice

UNIT XII – International System of Units
  14.1 Rules of use
  14.2 Base and derived units
  14.3 Symbols

Basic Bibliography

BAZZO, W.A.; PEREIRA. L.T.V. **Introdução à Engenharia**. 6. ed.
Florianópolis: Ed. UFSC, 2000.
VALERIANO, Dalton L. **Gerência em Projetos**: pesquisa, desenvolvimento e
engenharia. São Paulo: Makron Books, 1998.
WICKERT, Jonathan A. **Introdução à engenharia mecânica**. São Paulo:
Thomson, 2007.

Supplementary Bibliography

BRASIL. *Lei nº 5.194, de 24 dezembro de 1966*. Regula o exercício das profissões de Engenheiro, Arquiteto e Engenheiro-Agrônomo, e dá outras providências. Disponível em: <http://www.planalto.gov.br/ccivil_03/Leis/L5194.htm>. Acesso em: 22 jun. 2013.

BRASIL. **Lei nº 6.496, de 7 de dezembro de 1977**. Institui a "Anotação de Responsabilidade Técnica", na prestação de serviços de Engenharia, de Arquitetura e Agronomia; autoriza a criação, pelo Conselho Federal de Engenharia, Arquitetura e Engenharia-CONFEA, de uma Mútua de Assistência Profissional; e da outras providências. Disponível em: <http://www.planalto.gov.br/ccivil_03/Leis/L6496.htm>. Acesso em: 22 jun. 2013.

BAZZO, W.A.; PEREIRA. L.T.V. **Engenharia**. Florianópolis: Ed. UFSC, 2015.

HOLTZAPPLE, Mark Thomas; REECE, W. Dan. Introdução à engenharia. Rio de Janeiro: LTC, 2006.

RAMOS FILHO, José de Miranda; PIOVEZAN, Dorvino Antonio. **Introdução dos profissionais do sistema CONFEA/CREA ao mercado de trabalho**. Florianópolis: Insular, 2008.

COURSE: Computer Science and Programming Applied to Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 90 h	**Code:** PF.EM.006
Syllabus: Description of computer systems. Definition of algorithms and their representation. Analysis of problem understanding and description through a programming language. Laboratory activities.	

Contents

UNIT I – Introduction to Algorithms
      1.1 Programming logic
      1.2 History of programming languages
      1.3 Types of programming languages
      1.4 Data types
      1.5 Variables and constants
      1.6 Graphical representation of an algorithm
      1.7 Pseudocode
      1.8 Mathematical operations
      1.9 Logical, arithmetic and relational operators

UNIT II – Conditional Statements
      2.1 Simple conditional statement
      2.2 Compound conditional statement
      2.3 Nested conditional statement
      2.4 Case (switch) statement

UNIT III – Repetition Structures (Loops)
      3.1 Stop condition, counter and accumulator
      3.2 For loop
      3.3 While loop
      3.4 Repeat–until loop
      3.5 Interruption before the stop condition is satisfied
      3.6 Move to the next iteration

UNIT IV – Homogeneous Data Structures
      4.1 Indexed variables
      4.2 Arrays (vectors)
      4.3 Matrices
      4.4 Operations with arrays and matrices

UNIT V – Problem Decomposition into Subroutines
      5.1 General concepts
      5.2 Parameters and arguments (by value and by reference)
      5.3 Types of functions
      5.4 External variables
      5.5 Scope rules
      5.6 Function prototype
      5.7 Function return

5.8 Variable initialization

5.9 Recursion

UNIT VI – Records (struct)

6.1 Definition of a struct

6.2 Variables of struct type

6.3 Indexed variables with struct

6.4 Manipulating struct using functions

6.5 Character strings with struct

UNIT VII – Pointers

7.1 Definition of a pointer

7.2 Pointer variables

7.3 Pointer operations

7.4 Pointer expressions

7.5 Array manipulation using pointers

7.6 Pointers and functions

UNIT VIII – Text File Handling

8.1 File pointer

8.2 File opening and its modes

8.3 File closing

8.4 Writing to a file

8.5 Reading data from a file

8.6 Deleting files

Basic Bibliography

VILARIM, Gilvan de Oliveira. **Algoritmos**: programação para iniciantes. 2. ed. Rio de Janeiro: Ciência Moderna, 2004. 270 p. ISBN 978857393316X.
ARAUJO, Jário. **Dominando a linguagem C**. Rio de Janeiro: Ciência moderna, 2004. 146 p. ISBN 85-7393-315-1.
FORBELLONE, André Luiz Villar; EBERSPACHER, Henri Frederico. **Lógica de programação**: a construção de algoritmos e estruturas de dados. 3. ed. São Paulo: Pearson, 2005. 218 p. ISBN 978-85-7605-024-7.

Supplementary Bibliography

CASTRO, J. **Linguagem C na prática**. Rio de Janeiro: Ciência moderna, 2008.
LOPES, Anita. **Introdução à programação**: 500 algoritmos resolvidos. Rio de Janeiro: Elsevier, 2002.
MANZANO, José Augusto N. G; OLIVEIRA, Jayr Figueiredo de**. Estudo dirigido de algoritmos**. 12. ed. São Paulo: Erica, 2008.
SCHILDT, Herbert. **C++:** guia para iniciantes. Rio de Janeiro: Ciência Moderna, 2002.
XAVIER, Gley Fabiano Cardoso. **Lógica de programação**. 11. ed. São Paulo: Senac São Paulo, 2007.

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Pró-Reitoria de Ensino

COURSE: Fundamentals of Chemistry Applied to Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 1th year
Total course load: 60 h	**Code:** PF.EM.075
Syllabus: Study of the electronic structure of atoms and analysis of their properties. Discussion of the periodic table and its potentialities. Survey of the types of chemical bonds and their implications for the structure of different ions and molecules. Introduction to thermochemistry. Guidelines on stoichiometric calculations. Analysis of chemical solutions and aqueous chemical reactions. Laboratory activities.	

Contents

UNIT I – Atomic Theory and Electronic Structure
      1.1 Historical background
      1.2 Dalton's model
      1.3 Electrical nature of matter
      1.4 Thomson's model
      1.5 Rutherford's model
      1.6 Rutherford–Bohr model
      1.7 Wave model
      1.8 Quantum numbers
      1.9 Pauling diagram

UNIT II – Periodic Table
      2.1 Historical background
      2.2 Periodic table families
      2.3 Determination of an element's position in the periodic table based on its electronic configuration
      2.4 Periodic properties

UNIT III – Thermochemistry
      3.1 Basic concepts of thermochemistry

UNIT IV – Chemical Bonds
      4.1 Chemical bonding and stability
      4.2 Ionic bonding
      4.3 Ionic bonding and energy
      4.4 Covalent bonding
      4.5 Covalent bonding and energy
      4.6 Types of covalent bonds
      4.7 Planar structural formulas of molecules
      4.8 Hybridization
      4.9 Valence Shell Electron Pair Repulsion Theory (VSEPR)
      4.10 Molecular geometry
      4.11 Geometry and polarity

UNIT V – Stoichiometry
>	5.1 Laws of mass relationships
>	5.2 Atomic mass, molecular mass and mole
>	5.3 Balancing chemical equations
>	5.4 Stoichiometric calculations involving limiting reagent, purity and yield

UNIT VI – Solutions
>	6.1 Concept
>	6.2 Concentration units: mol/L, g/L
>	6.3 Mixing of solutions
>	6.4 Dilution of solutions
>	6.5 Volumetric analysis

UNIT VII – Chemical Reactions and Chemical Equilibrium
>	7.1 Reactions in aqueous medium
>	7.2 Neutralization, precipitation and oxidation–reduction reactions
>	7.3 Equilibrium constants and Le Chatelier's principle
>	7.4 Equilibrium calculations
>	7.5 Electrochemistry and basic concepts of metal corrosion

Basic Bibliography

Brown, Theodore L.; Lemay Jr., H. Eugene; Bursten, Bruce E.; Burdge, Julia R. **Química**: A Ciência Central. 9. ed. São Paulo: Editora Pearson Prentice Hall Inc., 2005.
Treichel Jr. Paul; Treichel Jr. Paul; Kotz, John C.; Kotz, John C. **Química Geral e Reações Químicas**. Vol. 1. 6. ed. São Paulo: Editora Cengage Learning, 2009.
Treichel Jr. Paul; Treichel Jr. Paul; Kotz, John C.; Kotz, John C. **Química Geral e Reações Químicas** - Vol. 2. 6. ed. São Paulo: Editora Cengage Learning, 2009.

Supplementary Bibliography

CARVALHO, Geraldo Camargo de. **Química Moderna**. São Paulo: Scipione, 1997.
Atkins, Peter; Jones, Loretta - **Princípios de Química**: Questionando a Vida Moderna e o Meio Ambiente. 3. ed. Porto Alegre: Editora Bookman, 2006.
Brown, L.S. e Holme, T.A.; tradução Maria Lucia Godinho de Oliveira; revisão técnica Robson Mendes Matos. **Química geral aplicada à engenharia**. São Paulo: Cengage Learning, 2009.
Gentil, Vicente. **Corrosão**. 5. ed. Rio de Janeiro: Editora Livros Técnicos e Científicos, 2007.
Gemelli, Enori. **Corrosão de Materiais Metálicos e sua caracterização**. Rio de Janeiro: Editora Livros Técnicos e Científicos, 2001.

COURSE: Mechanical Construction Materials	
Effective: from 2018/1	**Academic period:** 2nd year
Total course load: 60 h	**Code:** PF.EM.014
Syllabus: Definition of crystallography. Introduction to material properties. Introduction to the solid state. Analysis of solid-state transformations. Fundamentals of property modification in solids. Introduction to ferrous and non-ferrous metals: steels and cast irons. Description of aluminum and its alloys. Description of copper and its alloys. Introduction to ceramic, polymeric and composite materials. Application of destructive and non-destructive mechanical testing. Definition of corrosion. Fundamentals of new materials.	

Contents

UNIT I – Introduction
      1.1 Importance of the study of mechanical construction materials
      1.2 Criteria for material selection
      1.3 Classification of mechanical construction materials

UNIT II – Structure of Materials
      2.1 Atoms and atomic bonding
      2.2 Atomic states and arrangements of matter
      2.3 Substructural defects (point, line and interfacial defects)
      2.4 Main crystalline systems of materials
      2.5 Preferred slip directions and planes of crystalline systems
      2.6 Allotropy / polymorphism: advantages and disadvantages
      2.7 Diffusion

UNIT III – Mechanical Properties of Materials
      3.1 Elastic deformation
      3.2 Plastic deformation

UNIT IV – Dislocations and Strengthening Mechanisms
      4.1 Dislocations and plastic deformation
      4.2 Strengthening mechanisms in metals
      4.3 Recovery, recrystallization and grain growth

UNIT V – Failures
      5.1 Fracture
      5.2 Fatigue
      5.3 Creep

UNIT VI –Phase Diagrams
      6.1 Unary phase diagram
      6.2 Binary phase diagram
      6.3 The iron–carbon system

UNIT VII – Phase Transformations in Metals: Development of Microstructure and Changes in Mechanical Properties
       7.1 Phase transformations
       7.2 Microstructural and property changes in iron–carbon alloys

UNIT VIII – Metallic Materials
       8.1 Types of metallic alloys
       8.2 Basics of metallurgy
       8.3 Basics of forming processes
       8.4 Heat treatments, thermochemical and thermomechanical treatments and their application in engineering
       8.5 Classification and selection of metallic materials and their applications in equipment

UNIT IX – Polymeric Materials
       9.1 Basics of manufacturing
       9.2 Structural improvement
       9.3 Properties of polymers and applications in engineering

UNIT X – Ceramic Materials
       10.1 Basics of manufacturing
       10.2 Structure of ceramics
       10.3 Properties of ceramics and applications in engineering

UNIT XI – Composite Materials
       11.1 Basics of manufacturing
       11.2 Structure of composites
       11.3 Properties of composites and their use

UNIT XII – Mechanical Testing
       12.1 Destructive tests
       12.2 Non-destructive tests

UNIT XIII – Corrosion and Degradation of Materials
       13.1 Corrosion of metals
       13.2 Corrosion of ceramic materials
       13.3 Degradation of polymers

Basic Bibliography

CALLIESTER JR., William D. **Ciência e engenharia de materiais**: uma introdução. 7. ed. Rio de Janeiro: LTC, 2008. 705 p.
CHIAVERINI, V. **Tecnologia mecânica**: estrutura e propriedades das ligas metálicas. 2. ed. São Paulo: Mcgraw - Hilll, 1986. 2 v.
CHIAVERINI, V. **Aços e ferros fundidos**: características gerais, tratamentos térmicos, principais tipos. 7. ed. São Paulo: Associação Brasileira de Metalurgia e Materiais, 1996. 599 p.

Supplementary Bibliography

CALLISTER JR, Willian D. **Fundamentos da ciência e engenharia de materiais**: uma abordagem integrada. 2. ed. Rio de Janeiro: LTC, 2006. 702 p.

GEMELLI, E. **Corrosão de materiais metálicos e sua caracterização**. Rio de Janeiro: Editora LTC - Livros Técnicos e Científicos, 2001. 183 p. ISBN 521612907 183 p.

SOUSA, S. A. **Ensaios mecânicos de materiais metálicos**. São Paulo: E. Blucher, 1974. 197 p.

Freire, W. J; Beraldo, A. L. **Tecnologias e materiais alternativos de construção**. Campinas (sp): Ed. Unicamp, 2003. 331 p.

CHIAVERINI, V. **Tratamento térmico das ligas metálicas**. São Paulo: Associação Brasileira de Metalurgia e Materiais, 2003. 272 p.

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COURSE: Vector Mechanics Applied to Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 2nd year
Total course load: 90 h	**Code:** PF.EM.015
Syllabus: Study of vectors. Analysis of the fundamentals of Newtonian mechanics. Study of forces applied to particles and rigid bodies. Study of equilibrium of particles and rigid bodies. Structural analysis. Application of internal forces in structural elements. Study of distributed forces in extended bodies.	

Contents

UNIT I – Review of Vectors and Force
      1.1 Scalars and vectors
      1.2 Vector operations
      1.3 Position vector
      1.4 Force vector along a line

UNIT II – Equilibrium of a Particle
      2.1 Two-dimensional equilibrium conditions of a particle
      2.2 Cables and pulleys
      2.3 Three-dimensional equilibrium conditions of a particle

UNIT III – Systems of Forces
      3.1 Moment of a force and the principle of transmissibility
      3.2 Couples
      3.3 Simple distributed loading

UNIT IV – Equilibrium of a Rigid Body
      4.1 Two-dimensional equilibrium
      4.2 Three-dimensional equilibrium

UNIT V – Structural Analysis
      5.1 Simple trusses
      5.2 Method of joints and zero-force members
      5.3 Space trusses
      5.4 Structures and machines

UNIT VI – Internal Forces
      6.1 Normal and shear forces and sign conventions
      6.2 Shear force and bending moment equations and diagrams
      6.3 Cables

UNIT VII – Friction
      7.1 Dry friction
      7.2 Friction forces in screws, belts and bearings
      7.3 Rolling resistance

UNIT VIII – Center of Gravity and Centroids
      8.1 Centers of gravity, mass and volume
      8.2 Area centroids
      8.3 Composite bodies
      8.4 Pappus–Guldinus theorem
      8.5 Resultant force of a general distributed load

UNIT IX – Moments of Inertia
      9.1 Moment of inertia of simple and composite areas. Radii of gyration
      9.2 Product of inertia of area
      9.3 Mohr's circle
      9.4 Mass moments of inertia
      9.5 Parallel-axis theorems

UNIT X – Virtual Work
      10.1 Work of a force
      10.2 Principle of virtual work
      10.3 Conservative forces
      10.4 Potential energy
      10.5 Equilibrium

UNIT XI – Particle Kinematics
      11.1 Rectilinear kinematics with constant velocity and constant acceleration
      11.2 General curvilinear motion
      11.3 Projectile motion
      11.4 Relative motion

UNIT XII – Force and Acceleration
      12.1 Newton's laws
      12.2 Equations of motion in rectangular and curvilinear coordinates
      12.3 Central force

UNIT XIII – Work and Energy
      13.1 Work of constant and variable forces
      13.2 Work–energy principle
      13.3 Power
      13.4 Conservative forces and conservation of energy

UNIT XIV – Linear Momentum
      14.1 Impulse and linear momentum
      14.2 Conservation of total linear momentum
      14.3 Collisions
      14.4 Impulse and angular momentum

UNIT XV – Kinematics of Rigid Bodies
      15.1 Translation of a rigid body
      15.2 Rotation of a rigid body

UNIT XVI – Dynamics of Rigid Bodies
      16.1 Mass moment of inertia and the parallel-axis theorem
      16.2 Plane motion equations for translation and rotation
      16.3 Equations of motion for general plane motion

UNIT XVII – Work and Energy in the Motion of Rigid Bodies
      17.1 Work and energy
      17.2 Work of a couple moment
      17.3 Work–energy principle
      17.4 Conservation of energy

UNIT XVIII – Angular Momentum
      18.1 Angular momentum
      18.2 Impulse
      18.3 Conservation of angular momentum
      18.4 Eccentric collisionUNIT XIII – Work and Energy

Basic Bibliography

HIBBELER, R. C. **Mecânica para Engenharia** – Dinâmica. 12. ed. São Paulo: Pearson, 2012.
BEER, F. P.; MAZUREK, D. F.; JOHNSTON Jr, E. R.; EISENBERG, E. R. **Mecânica vetorial para engenheiros** – Estática. 9. ed. São Paulo: AMGH, 2012.
TONGUE, B. H.; SHEPPARD, S. D. **Estática** - Análise e Projeto de Sistemas em Equilíbrio. São Paulo: LTC, 2007.

Supplementary Bibliography

NELSON, E. W.; BEST, C. L.; McLEAN, W. G.; POTTER, M. C. **Engenharia Mecânica** – Estática. Coleção Schaum, São Paulo: Bookman, 2013.
PLESHA, M. E.; GRAY, G. L.; COSTANZO, F. **Mecânica para Engenharia** – Estática. São Paulo: Bookman, 2014.
NELSON, E. W.; BEST, C. L.; McLEAN, W. G.; POTTER, M. C. **Engenharia Mecânica** – Dinâmica. Coleção Schaum, São Paulo: Bookman, 2013.
PLESHA, M. E.; GRAY, G. L.; COSTANZO, F. **Mecânica para Engenharia** – Dinâmica. São Paulo: Bookman, 2014.
MERIAN, J. L.; KRAIGE, L. G. **Mecânica para engenharia**, Vol I – Estática. 6. ed. São Paulo: LTC, 2009.

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COURSE: Probability and Statistics	
Effective: from 2018/1	**Academic period:** 2th year
Total course load: 60 h	**Code:** PF.EM.016
Syllabus: Introduction to Statistics and its role in Engineering. Study of Descriptive Statistics. Probability Analysis. Study of Sampling Concepts. Statistical Inference Analysis.	

Contents

UNIT I – Introduction to Statistics and Its Role in Engineering
  1.1 What is Statistics
  1.2 Data Collection
  1.3 Some Applications of Statistics in Engineering
  1.4 Introduction to the Organization and Presentation of Statistical Data
  1.5 Analysis of Measures of Position
  1.6 Introduction to Measures of Dispersion or Variability

UNIT II – Descriptive Statistics
  2.1 Variables and Graphs
  2.2 Organization and Presentation of Statistical Data
  2.3 Frequency Distributions
  2.4 Mean, Median, Mode and Other Measures of Central Tendency
  2.5 Standard Deviation and Other Measures of Dispersion
  2.6 Use of Statistical Software

UNIT III – Probability
  3.1 Random Experiment, Random Variables, Sample Space and Event
  3.2 Types of Events
  3.3 Basic Rules of Probability
  3.4 Fundamental Concepts and Theorems
  3.5 Probability Distributions
  3.6 Combinatorial Analysis
  3.7 Study of Probability Distributions

UNIT IV – Sampling Concepts
  4.1 Fundamental Concepts
  4.2 Types of Sampling
  4.3 Sample Size Calculation
  4.4 Discrete and Continuous Distributions
  4.5 Sampling Survey Practices
  4.6 Discrete and Continuous Distributions
  4.7 Confidence Interval

UNIT V – Statistical Inference
  5.1 Estimation Theory and Hypothesis Testing
  5.2 Simple Linear Regression
  5.3 Correlation

Basic Bibliography

LARSON, R. **Estatística aplicada**. 2. ed. São Paulo: Pearson Prentice Hall, 2007.
LEVINE, D. M. et al. **Estatística**: teoria e aplicações. Rio de Janeiro: LTC, 2008.
SPIEGEL, M. R. **Estatística**. 4. ed. Porto Alegre: Bookman, 2009.

Supplementary Bibliography

CRESPO, A. A. **Estatística Fáci**l / Antônio Arnot Crespo. 19. ed. atual. São Paulo: Saraiva, 2009.
HINES, W. W. et al. **Probabilidade e estatística na engenharia**. 4. ed. Rio de Janeiro: LTC, 2006.
MEYER, Paul L. **Probabilidade**: aplicações à estatística. São Paulo: LTC, 1991.
MONTGOMERY, D. C; RUNGER, G. C. Estatística aplicada e probabilidade para engenheiros. 4. ed. Rio de Janeiro: LTC, 2009.
ROSS, S. **Probabilidade**: um curso moderno com aplicações. Porto Alegre: Bookman, 2010.

COURSE: Differential and Integral Calculus II	
Effective: from 2018/1	**Academic period:** 2th year
Total course load: 150 h	**Code:** PF.EM.009
Syllabus: Study of sequences and series. Development of the concept of differential equations, including first- and second-order differential equations. Application of Fourier Series. Investigation of partial differential equations. Introduction to vector calculus.	

Contents

UNIT I – Sequences and Series
      1.1 Sequences
      1.2 Infinite series – convergence criteria
      1.3 Power series
      1.4 Taylor series

UNIT II – Differential Equations
      2.1 Concept of differential equations
      2.2 Classification by: variables, order, degree, linearity
      2.3 Types of solutions for differential equations

UNIT III – First-Order Differential Equations
      3.1 Linear equations
      3.2 Differential equations with separable variables
      3.3 Exact equations
      3.4 Homogeneous and reducible to homogeneous equations
      3.5 Bernoulli's equation

UNIT IV – Second-Order Linear Differential Equations
      4.1 Concept of second-order linear differential equations
      4.2 Homogeneous equations with constant coefficients
      4.3 Non-homogeneous linear equations with constant coefficients: method of variation of parameters, method of undetermined coefficients

UNIT V – Systems of Differential Equations
      5.1 First-order linear systems
      5.2 Homogeneous linear systems with constant coefficients
      5.3 Real eigenvalues
      5.4 Complex eigenvalues
      5.5 Repeated eigenvalues
      5.6 Non-homogeneous linear systems

UNIT VI – Laplace Transforms
      6.1 Definition of the Laplace transform
      6.2 Solving Initial Value Problems
      6.3 Step functions
      6.4 Impulse function
      6.5 Convolution integral

UNIT VII – Fourier Series
      7.1 Inner product of functions. Norm, orthogonal and orthonormal function sets
      7.2 Orthogonality of trigonometric functions
      7.3 Generalized Fourier series

UNIT VIII – Partial Differential Equations
      8.1 First-order linear partial differential equations
      8.2 Conservation principles
      8.3 Heat conduction equation
      8.4 Method of separation of variables
      8.5 Wave equation
      8.6 Laplace's equation
      8.7 Power series method
      8.8 Legendre's equation
      8.9 Bessel and Gauss equations

UNIT IX – Vector Calculus
      9.1 Vector functions of several variables
      9.2 Line integrals
      9.3 Conservative fields
      9.4 Green's theorem
      9.5 Surface integrals
      9.6 Flux of a vector field
      9.7 Divergence theorem (Gauss's theorem)
      9.8 Stokes's theorem in space

Basic Bibliography

BOYCE, W. E.; DIPRIMA, R. **Equações Diferenciais Elementares e Problemas de Valores de Contorno**. 9. ed. São Paulo: LTC, 2010.
WEIR, Maurice D.; HASS, Joel; GIORDANO, Frank R. **Cálculo**: George B. Thomas. Vol. 2. 12. ed. São Paulo: Pearson, 2009.
ZILL, D.G.; CULLEN, M.R. **Equações Diferenciais**. vol. 1. 3. ed. São Paulo: Makron Books, 2001.

Supplementary Bibliography

ANTON, Howard; BIVENS, Irl; DAVIS, Stephen. **Cálculo**. vol. 2. 8. ed. Porto Alegre: Bookman, 2007.
ZILL, D.G.; CULLEN, M.R. **Equações Diferenciais**. vol. 2. 3. ed. São Paulo: Makron Books, 2001.
EDWARDS, B. HOSTETLER, R. e LARSON, R. **Cálculo e Geometria Analítica**, Vol. 2. São Paulo: LCT, 2000. Serviço Público Federal Instituto Federal de Educação, Ciência e Tecnologia Sul-rio-grandense Pró-Reitoria de Ensino
SPIEGEL, M. **Transformada de Laplace**. Coleção Schaum. São Paulo: Ed. Mc Graw-Hill, 1981.
SPIEGEL, M. R. **Análise de Fourier**. Coleção Schaum. São Paulo: Ed. Mc Graw-Hill, 1976.

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COURSE: Technical Drawing Applied to Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 2nd year
Total course load: 90 h	**Code:** PF.EM.011
Syllabus: Definition and indication of dimensional and geometric tolerances. Study of surface finish in technical drawing. Characterization of welded joints. Study of detail drawings. Detailing of machine elements. Presentation of mechanical assemblies and details. Introduction to computer-aided technical drawing.	

Contents

UNIT I – Indication of Dimensional Tolerances in Technical Drawing
　　　　1.1 Introduction
　　　　1.2 ISO tolerance systems
　　　　1.3 Fits
　　　　1.4 Representation and interpretation in technical drawings

UNIT II – Indication of Geometric Tolerances in Technical Drawing
　　　　2.1 Introduction
　　　　2.2 Form tolerances
　　　　　　　2.2.1 Definitions
　　　　　　　2.2.2 Symbols
　　　　　　　2.2.3 Representation and interpretation in technical drawings
　　　　2.3 Position tolerance
　　　　　　　2.3.1 Definitions
　　　　　　　2.3.2 Symbols
　　　　　　　2.3.3 Representation and interpretation in technical drawings
　　　　2.4 Orientation tolerance
　　　　　　　2.4.1 Definitions
　　　　　　　2.4.2 Symbols
　　　　　　　2.4.3 Representation and interpretation in technical drawings
　　　　2.5 Runout tolerance
　　　　　　　2.5.1 Definitions
　　　　　　　2.5.2 Symbols
　　　　　　　2.5.3 Representation and interpretation in technical drawings

UNIT III – Indication of Surface Finish in Technical Drawing
　　　　3.1 Introduction
　　　　3.2 Symbols for indicating surface finish – NBR 8404
　　　　3.3 Arrangement of surface finish symbols

UNIT IV – Simplified Representation of Center Holes
　　　　4.1 Introduction
　　　　4.2 Types of center holes
　　　　4.3 Simplified representation – NBR 12288

UNIT V – Representation of Welded Joints
　　　　5.1 Introduction
　　　　5.2 Welding symbols
　　　　5.3 Application of welding symbols in technical drawing

UNIT VI – Representation of Threaded Parts
      6.1 Layout of the cylindrical helix
      6.2 Drawing of square threads in normal and simplified representation
      6.3 Simplified representation of threaded parts – NBR 8993
      6.4 Representation of bolts, nuts and washers

UNIT VII – Representation of Springs – NBR 11145
      7.1 Cylindrical helical springs with circular section
      7.2 Conical helical springs with rectangular section
      7.3 Spiral springs with rectangular section
      7.4 Semi-elliptical leaf spring packs

UNIT VIII – Representation of Gears – NBR 11534
      8.1 Spur cylindrical gears
      8.2 Helical cylindrical gears
      8.3 Straight bevel gears – bevel gear pair
      8.4 Worm and worm wheel
      8.5 Rack

UNIT IX – Drawing of Mechanical Assemblies
      9.1 Introduction
      9.2 Disassembly and coding of assemblies
      9.3 Presentation of drawings: sheets and title blocks
      9.4 Exploded-view assemblies
      9.5 Application to a mechanical assembly

UNIT X – Introduction to CAD
      10.1 Basic concepts
      10.2 Types of modeling
      10.3 Coordinate systems and data input systems
      10.4 Modeling creation strategy
      10.5 Construction, editing and visualization commands
      10.6 Section views
      10.7 Representation of machine elements
      10.8 Drawings of fastening elements
      10.9 Drawings of transmission elements
      10.10 Basic notions of design and representation of mechanical assemblies and details
      10.11 Geometric drawing and modeling

Basic Bibliography

BUENO, C. P.; PAPAZOGLOU, R. S. **Desenho técnico para engenharias**. Curitiba: Juruá Editora, 2008. 196 p.
FRENCH, T.E.; VIERCK, C. J. **Desenho técnico e tecnologia gráfica**. 8. ed. São Paulo: Globo, 2005. 1093 p.
RIBEIRO, A. C. **Curso de desenho técnico e autocad**. São Paulo: Pearson Education do Brasil, 2013. 362 p.

Supplementary Bibliography

BALDAM, R. L. **AutoCAD 2008**: utilizando totalmente. São Paulo: Érica, 2008.
460 p.
LEAKE, James M.; BORGERSON, Jacob L. **Manual de desenho técnico para
a engenharia**: desenho, modelagem e visualização. Rio de Janeiro: LTC,
2016. 368p.
LIMA, C. C. N. A. **Estudo dirigido de AutoCAD 2004**. 5. ed. São Paulo: Érica,
2007. 222 p.
PUTNOKI, J. C. **Elementos de geometria & desenho geométrico**. São Paulo:
Scipione, 1989. 3 v.
SILVA, A. et al. **Desenho técnico moderno**. 4. ed. Rio de Janeiro: LTC, 2006.
475 p.

COURSE: Applied Physics for Mechanical Engineering II	
Effective: from 2018/1	**Academic period:** 2nd year
Total course load: 150 h	**Code:** PF.EM.013
Syllabus: Introduction to electrostatic and electrodynamic theory. Analysis of magnetism and electromagnetism. Development of the principle of interference. Studies on diffraction and polarization of light. Introduction to quantum and relativistic mechanics. Introduction to atomic and nuclear physics. Laboratory activities.	

Contents

UNIT I – Electric Charges
      1.1 Electric charges and quantization of electric charge
      1.2 Conductors and insulators
      1.3 Coulomb's law

UNIT II – Electric Fields
      2.1 Electric field and electric field lines
      2.2 Electric fields of a point charge and of an electric dipole
      2.3 Electric fields produced by linear and surface charge distributions
      2.4 Behavior of a point charge in an electric field

UNIT III – Gauss's Law
      3.1 Electric flux
      3.2 Gauss's law
      3.3 Charged conductor in electrostatic equilibrium
      3.4 Application of Gauss's law to conductors with cylindrical, planar and spherical symmetry

UNIT IV – Electric Potential
      4.1 Electric potential energy
      4.2 Electric potential and equipotential surfaces
      4.3 Calculation of electric potential from the field
      4.4 Potential due to a point charge and to a discrete charge distribution
      4.5 Potential due to a continuous charge distribution
      4.6 Calculation of the field from the potential

UNIT V – Capacitance
      5.1 Capacitance and its calculation
      5.2 Capacitor associations
      5.3 Energy stored in the electric field
      5.4 Capacitors with dielectrics
      5.5 Dielectrics and Gauss's law

UNIT VI – Electric Current and Resistance
      6.1 Electric current and current density
      6.2 Electrical resistance and resistivity
      6.3 Ohm's law and ohmic resistors
      6.4 Power in electric circuits
      6.5 Semiconductivity and superconductivity

UNIT VII – Circuits
- 7.1 Electromotive force
- 7.2 Single-loop and multi-loop circuits
- 7.3 Kirchhoff's laws (first and second laws)
- 7.4 Multimeters
- 7.5 RC circuit analysis

UNIT VIII – Magnetic Fields
- 8.1 Magnetism, sources of magnetism and magnetic field
- 8.2 Crossed fields and the Hall effect
- 8.3 Magnetic force on current-carrying wires and loops
- 8.4 Magnetic dipole moment
- 8.5 Origins of atomic magnetism

UNIT IX – Magnetic Fields Produced by Currents
- 9.1 Biot–Savart law in scalar and vector form
- 9.2 Forces between parallel currents
- 9.3 Ampère's law

UNIT X – Induction and Inductance
- 10.1 Magnetic flux and Lenz's law
- 10.2 Faraday's law of induction
- 10.3 Induced electric fields
- 10.4 Inductors, inductance and self-inductance
- 10.5 RL circuits
- 10.6 Energy and energy density in the magnetic field

UNIT XI – Electromagnetic Oscillations and Alternating Current
- 11.1 Oscillations in LC circuits and mechanical analogy
- 11.2 Damped oscillations in RLC circuits
- 11.3 Alternating currents
- 11.4 Forced electrical oscillations

UNIT XII – Magnetism of Matter
- 12.1 Gauss's law for magnetic fields
- 12.2 Induced magnetic fields
- 12.3 Displacement current
- 12.4 Maxwell's equations
- 12.5 Magnetic properties of materials
- 12.6 Diamagnetism, paramagnetism and ferromagnetism

UNIT XIII – Electromagnetic Waves
- 13.1 Qualitative and mathematical descriptions of electromagnetic waves
- 13.2 Poynting vector
- 13.3 Radiation pressure
- 13.4 Polarization
- 13.5 Reflection, refraction and polarization of electromagnetic waves

UNIT XIV – Images
- 14.1 Light
- 14.2 Images in plane and spherical mirrors
- 14.3 Thin lenses
- 14.4 Optical instruments

UNIT XV – Interference and Diffraction
    15.1 Principle of superposition of light
    15.2 Coherence
    15.3 Interference in thin films
    15.4 Young's and Michelson's experiments
    15.5 Single-slit diffraction
    15.6 Double-slit diffraction
    15.7 Diffraction gratings

UNIT XVI – Principles of Special Relativity
    16.1 Postulates of relativity
    16.2 Relativity of time, distances and velocities
    16.3 Galilean and Lorentz transformations
    16.4 Doppler effect for light

UNIT XVII – Principles of Quantum Mechanics
    17.1 Photons and the photoelectric effect
    17.2 Light and probability waves
    17.3 Electrons and matter waves
    17.4 Schrödinger equation
    17.5 Heisenberg uncertainty principle
    17.6 Tunneling
    17.7 Confined electrons
    17.8 Bohr model of the hydrogen atom

UNIT XVIII – Principles of Atomic Physics
    18.1 Electron spin
    18.2 Stern–Gerlach experiment
    18.3 Magnetic resonance
    18.4 Laser
    18.5 Energy levels and electronic conduction
    18.6 Doped semiconductors
    18.7 Diode and LED
    18.9 Transistor

UNIT XIX – Principles of Nuclear Physics
    19.1 Properties of atomic nuclei
    19.2 Radioactive decay
    19.3 Radioactive dating and radiation level measurements
    19.4 Nuclear models
    19.5 Nuclear fission and nuclear energy
    19.6 Nuclear reactor
    19.7 Nuclear fusion and the Sun

UNIT XX – Principles of Fundamental Particle Physics
    20.1 Fundamental particles and historical developments
    20.2 Leptons and hadrons
    20.3 Quark model
    20.4 Cosmic microwave background radiation
    20.5 Dark matter
    20.6 The Big Bang and the expansion of the universe

Basic Bibliography

HALLIDAY, D.; RESNICK, R.; WALKER, J. **Fundamentos da Física**, Vol. 03 – Eletromagnetismo. 9. ed. Rio de Janeiro: LTC, 2012.
HALLIDAY, D.; RESNICK, R.; WALKER, J. **Fundamentos da Física**, Vol. 04 – Óptica e física moderna. 9. ed. Rio de Janeiro: LTC, 2012.
TIPLER, P. A.; MOSCA, G. **Física para Cientistas e Engenheiros**, Vol. II – Eletricidade, Magnetismo e óptica. 6. ed. Rio de Janeiro: LTC, 2009.
TIPLER, P. A.; MOSCA, G. **Física para Cientistas e Engenheiros**, Vol. III – Física moderna. 6. ed. Rio de Janeiro: LTC, 2009.

Supplementary Bibliography

ALONSO, M.; FINN, E. J. **Física** – Um curso universitário, vol. II – Campos e ondas. São Paulo: Edgard Blucher, 1972.
YOUNG, H. D.; FREEDMAN, R. A. **Física III** – Eletromagnetismo. 12. ed. São Paulo: Pearson, 2012.
YOUNG, H. D.; FREEDMAN, R. A. **Física IV** – Ótica e física moderna. 12. ed. São Paulo: Pearson, 2012.
JEWETT Jr, J. W.; SERWAY, R. A. **Princípios de física**, vol. III Eletromagnetismo. São Paulo: Cengage, 2014.
JEWETT Jr, J. W.; SERWAY, R. A. **Princípios de física**, vol. IV – Óptica e física moderna. São Paulo: Cengage, 2014.
FEYNMAN, R. P. **Lições de Física de Feynman**, vol. I. São Paulo: Bookman, 2008.
FEYNMAN, R. P. **Lições de Física de Feynman**, vol. II. São Paulo: Bookman, 2008.
FEYNMAN, R. P. **Lições de Física de Feynman**, vol. III. São Paulo: Bookman, 2008.
SPIEGEL, M. R.; LIPSCHUTZ, S.; LIU, J. **Manual de Fórmulas e Tabelas Matemáticas** – Coleção Schaum. São Paulo: Bookman, 2011.

Serviço Público Federal
Instituto Federal de Educação, Ciência e Tecnologia Sul-rio-grandense
Pró-Reitoria de Ensino

COURSE: Numerical Calculus Applied to Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 2th year
Total course load: 90 h	**Code:** PF.EM.010
Syllabus: Introduction to a programming environment applied to numerical calculus; study of errors; real zeros of real functions; analysis and solution of linear and nonlinear systems; curve fitting techniques; characterization of polynomial interpolation; understanding of numerical integration and numerical solution of ordinary differential equations.	

Contents

UNIT I – Introduction to Computational Numerical Methods
      1.1 Basic concepts
      1.2 Errors in numerical approximations
      1.3 Classification of errors
      1.4 Basic MATLAB commands
      1.5 MATLAB programming
      1.6 Error study using MATLAB

UNIT II – Zeros of Real Functions
      2.1 Root isolation
      2.2 Bisection method
      2.3 Iterative methods
            2.3.1 Newton's method
            2.3.2 Secant method
      2.4 Polynomial roots
      2.5 Finding zeros of real functions using MATLAB

UNIT III – Solving Linear Systems
      3.1 Direct methods
            3.1.1 Gaussian elimination
            3.1.2 LU decomposition
      3.2 Matrix inversion method
      3.3 System conditioning
      3.4 Iterative methods
            3.4.1 Gauss-Seidel
            3.4.2 Over- and under-relaxation
      3.5 Solving linear systems with MATLAB

UNIT IV – Solving Nonlinear Systems
      4.1 Newton's method
      4.2 Quasi-Newton method
      4.3 Solving nonlinear systems with MATLAB

UNIT V – Curve Fitting
      5.1 Least squares method
      5.2 Polynomial interpolation
            5.2.1 Lagrange method
            5.2.2 Newton method
      5.3 Curve fitting with MATLAB

UNIT VI – Numerical Integration
      6.1 Newton-Cotes method
      6.2 Trapezoidal rule
      6.3 Simpson's rules
      6.4 Numerical integration with MATLAB

UNIT VII – Numerical Solution of Ordinary Differential Equations
      7.1 Euler's method
      7.2 Runge-Kutta methods
      7.3 Numerical solution of ODEs using MATLAB

Basic Bibliography

BARROSO, Leônidas C. et al. **Cálculo Numérico com aplicações**. 2. ed. São Paulo: Editora HARBRA, 1987. 367p.

BURDEN, R. L.; FAIRES, J. D. **Análise Numérica**. 1. ed. São Paulo: CENGAGE Learning, 2008. 736p.

CHAPRA, Steven C.; CANALE, Raymond P. **Métodos Numéricos para Engenharia.** 5. ed. São Paulo: McGraw-Hill, 2008. 832p.

Supplementary Bibliography

CHAPRA, Steven C. **Métodos Numéricos Aplicados com MATLAB para Engenheiros e Cientistas**. São Paulo: MCGraw-Hill, 2013.

FRANCO, Neide Bertoldi. **Cálculo numérico**. São Paulo: Pearson Prentice Hall, 2006.

GILAT, A.; SUBRAMANIAM, V. **Métodos Numéricos para Engenheiros e Cientistas:** uma introdução com aplicações usando o MATLAB. Porto Alegre, 2008.

QUARTERONI, Alfio; SALERI, Fausto. **Cálculo Científico com MATLAB e Octave**. Milão: Springer, 2007.

RUGGIERO, Márcia A. Gomes; LOPES, Vera Lúcia da Rocha. **Cálculo numérico:** aspectos teóricos e computacionais. 2. ed. São Paulo: Pearson Makron Books, 1996.

COURSE: Machine Elements	
Effective: from 2018/1	**Academic period:** 2nd year
Total course load: 60 h	**Code:** PF.EM.012
Syllabus: Study and detailed analysis of fastening elements, belt and chain drives, gears, worm and worm gear transmissions, springs, bearings, shafts and line shafts, wire ropes, keys, sliding bearings, brakes, clutches, couplings and welded joints.	

Contents

UNIT I – Introduction
      1.1 Phases and factors of design
      1.2 Strength – basic concepts
      1.3 Systems and conversion of units

UNIT II – Stress Analysis
      2.1 Stresses
      2.2 Uniform stress
      2.3 Elastic deformation
      2.4 Stress–strain relationship
      2.5 Normal stress in bending
      2.6 Shear stress in bending
      2.7 Torsion

UNIT III – Fastening Elements
      3.1 Thread standards and definitions in bolts
      3.2 Power screws
      3.3 Stress in thread flanks
      3.4 Bolt preloading
      3.5 Assembly – tightening torque
      3.6 Keys and retaining rings

UNIT IV – Flexible Elements
      4.1 Belt drives
      4.2 Chain drives
      4.3 Drive cables
      4.4 Flexible shafts

UNIT V – Gears
      5.1 Spur gears
      5.2 Helical gears
      5.3 Straight bevel gears
      5.4 Worm and worm wheel

UNIT VI – Springs
      6.1 Stress and deflection in helical springs
      6.2 Extension springs
      6.3 Compression springs
      6.4 Torsion helical springs

UNIT VII – Rolling Bearings
      7.1 Types of rolling bearings
      7.2 Bearing life
      7.3 Bearing loads
      7.4 Static and dynamic load ratings
      7.5 Lubrication and shaft details

UNIT VIII – Shafts and Line Shafts
      8.1 Static loads
      8.2 Loads in power transmissions
      8.3 Alternating bending
      8.4 Constant torsion
      8.5 Stress concentration factors

UNIT IX – Clutches, Brakes and Couplings
      9.1 Drum-type brakes and clutches
      9.2 Band brakes and clutches
      9.3 Axial contact clutches
      9.4 Conical clutches and brakes
      9.5 Various types of clutches and couplings

UNIT X – Sliding Bearings
      10.1 Friction coefficients
      10.2 Bearing design
      10.3 Types of bearings
      10.4 Boundary lubrication
      10.5 Design of bearings under boundary lubrication

UNIT XI – Welded Joints
      11.1 Butt welds and fillet welds
      11.2 Torsion and welded joints
      11.3 Bending and welded joints
      11.4 Strength of welded joints

Basic Bibliography

CUNHA, L..B. **Elementos de Maquinas**. Rio de janeiro: LTC - Livros Técnicos e Científicos Editora S. A., 2005.
NORTON, R. L. **Projeto de máquinas**: uma abordagem integrada. 2. ed. Porto Alegre: Editora Bookman, 2004.
SHIGLEY, J.E. **Elementos de Maquinas**. Rio de janeiro: LTC - Livros Técnicos e Científicos Editora S. A., 1981, vols. 1 e 2.

Supplementary Bibliography

JUVINALL, R. C. e Marshek, K. M. **Projeto de Componentes de Máquinas**.
Rio de Janeiro: LTC, 2008.
MELCONIAN, S. **Elementos de máquinas**. 9. ed. São Paulo: Ed Érica, 2009.
NIEMANN, G. **Elementos de máquinas**. São Paulo: Edgard Blücher, 1971.
PUGLIESI, M; BINI, E; RABELLO, I D. **Tolerâncias, Rolamentos e
Engrenagens**. Hemus, 2007.
SHIGLEY, J.E., Mischke, C.R., Budynas, R.G. **Projeto de engenharia
mecânica**. Porto Alegre: Bookman, 2005.

COURSE: Applied Computer Graphics	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 90 h	**Code:** PF.EM.017
Syllabus: Interface between software resources and mechanical technical drawing, applied to the drawing of parts and assemblies, using specific CAD tools, developing simulations with emphasis on product design validation. Laboratory activities.	

Contents

UNIT I – Introduction to Computer-Aided Design
      1.1 Application of CAD tools in three-dimensional design
      1.2 Part modeling and generation of mechanical assemblies
      1.3 Detailing of mechanical parts and assemblies
      1.4 Insertion of components using the design library

UNIT II – Sheet Metal
      2.1 Base flange / tab
      2.2 Conversion to sheet metal
      2.3 Lofted bend
      2.4 Edge flange
      2.5 Hem, jog and sketched bend
      2.6 Break-corner, corners, bend and unfold
      2.7 Insertion of bends, slots and K-factor
      2.8 Detailing of sheet-metal parts

UNIT III – Introduction to the Simulation Process
      3.1 Analysis process and functionality of analysis commands
      3.2 Creating a study and defining materials
      3.3 Mesh control, stress concentrations and boundary conditions
      3.4 Motion restraint options
      3.5 Mesh generation and execution of analyses
      3.6 Shell elements and surface thicknesses

UNIT IV – Simulations
      4.1 Assembly analysis with contacts, connectors and loads
      4.2 Symmetric and free self-balanced assemblies
      4.3 Assembly analysis with connectors and mesh refinement
      4.4 Compatible, incompatible and adaptive meshes
      4.5 Thin-component analysis
      4.6 Analysis of solids, beams, structures and shells with mixed mesh
      4.7 Sub-modeling and design study
      4.8 Thermal analysis and thermal analysis with radiation
      4.9 Pressure vessel analysis
      4.10 Large-displacement analysis
      4.11 Frequency analysis of parts and assemblies
      4.12 Buckling analysis
      4.13 Fatigue analysis
      4.14 Drop-test analysis
      4.15 Optimization analysis

Basic Bibliography

FIALHO, A. B. **SolidWorks Premium 2009**: Teoria e prática no desenvolvimento de produtos industriais. São Paulo, SP: Érica, 2009. 568p.
FIALHO, A. B. **Cosmos**: Plataforma CAE do SolidWorks. São Paulo, SP: Érica, 2008. 352p.
SPECK, H. J. **Desenho técnico auxiliado pelo SolidWorks**. São Paulo, SP: Visual Books, 2011.

Supplementary Bibliography

FIALHO, Arivelto B. **SolidWorks Premium 2013**: Plataforma para projetos CAD/CAE/CAM para projeto, desenvolvimento e validação de produtos industriais. São Paulo, SP: Érica, 2013.
FIALHO, A. B. **SolidWorks Premium 2008**: Teoria e prática no desenvolvimento de produtos industriais, plataforma para projetos CAD/CAD/CAM. São Paulo, SP: Érica, 2007.
KUROWSKI, P. M. **Engineering Analysis with SolidWorks Simulation 2013**. Mission, Kan.: SDC Publications, Schroff, 2013.
PREDABOM, E. P.; BOCCHESE, C. **SolidWorks 2004**: projeto e desenvolvimento. 6.ed. São Paulo, SP: Érica, 2007.
SPECK, H. J.; SOUZA, A. C.; ROHLEER, E.; GÓMEZ, L. A. **Proposta de conteúdo para uma disciplina de modelagem sólida para os cursos de engenharia**, COBENGE, 2001.

COURSE: Dimensional and Geometric Control	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 60 h	**Code:** PF.EM.018
Syllabus: Study of unit systems, as well as measuring instruments and devices. Understanding of the international system of tolerances and fits and identification of parameters in the pursuit of quality. Study of the International System of Units (SI). Tolerances and fits. Analysis of form and position deviations. Surface roughness. Dimensional and geometric inspection equipment. Calibration of basic dimensional measuring instruments. Measurement System Analysis (MSA).	

Contents

UNIT I – Generalities
      1.1 Identify the metrological chain
      1.2 Define the metre
      1.3 Define fundamental and general terms of metrology
      1.4 Identify the International System of Units
      1.5 Identify the spelling and pronunciation of the units

UNIT II – Measurement Systems
      2.1 Define measurement systems
      2.2 Perform conversions between measurement systems

UNIT III – Scale
      3.1 Identify the types of scales and their applications
      3.2 Interpret readings in the metric and imperial systems
      3.3 Define the thickness, height and spacing of the marks
      3.4 Identify precautions during use

UNIT IV – Vernier Caliper
      4.1 Identify its nomenclature and resolution
      4.2 Identify the types of vernier calipers and their applications
      4.3 Interpret readings in the metric and imperial systems
      4.4 Identify measurement errors
      4.5 Identify precautions during use

UNIT V – Micrometer
      5.1 Identify its nomenclature and resolution
      5.2 Identify the types of micrometers and their applications
      5.3 Interpret readings in the metric and imperial systems
      5.4 Identify measurement errors
      5.5 Identify precautions during use

UNIT VI – Dial Indicator
      6.1 Identify its nomenclature and resolution
      6.2 Interpret readings in the metric and imperial systems
      6.3 Identify precautions during use

UNIT VII – Gauge Blocks
     7.1 Identify the relationship between blocks and their resolution
     7.2 Assemble combinations
     7.3 Identify applications (e.g., dovetail calculation)
     7.4 Identify the classes and their use

UNIT VIII – Goniometer
     8.1 Identify its nomenclature and resolution
     8.2 Interpret readings
     8.3 Identify applications

UNIT IX – Sine Bar
     9.1 Identify its application
     9.2 Exercises (calculations)

UNIT X – Sine Table
     10.1 Identify the types of tables and their applications
     10.2 Exercises (calculations)

UNIT XI – Tolerances
     11.1 Tolerance terminology
     11.2 Fit terminology

UNIT XII – Gauges
     12.1 Definitions
     12.2 Examples

UNIT XIII – Systems of Tolerances and Fits
     13.1 Tolerance unit
     13.2 Dimension groups
     13.3 Criteria for selecting dimension groups
     13.4 Work quality

UNIT XIV – Tolerance Zones
     14.1 Symbolic representation
     14.2 Hole-basis system
     14.3 Shaft-basis system
     14.4 Fundamental deviations
     14.5 Values of fundamental deviations for shafts
     14.6 Determination of fundamental deviations for holes

UNIT XV – Classes of Fits
     15.1 Selection of tolerance
     15.2 Main applications of the hole-basis system
     15.3 Temperature of fixed fits
     15.4 Examples of tolerance applications

UNIT XVI – Quality

16.1 Company-Wide Quality Control (CWQC)

16.1.1 Company objectives

16.1.2 How to achieve the main objective

16.1.3 Concept of quality

16.1.4 Concept of control

16.1.5 Types of production control

16.1.6 Process concepts

16.1.7 Histogram

Basic Bibliography

ALBERTAZZI, A; Sousa, A. **Fundamentos de Metrologia**; científica e Industrial. São Paulo: Ed Manole, 2008.

LIRA, Francisco Adval de. **Metrologia na Indústria**. São Paulo: Ed Érica, 2004.

NETO, João CIrilo DA Silva. .**Metrologia e Controle Dimensional**: conceitos, normas e aplicações. Rio de Janeiro: Ed Elsevier Brasil. CAMPUS - RJ, 2012.

Supplementary Bibliography

AGOSTINHO, O. L. **Tolerâncias, ajustes, desvios e análise de dimensões**. São Paulo: Ed Edgard Blucher, 2001.

SANTOS JR, M. J; IRIGOYEN, E R C. **Metrologia Dimensional Teoria e Prática**. Porto Alegre: UFRGS, 1995.

SCHMIDT, W. **Metrologia Aplicada**, 1. ed. São Paulo: Epse, 2003.

GONZÁLES, C. G. **Metrologia**, 2. Ed. México: McGraw-Hill, 1998.

TORREIRA, Raul Peragallo. **Instrumentos de Medição Elétrica**. São Paulo: Ed Hemus, 2004.

COURSE: Electricity	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 60 h	**Code:** PF.EM.019
Syllabus: Basic introduction to electricity, electrical circuits, transformers and electric motors. Fundamentals of electricity for instrumentation: analysis of electrical circuits; applications of Thévenin's and Norton's theorems. Introduction to basic electronic instruments: power supplies, generators, multimeters and oscilloscopes. Study of active analog components, both discrete and integrated. Study of analog electronic circuits applied to measurement and control instrumentation. Introduction to digital electronics: characterization, numbering systems and codes. Introduction to combinational and sequential logic. Introduction to an overview of microcomputer architecture. Study of the structure of process signal acquisition systems.	

Contents

UNIT I – Basic Concepts of Electricity
    1.1 Voltage, current, resistance, power supply, power and Ohm's law
    1.2 Circuit elements: resistor associations and source associations
    1.3 Equations for the analysis of linear RLC circuits
    1.4 Inductors and capacitors. Power, power factor and its correction
    1.5 Three-phase circuits. Basic notions of electric power generation, transmission and distribution

UNIT II – Transformers
    2.1 Basic principles, coupling coefficient, transformation ratio and losses
    2.2 Types of transformers: autotransformer and three-phase transformer (operation at no-load and under load)

UNIT III – Electric Motors
    3.1 Basic concepts and types of motors. Induction motor
    3.2 Motor starting characteristics
    3.3 Star–delta starter and electronic starter for three-phase motors

UNIT IV – Fundamentals of Electricity for Instrumentation
    4.1 Circuit analysis
    4.2 Thévenin's and Norton's theorems
    4.3 Basic electronic instrumentation

UNIT V – Analog Electronic Components and Circuits
    5.1 Introduction to electronic components
    5.2 Diode
    5.3 Transistor
    5.4 Operational amplifier
    5.5 Other discrete and integrated components

UNIT VI – Digital Electronics

6.1 Fundamentals of digital electronics; combinational logic: logic gates, TTL and CMOS logic families, Boolean algebra, numbering systems and codes, and sequential circuits

6.2 Introduction to programmable systems, general structure of a computer, communication interfaces, analog-to-digital and digital-to-analog conversion, and signal acquisition boards

Basic Bibliography

DEL TORO V**. Fundamentos de máquinas elétricas**. Rio de Janeiro: LTC, 1994.

EDMINISTER, J.A., **Circuitos Elétricos**. 2. ed. Coleção Schaum, São Paulo: McGraw-Hill, 1985.

FITZGERALD, A. E. **Máquinas Elétricas**. 6. ed. São Paulo: McGraw-Hill, 2006.

IRWIN, D. J. Análise de Circuitos em Engenharia. 4. ed. São Paulo: Makron Books do Brasil, 1999.

Supplementary Bibliography

GUSSOW, M**. Eletricidade básica**. 2. ed. São Paulo, SP: Pearson Makron Books, 1997.

MARKUS, O. **Circuitos elétricos**: corrente contínua e corrente alternada: teoria e exercícios. 8. ed. São Paulo, SP: Érica, 2010.

KOSOW I. **Máquinas elétricas e transformadores**. São Paulo: Globo, 2005.

NILSSON, J.W.; RIEDEL, S.A. **Circuitos Elétricos**. 6. ed. São Paulo: Livros Técnicos e Científicos Editora, 2003;

MALVINO, A. P**. Eletrônica**. vol. I e II, 4. ed. São Paulo: Makron Books do Brasil, 1997.

TOCCI, R. J. **Sistemas digitais**: princípios e aplicações. São Paulo: Livros Técnicos e Científicos Editora S. A, 2000.

COURSE: Fluid Mechanics for Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 90 h	**Code:** PF.EM.020
Syllabus: Introduction to the fundamental concepts and physical properties of a fluid. Study of fluid statics. Analysis of the integral and differential formulations of the conservation laws. Study of the Buckingham Pi theorem and inviscid flow. Analysis of incompressible flow, equations and applications. Introduction to the linear and angular momentum equations for a control volume. Dimensional analysis. Description of similarity. Study of internal flow of real fluids. Introduction to the concept of boundary layer. Introduction to transition and turbulence.	

Contents

UNIT I – Introduction
      1.1 Definition of a fluid
      1.2 Fluid as a continuous medium
      1.3 Dimensions and units
      1.4 Fluid properties
      1.5 Basic techniques for flow analysis. Flow fields

UNIT II – Pressure Distribution in a Fluid
      2.1 Pressure and pressure gradient
      2.2 Equilibrium of a fluid element
      2.3 Hydrostatic pressure distribution
      2.4 Applications to manometry
      2.5 Hydrostatic forces, buoyancy and stability
      2.6 Pressure measurement

UNIT III – Integral Relations for a Control Volume
      3.1 Reynolds transport theorem
      3.2 Conservation of mass
      3.3 Frictionless flow: Bernoulli's equation

UNIT IV – Differential Relations for a Fluid Particle
      4.1 Acceleration field of a fluid
      4.2 Differential equation of mass conservation
      4.3 Differential equation of linear momentum
      4.4 Differential equation of energy
      4.5 Boundary conditions for the basic equations
      4.6 Stream function
      4.7 Vorticity and irrotationality
      4.8 Some potential flows

UNIT V – Dimensional Analysis and Similarity
      5.1 Principle of dimensional homogeneity
      5.2 Buckingham Pi theorem
      5.3 Nondimensionalization of the basic equations

UNIT VI – Viscous Flow in Ducts
        6.1 Reynolds number regimes
        6.2 Internal and external viscous flows
        6.3 Pipe flow problems
        6.4 Flow meters

UNIT VII – Flow Around Immersed Bodies
        7.1 Boundary-layer equations
        7.2 Boundary layer over a flat plate
        7.3 Boundary layer with pressure gradient

UNIT VIII – Introduction to Transition and Turbulence
        8.1 Fundamental concepts

Basic Bibliography

BRUNETTI, F. **Mecânica dos Fluídos**. 2. ed. São Paulo: Pearson Prentice Hall, 2008., 2014.
FOX, Robert W.; MCDONALD, Alan T.; PRITCHARD, Philip J. **Introdução a Mecânica Dos Fluídos**. 8. ed. São Paulo: LTC. 2014.
WHITE, F. M. **Mecânica dos Fluídos**. 6. ed. Porto Alegre: McGraw Hill,2003.

Supplementary Bibliography

LANASA, Paul J.; Upp, e. Loy**. Fluid Flow Measurement**: A Practical Guide to Accurate Flow Measurement. GULF PROFESSIONAL PUBLISHING. 2012.
LANDAU, L. D; LIFSHITS, E. M. **Fluid Mechanics**. Second Edition. Pergamon Press. 1987.
MUNSON, Bruce R.; OKIISHI, Theodore H.; YONG, Donald F**. Fundamentos da Mecânica Dos Fluidos**. 1. ed. Edgar Blucher. 2004.
POST, Scott. **Mecânica Dos Fluidos Aplicada e Computacional**. 1. ed. São Paulo: LTC, 2013.
ZEYTOUNIAN, R. K. **Theory and Applications of Viscous Fluid Flows**. SPRINGER VERLAG, 2001.

COURSE: Solid Mechanics I	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 90 h	**Code:** PF.EM.021
Syllabus: Introduction to Solid Mechanics. Study of internal loadings. Study of stresses and strains. Analysis of axial loading. Study of torsion. Analysis of simple bending. Study of shear in beams. Analysis of combined loadings. Stress analysis and transformation. Strain analysis and transformation. Description of failure criteria. Fundamentals of the safety factor.	

Contents

UNIT I – Stress
1.1 Introduction
1.2 Equilibrium of a deformable body
1.3 Stress
1.4 Average normal stress
1.5 Average shear stress
1.6 Allowable stress

UNIT II – Strain
2.1 Strain
2.2 Concept of strain

UNIT III – Mechanical Properties of Materials
3.1 Tensile and compressive testing
3.2 Stress–strain diagram
3.3 Stress–strain behavior of ductile and brittle materials
3.4 Hooke's law
3.5 Strain energy
3.6 Poisson's ratio
3.7 Shear stress–strain diagram
3.8 Failure of materials due to creep and fatigue
3.9 Allowable stress and factor of safety

UNIT IV – Axial Load
4.1 Saint-Venant's principle
4.2 Elastic deformation of a member subjected to axial load
4.3 Principle of superposition
4.4 Statically indeterminate axially loaded members
4.5 Force method of analysis for axially loaded members
4.6 Thermal stress
4.7 Stress concentrations
4.8 Inelastic axial deformation
4.9 Residual stress

UNIT V – Torsion
>   5.1 Torsional deformation of a circular shaft
>   5.2 Power transmission
>   5.3 Angle of twist
>   5.4 Statically indeterminate members subjected to torque
>   5.5 Noncircular solid shafts
>   5.6 Thin-walled tubes with closed cross sections
>   5.7 Stress concentration
>   5.8 Inelastic torsion
>   5.9 Residual stress

UNIT VI – Bending
>   6.1 Shear force and bending moment diagrams
>   6.2 Unsymmetrical bending
>   6.3 Bending deformation of a straight member
>   6.4 Composite beams
>   6.5 Curved beams
>   6.6 Stress concentrations
>   6.7 Inelastic bending
>   6.8 Residual stress

UNIT VII – Transverse Shear
>   7.1 Shear in straight members
>   7.2 Shear stresses in beams
>   7.3 Shear flow in structures composed of several elements
>   7.4 Shear flow in thin-walled members
>   7.5 Shear center for open cross sections

UNIT VIII – Combined Loads
>   8.1 Thin-walled pressure vessels
>   8.2 State of stress caused by combined loads

UNIT IX – Stress Transformation
>   9.1 Plane stress transformation
>   9.2 Principal stresses and maximum in-plane shear stress
>   9.3 Mohr's circle for plane stress
>   9.4 Stress in shafts subjected to axial load and torsion
>   9.5 Stress variation along a prismatic beam
>   9.6 Absolute maximum shear stress

UNIT X – Strain Transformation
>   10.1 Plane strain
>   10.2 Mohr's circle for plane strain
>   10.3 Absolute maximum shear strain
>   10.4 Strain rosettes
>   10.5 Relationships between the material and its properties

UNIT XI – Failure Criteria
>   11.1 Maximum Shear Stress Theory – Tresca yield criterion
>   11.2 Maximum Distortion Energy Theory – von Mises and H. Hencky criterion
>   11.3 Maximum Normal Stress Theory – W. Rankine
>   11.4 Mohr failure criterion

Basic Bibliography

HIBBELER, R. C. **Resistência dos materiais**. 5. ed. São Paulo, SP: Pearson, 2004, 670 p.

BEER, F. P.; JOHNSTON JR., E. Russell. **Resistência dos materiais**. 3. ed. São Paulo: Pearson Makron Books, 1995. 1255 p.

POPOV, E. P. **Introdução à mecânica dos sólidos**. São Paulo: Blucher, 1978. 534 p.

Supplementary Bibliography

FELBECK, D. K**. Introdução aos mecanismos de resistência mecânica**. São Paulo: E. BLUCHER, 1971.

MELCONIAN, S. **Mecânica técnica e resistência dos materiais**. 18. ed. São Paulo: Érica, 2007.

SINGER, F. L**. Resistencia de materiales**. Santa Maria La Ribera, Me: Harpper & Row, 1971.

NASH, W. A. **Resistência de materiais**. 4. ed. Rio de Janeiro: Editora McGraw–Hill Interame, 2001.

CALLIESTER JR., William D. **Ciência e engenharia de materiais**: uma introdução. 7.ed. Rio de Janeiro: Ltc, 2008.

COURSE: Mechanisms	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 60 h	**Code:** PF.EM.022
Syllabus: Introduction to materials handling, lifting machines and transport systems. Study of the design and sizing of devices and equipment for handling, transporting and lifting loads. Application of methods for analysis and synthesis of mechanisms.	

Contents

UNIT I – Introduction to Lifting and Transport Machine Systems
      1.1 Types of transport
      1.2 Types of installations
      1.3 Groups of machines

UNIT II – Component Parts of Lifting and Transport Machines
      2.1 Flexible lifting elements (wire ropes, link chains and roller chains)
      2.2 Pulleys, drums and hoists
      2.3 Toothed wheels (gears)
      2.4 Load-handling devices
      2.5 Motors
      2.6 Rails
      2.7 Wheels
      2.8 Control devices

UNIT III – Lifting Machines
      3.1 Overhead cranes
      3.2 Freight elevators
      3.3 Hoists
      3.4 Cranes
      3.5 Winches
      3.6 Gantry cranes
      3.7 Mobile booms
      3.8 Other equipment

UNIT IV – Concepts Related to the Study of Mechanisms
      4.1 Science of mechanisms
      4.2 Machines and mechanisms
      4.3 Classification of mechanisms
      4.4 Rigid body
      4.5 Classification of a rigid body
      4.6 Degrees of freedom
      4.7 Kinematic pairs
      4.8 Dead center
      4.9 Inversion of mechanisms

UNIT V – Characteristic Mechanisms
        5.1 Four-bar mechanisms
        5.2 Slider–crank mechanism
        5.3 Scotch yoke mechanism
        5.4 Quick-return mechanisms
        5.5 Straight-line generating mechanisms
        5.6 Pantograph
        5.7 Geneva wheel
        5.8 Universal joints
        5.9 Other mechanisms

UNIT VI – Kinematic Analysis of Mechanisms with Planar Motion
        6.1 Coincident points
        6.2 Linear motion of a point
        6.3 Angular motion
        6.4 Relative motion
        6.5 Instantaneous center of rotation
        6.6 Kennedy's theorem
        6.7 Methods for determining velocities in mechanisms
        6.8 Mechanisms with direct contact
        6.9 Angular velocity ratio
        6.10 Relative acceleration of particles in mechanisms

UNIT VII – Synthesis of Articulated Mechanisms
        7.1 Characteristic methods

UNIT VIII – Study of Cams
        8.1 Types of follower motion
        8.2 Types of followers and cams
        8.3 Geometry of the radial cam
        8.4 Displacement diagram
        8.5 Pressure angle and radius of curvature
        8.6 Considerations on cam manufacturing
        8.7 Considerations on cam design

Basic Bibliography

NORTON, R., L. **Cinemática e dinâmica dos mecanismos**. São Paulo:
McGraw-Hill, 2010.
SANTOS, I. F. **Dinâmica de sistemas mecânicos**: modelagem, simulação,
visualização, verificação. São Paulo: Makron Books, 2001.
FERRARESI, D. **Máquinas de elevação e transporte**. Revisada por
Purquerio, Benedito de. São Carlos, SP: EESC-USP, 2001. 95p.

Supplementary Bibliography

HIBBELER, R. **Dinâmica**: mecânica para engenharia. São Paulo: Ed. Pearson Prentice Hall, 2011.

MABIE, H. H., & OCVIRK, F. W. **Dinâmica das máquinas**. São Paulo: Ed. Livros Técnicos e Científicos. 1980.

BRASIL, H. V. **Máquinas de levantamento**. Rio de Janeiro: Ed. Guanabara Dois, 1998. 230p.

RUDENKO, N**. Máquinas de elevação e transporte**. São Paulo: Livros Técnicos e Científicos Editora S/A., 1998. 230p.

MABIE, H.H.; OCVIRK, F.W. **Mecanismos**. São Paulo: Livro Técnico e Científico S.A., 1988.

COURSE: Thermodynamics I	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 60 h	**Code:** PF.EM.023
Syllabus: Introduction to the properties of pure substances. Study of work and heat. Study of systems and control volumes. Definition of the first and second laws of thermodynamics. Study of the second law of thermodynamics for control volumes. Study of entropy. Fundamentals of reversibility and irreversibility. Study of power cycles. Understanding of psychrometric concepts.	

Contents

UNIT I – Fundamental Concepts
      1.1 Thermodynamic system
         1.1.1 Open system
         1.1.2 Closed system
         1.1.3 Isolated system
      1.2 State
      1.3 Process

UNIT II – Thermodynamic Properties of Vapors
      2.1 Quality (dryness fraction)
      2.2 Specific volume
      2.3 Entropy
      2.4 Enthalpy
      2.5 Internal energy

UNIT III – Thermodynamic Charts
      3.1 Pure substance
      3.2 Temperature–entropy diagram
      3.3 Mollier diagram (h–s diagram)

UNIT IV – Steam Tables
      4.1 Dependent and independent properties
      4.2 Saturated liquid and vapor tables
      4.3 Superheated vapor tables

UNIT V – Heat and Work
      5.1 Heat
      5.2 Unit of heat
      5.3 Work
      5.4 Work during gas expansion
      5.5 Steady-state (steady-flow) regime

UNIT VI – First Law of Thermodynamics
      6.1 Energy conservation
      6.2 Energy of the fluid crossing the system boundary
      6.3 General thermodynamic equation

UNIT VII – Second Law of Thermodynamics
       7.1 Kelvin–Planck statement
       7.2 Clausius statement
       7.3 Carnot cycle

UNIT VIII – Rankine Cycle
       8.1 Ideal Rankine cycle
       8.2 Efficiency of the Rankine cycle
       8.3 Factors influencing the efficiency of the Rankine cycle

UNIT IX – Ideal Gas
       9.1 Equation of state
       9.2 Thermodynamic properties
       9.3 Behavior of water vapor as an ideal gas
       9.4 Isentropic process

UNIT X – Psychrometrics
       10.1 Partial pressure
       10.2 Dew-point temperature
       10.3 Relative and absolute humidity
       10.4 Saturation temperature and wet-bulb temperature
       10.5 Enthalpy of atmospheric air

Basic Bibliography

IENO, G.; NEGRO, L. **Termodinâmica**. São Paulo: Ed Pearson Hall, 2004.
SARAIVA, L. E. **Termodinâmica macroscópica essencial**. 1. ed. Passo Fundo: UPF Editora, 2011. v. 1.
VAN WILEN, G.; SONNTAG, R. E. **Fundamentos da Termodinâmica**. 8. ed. São Paulo: Ed. Edgard Blücher Ltda, 2003.

Supplementary Bibliography

MORAN, M. J.; SHAPIRO, H. N. **Princípios de termodinâmica para engenharia**. 6. ed. Rio de Janeiro: LTC, 2001.
VAN WILEN, G.; SONNTAG, R. E.; BORGNAKKE, C. **Fundamentos da Termodinâmica Clássica**. São Paulo: Ed. Edgard Blücher Ltda, 2003.
DA COSTA, E, C. **Física Industrial. Termodinâmica parte I**. 8. ed. Porto Alegra: Ed. Globo, 2005.
DA COSTA, E. C. **Física Industrial. Termodinâmica parte II**. 8. ed. Porto Alegre: Ed. Globo, 2005.
OLIVEIRA, Mário José de. **Termodinâmica**. São Paulo: Livraria da Física, 2005.

COURSE: Manufacturing Processes	
Effective: from 2018/1	**Academic period:** 3rd year
Total course load: 90 h	**Code:** PF.EM.024
Syllabus: Introduction to machining processes. Study of cutting parameters. Application of operations on conventional machine tools: drilling machines, lathes, milling machines and grinding machines, including their general aspects, classification and applications, nomenclature, operation and maintenance. Description of machining tools: fundamentals and geometry; materials used in their manufacture; mechanisms of tool wear and failure; main families of machine-tool systems, their characteristics and applications. Analysis of machining costs and productivity. Introduction to defects introduced in machined products by processing and the consequences of such defects for product application and performance. Understanding of sheet metal forming processes.	

Contents

UNIT I – Concepts
      1.1 Basic concepts of machining
      1.2 Machining processes
            1.2.1 Turning
            1.2.2 Planing
            1.2.3 Drilling
            1.2.4 Boring
            1.2.5 Milling
            1.2.6 Broaching
      1.3 Other machining processes
            1.3.1 Grinding and other abrasive processes
            1.3.2 Non-conventional machining processes

UNIT II – Concepts of Machining Technology
      2.1 Motions in machining
      2.2 Auxiliary concepts
      2.3 Surfaces defined on the workpiece
      2.4 Feed parameters
      2.5 Depth-of-cut parameters
      2.6 Chip-related quantities

UNIT III – Cutting Wedge Geometry
      3.1 Structural parts of a cutting tool
      3.2 Reference systems
      3.3 Cutting angles for determining the position and shape of the cutting wedge
      3.4 Influence of tool angles

UNIT IV – Chip Formation Mechanism
      4.1 General aspects
      4.2 Classification of chips
      4.3 Built-up edge
      4.4 Cutting temperature
      4.5 Storage care and environmental preservation

UNIT V – Cutting Forces and Power
    5.1 Forces during machining
    5.2 Machining power
    5.3 Variation of cutting force with working conditions
    5.4 Calculation of specific cutting pressure

UNIT VI – Machinability
    6.1 Concepts

UNIT VII – Tool Materials
    7.1 General aspects
    7.2 Description of tool materials

UNIT VIII – Failures and Wear
    8.1 Types of failures and wear
    8.2 Mechanisms causing tool wear

UNIT IX – Cutting Fluids
    9.1 Types and characteristics
    9.2 Influence on the environment

UNIT X – Tool Life Curve
    10.1 Concepts

UNIT XI – Determination of Economic Machining Conditions
    11.1 Cutting speed for maximum production and minimum-cost cutting speed
    11.2 Maximum efficiency range
    11.3 Product design considerations for machining

UNIT XII – Metal Forming Processes
    12.1 Overview of metal forming
    12.2 Behavior of metals in forming
    12.3 Temperature in metal forming
    12.4 Friction and lubrication in metal forming

UNIT XIII – Bulk Metal Forming Processes
    13.1 Rolling
    13.2 Forging
    13.3 Extrusion
    13.4 Drawing

UNIT XIV – Sheet Metal Forming
    14.1 Cutting operations
    14.2 Bending operations
    14.3 Stamping
    14.4 Other sheet-metal forming operations
    14.5 Dies and presses used in sheet-metal forming processes

Basic Bibliography

MACHADO A.R.; COELHO R.T; ABRÃO A. M. et al. **Teoria da Usinagem dos Materiais**. 3. ed. São Paulo: Editora: Blucher, 2015.
FERRARESI, D. **Fundamentos da Usinagem dos Metais**. 12. ed. São Paulo: Edgard Blucher, 2006.
BRESCIANI F. E. **Conformação Plástica dos Metais**. 5. ed. Volumes 1 e 2. São Paulo: Editora: UNICAMP, 2013.

Supplementary Bibliography

CETLIN, P.R.; HELMANN, H. **Fundamentos de Conformação Mecânica dos Metais.** Rio de Janeiro: Guanabara Dois, 2012.
CALLISTER, W. D. Jr. **Ciência e Engenharia dos Materiais**: Uma Introdução. 5. ed. São Paulo: Editora LTC, 2014.
BLAIN, Paul. **Laminação e forjamento dos aços**. São Paulo: ABM, 1964.
DINIZ, A.E., MARCONDES, F.C. e COPPINI, N.L. **Tecnologia da Usinagem dos Metais**. São Paulo: MM Editora, 1999.
GROOVER, M. P. **Introdução aos Processos de fabricação** 1. ed. Rio de Janeiro: Editora: LTC, 2014.

COURSE: Fundamentals of Steam Generation	
Effective: from 2018/1	**Academic period:** elective
Total course load: 60 h	**Code:** PF.EM.063
Syllabus: Application of water steam. Study of boiler types. Analysis of installation and safety standards. Study of boiler accessories and auxiliary equipment. Study of water treatment. Analysis of boiler energy balance. Identification of accessories for steam and condensate networks. Sizing and specification of accessories. Study of piping sizing criteria based on recommended velocity. Analysis of pressure losses in steam and condensate networks. Calculation and specification of thermal insulation for steam networks. Development of small projects and/or computer programs.	

Contents

UNIT I – Water Steam
      1.1 Basic concepts of Thermodynamics
      1.2 Water steam
            1.2.1 Phase diagram
            1.2.2 Isobaric vaporization
      1.3 Saturated steam
            1.3.1 Quality and moisture content
            1.3.2 Tables and notation
            1.3.3 Total heat
      1.4 Superheated steam
            1.4.1 Superheated steam tables
            1.4.2 Use of tables and Mollier diagram
            1.4.3 Software for water-steam properties

UNIT II – Steam Generators
      2.1 Definition
            2.1.1 Classification
            2.1.2 Operating principle
            2.1.3 Main components
      2.2 Furnaces
            2.2.1 Types
            2.2.2 Description
            2.2.3 Sizing of the combustion chamber and grates
      2.3 Burners
            2.3.1 Types
            2.3.2 Description
            2.3.3 Applications
      2.4 Equipment of a steam generator
            2.4.1 Feedwater preheaters (economizers)
            2.4.2 Air preheaters
            2.4.3 Steam superheaters
      2.5 Thermal balance of a steam generator
            2.5.1 Examples

UNIT III – Steam Distribution
    3.1 Steam distribution and drainage
        3.1.1 Piping
        3.1.2 Steam traps
        3.1.3 Condensate return
        3.1.4 Combustion control

Basic Bibliography

BAZZO E. **Geração de Vapor**. Florianópolis: Editora da UFSC, 1992.
PINHEIRO, Paulo César da Costa. **Notas de Aula**. Minas Gerais: Escola de Engenharia da UFMG, 2006.
NADRUP Ingvar; NOVAES Mário Solé de. **Operação de Caldeiras de Vapor.** Rio de Janeiro: CNI, 1981.

Supplementary Bibliography

Atkins, Peter; Jones, Loretta. **Princípios de Química**: Questionando a Vida Moderna e o Meio Ambiente. 3. ed. Porto Alegre: Editora Bookman, 2006.
Brown, L.S. e Holme, T.A.; tradução Maria Lucia Godinho de Oliveira; revisão técnica Robson Mendes Matos. **Química geral aplicada à engenharia**. São Paulo: Cengage Learning, 2009.
PANKRATOV G. **Problemas de Termotecnia**. Moscou: Editorial Mir, 1987.
PERA Hildo. **Geradores de Vapor de Água**. São Paulo: Grêmio Politécnico da USP, 1966.
MME/CNP. **Economia de Combustível** (12 folhetos) 1979. (Baseado em texto da Spirax Sarco Ltd, Inglaterra, traduzido pela Sarco SA.

COURSE: Introduction to Control Systems	
Effective: from 2018/1	**Academic period:** 4th year
Total course load: 90 h	**Code:** PF.EM.025
Syllabus: Introduction to control systems. Study of dynamic models of mechanical and electrical systems. Analysis of dynamic response. Study of basic properties of feedback systems. Root locus method analysis. Frequency response method analysis. Analysis and design of control systems in state space. PID controllers.	

Contents

UNIT I – Introduction to Control Systems
        1.1 Introduction
        1.2 Examples of control systems
        1.3 Closed-loop vs. open-loop control
        1.4 Control system design and compensation

UNIT II – Mathematical Modeling of Mechanical and Electrical Systems
        2.1 Introduction
        2.2 Mathematical modeling of mechanical systems
        2.3 Mathematical modeling of electrical systems

UNIT III – Transient and Steady-State Response Analysis
        3.1 Introduction
        3.2 First-order systems
        3.3 Second-order systems
        3.4 Higher-order systems
        3.5 Transient response analysis using mathematical software
        3.6 Routh stability criterion

UNIT IV – Control System Analysis and Design by Root Locus Method
        4.1 Introduction
        4.2 Root locus plot
        4.3 Root locus plots for systems with positive feedback
        4.4 Control system design using root locus method

UNIT V – Control System Analysis and Design by Frequency Response Method
        5.1 Introduction
        5.2 Bode diagram
        5.3 Polar plots
        5.4 Gain (in dB) vs. phase angle plots
        5.5 Nyquist stability criterion
        5.6 Stability analysis
        5.7 Closed-loop frequency response of feedback systems
        5.8 Experimental determination of transfer functions
        5.9 Control system design using frequency response

UNIT VI – The PID Controller
        6.1 Introduction
        6.2 Ziegler-Nichols tuning rules for PID controllers
        6.3 PID controller design using frequency response method

6.4 PID controller design with computational optimization approach
6.5 Variants of PID control schemes
6.6 Two-degree-of-freedom control

UNIT VII – State-Space Control System Analysis
7.1 Introduction
7.2 Transfer function representation in state space
7.3 System model transformations using mathematical software
7.4 Solving the time-invariant state equation
7.5 Controllability
7.6 Observability

UNIT VIII – State-Space Control System Design
8.1 Introduction
8.2 Pole placement
8.3 Solving pole placement problems using mathematical software
8.4 Servo system design
8.5 State observers
8.6 Regulator system design with observers
8.7 Control system design with observers

Basic Bibliography

OGATA, Katsuhiko. **Engenharia de controle moderno**. 5. ed. São Paulo, SP: Pearson, 2010.
MAYA, Paulo Álvaro; LEONARDI, Fabrizio. **Controle essencial**. Pearson, 2011.
SILVEIRA, Paulo Rogério da; SANTOS, Winderson E. **Automação e controle discreto**. 9. ed. São Paulo, SP: Érica, 2009.

Supplementary Bibliography

CRAIG, John J. Robótica. 3. ed. São Paulo, SP: Pearson, 2012.
NISE, Norman S. **Engenharia de sistemas de controle**. 6. ed. Rio de Janeiro, RJ: LTC, c2012. xiv.
DORF, Richard C.; MATSUURA, Jackson Paul (Trad.). **Sistemas de controle modernos**. 11. ed. Rio de Janeiro, RJ: LTC, 2009.
FRANKLIN, Gene F.; POWELL, J. David; ABBAS, Emami-naeini. **Feedback Control of Dynamic Syste**ms. 5. ed. Upper Saddke River(nj): Pearson Prentice Hall, c2006.
NISE, N., **Control Systems Engineering**, John Wiley and Sons, 2004;
OPPENHEIM, Alan V.; WILLSKY, Alan S. **Sinais e sistemas**. 2. ed. São Paulo, SP: Pearson, 2010.

Serviço Público Federal
Instituto Federal de Educação, Ciência e Tecnologia Sul-rio-grandense
Pró-Reitoria de Ensino

COURSE: Solid Mechanics II	
Effective: from 2018/1	**Academic period:** 4th year
Total course load: 60 h	**Code:** PF.EM.026
Syllabus: Review of basic concepts of stress and strain. Study of energy principles. Study of column buckling. Analysis of failure theories for ductile and brittle materials under static loading. Study of fatigue failures resulting from variable loading. Analysis of linear elastic fracture mechanics. Analysis of elastoplastic fracture mechanics.	

Contents

UNIT I – Introduction
      1.1 Review of basic concepts of stress and strain

UNIT II – Study of Energy Principles
      2.1 Introduction
      2.2 Strain energy
      2.3 Specific strain energy
      2.4 Elastic strain energy for normal stresses
      2.5 Elastic strain energy for shear stresses
      2.6 Impact loading
      2.7 Design for impact loading
      2.8 Strain energy produced by a single applied force
      2.9 Determination of deformation due to a single applied load using strain energy

UNIT III – Column Buckling
      3.1 Introduction
      3.2 Structural stability
      3.3 Euler formula for columns with pinned ends
      3.4 Euler formula for columns with other end conditions

UNIT IV – Failure Theories for Ductile and Brittle Materials under Static Loading
      4.1 Static strength
      4.2 Stress concentration
      4.3 Failure theories
      4.4 Maximum shear stress theory for ductile materials
      4.5 Distortion energy theory for ductile materials
      4.6 Coulomb–Mohr theory for ductile materials
      4.7 Maximum normal stress theory for brittle materials
      4.8 Modified Mohr theory for brittle materials
      4.9 Selection of failure criteria
      4.10 Static or quasi-static loading of a shaft

UNIT V – Fatigue Failure Resulting from Variable Loading
      5.1 Introduction to metal fatigue
      5.2 Fatigue failure approach in analysis and design
      5.3 Stress–life (S–N) methods
      5.4 Stress-based life methods
      5.5 Strain–life methods
      5.6 Linear Elastic Fracture Mechanics method

5.7 Endurance limit
5.8 Fatigue strength
5.9 Modifying factors for the endurance limit
5.10 Stress concentration and notch sensitivity
5.11 Characterization of fluctuating stresses
5.12 Fatigue failure criteria under fluctuating stresses
5.13 Torsional fatigue strength under fluctuating stresses
5.14 Combination of loading modes
5.15 Fluctuating and variable stresses: cumulative fatigue damage
5.16 Surface fatigue strength

UNIT VI – Linear Elastic Fracture Mechanics
6.1 Crack propagation
6.2 Griffith criterion
6.3 Stress intensity factor
6.4 Geometric factor and the principle of superposition

UNIT VII – Elastoplastic Fracture Mechanics
7.1 Limitations of Linear Elastic Fracture Mechanics
7.2 Crack opening displacement
7.3 Dowling and Townley method
7.4 Stable crack growth

Basic Bibliography

BEER, Ferdinand Pierre; JOHNSTON JR., E. Russell. **Resistência dos materiais.** 3. ed. São Paulo: Pearson Makron Books, 1995.
HIBBELER, R. C. **Resistência dos materiais**. 5. ed. São Paulo, SP: Pearson, 2004.
SHIGLEY, Josephe E.; MISCHKE, Charles R.; BUDYNAS, Richard G. **Projeto de engenharia mecânica**. 7. ed. Porto Alegre, RS: Bookman, 2005.

Supplementary Bibliography

COLLINS, Jack A. **Projeto mecânico de elementos de máquinas**: uma perspectiva de prevenção da falha. Rio de Janeiro, RJ: LTC, 2006.
JUVINAL, Robert C.; SILVA, Fernando Ribeiro da (Trad.). **Fundamentos do projeto componentes de máquinas**. 4. ed. Rio de Janeiro, RJ: LTC, 2008.
POPOV, Egor Paul. **Introdução à mecânica dos sólidos**. São Paulo: Blucher, 1978.
SHACKELFORD, James F. **Ciência dos materiais**. 6. ed. São Paulo, SP: Pearson Education do Brasil, c2008.
UICKER JUNIOR, John J.; PENNOCK, Gordon R.; SHIGLEY, Joseph E. **Theory of machines and mechanisms**. 4 th.ed. New York: Oxford University Press, 2011.

COURSE: Integrated Design	
Effective: from 2018/1	**Academic period:** 4th year
Total course load: 60 h	**Code:** PF.EM.028
Syllabus: Importance of product design; design process, planning, execution and specification (informational design); product conception (conceptual design); modeling and simulation (preliminary design); evaluation of models and/or project prototypes (detailed design).	

Contents

UNIT I – Introduction to Product Development
      1.1 Basic concepts for integrated product development
      1.2 Importance for competitiveness
      1.3 Analysis of prescriptive models for product development
      1.4 Concurrent engineering
      1.5 Integrated product development model

UNIT II – Informational Design
      2.1 Processes and methodologies to support product planning
      2.2 Methods and tools to support product planning
      2.3 Concepts related to the preparation of design specifications
      2.4 Methodologies for developing design specifications

UNIT III – Conceptual Design
      3.1 Intuitive methods for generating concepts
      3.2 Systematic methods for generating concepts
      3.3 Functional synthesis method
      3.4 Reverse engineering
      3.5 Product life-cycle cost analysis
      3.6 Cost analysis in decision-making during the design process
      3.7 Methodology for concept evaluation and selection

UNIT IV – Preliminary Design
      4.1 Establishment of the final product layout
      4.2 Determination of technical and economic feasibility
      4.3 Definition of component dimensions
      4.4 Manufacturing planning

UNIT V – Detailed Design
      5.1 Product prototyping and testing
      5.2 Planning of the structuring and assembly process
      5.3 Packaging design and preparation of the product manual
      5.4 Product optimization and certification (approval)

Basic Bibliography

BACK, N. [et al.], **Projeto integrado de produtos**: planejamento, concepção e modelagem. Barueri: Manole, 2008.

BACK, N., **Metodologia de Projeto de produtos Industriais**. Guanabara Dois, 1983.

BAXTER, M., **Projeto de Produto**: Guia Prático para o Desenvolvimento de Novos Produtos. Edgard Blücher, 1998.

Supplementary Bibliography

BARBOSA, A. N. F. **Projeto e Desenvolvimento de Produtos**. São Paulo: Atlas, 2009.

MAGRAB, E., **Integrated Product and Process Design and Development**: The Product Realization Process. CRC Press LLC, 1997.

PAHL, G.; BEITZ, W., **Engineering Design**: a Systematic Approach. ED. Springer Verlag, 1996.

ROZENFELD, H.; FORCELLINI, F.A.; AMARAL, D.C.; TOLEDO, J.C.; SILVA, S.L.; ALLIPRANDINI, D.H.; SCALICE, R.K. **Gestão de Desenvolvimento de Produtos**: uma referência para a melhoria do processo. São Paulo: Saraiva, 2006.

TAKAHASHI, S. & TAKAHASHI, V. P. **Gestão de inovação de produtos**: estratégia, processo, organização e conhecimento. Rio de Janeiro: Editora Campus, 2007.

COURSE: Flow Machines	
Effective: from 2018/1	**Academic period:** elective
Total course load: 60 h	**Code:** PF.EM.062
Syllabus: Study of industrial piping systems. Understanding of the construction elements of flow machines. Application of fundamental equations for flow machines. Study of losses and efficiencies. Analysis of hydraulic similarity. Study of hydraulic and wind turbines. Study of fans.	

Contents

UNIT I – Industrial Piping
       1.1 Materials, manufacturing processes and dimensional standardization
       1.2 Pipe joining methods, valves, fittings and piping identification
       1.3 Calculation of piping diameter
       1.4 Calculation of piping wall thickness

UNIT II – Selection of Flow Machines
       2.1 Types of pumps
       2.2 Pumping systems
       2.3 Pumps in parallel and in series
       2.4 Calculation of pumping systems
       2.4 Basic concepts of cavitation
       2.5 Basic concepts of similarity

UNIT III – Hydraulic Turbines
       3.1 Types of turbines

UNIT IV – Wind Turbines
       4.1 Types of turbines

UNIT V – Fans
       5.1 General concepts
       5.2 General energy equation applied to compressible fluids
       5.3 Determination of the operating point

Basic Bibliography

SILVA TELLES, Pedro C. **Tubulações Industriais** - Materiais, Projeto, Montagem. 10. ed. Rio de Janeiro: LTC, 2001.
SILVA TELLES, Pedro C. **Tubulações Industriais** – Cálculo. 9. ed. Rio de Janeiro: LTC, 1999.
SOUZA, Zulcy de**, Dimensionamento de Máquinas de Fluxo**. São Paulo: Edgar Blucher, 1991.

Supplementary Bibliography

SILVA, Napoleão F. **Bombas alternativas industriais**: teoria e prática. Rio de Janeiro: Interciência, 2007.

MACINTYRE, Archibald Joseph. **Bombas e instalações de Bombeamento**. 2. ed. Rio de Janeiro: LTC, 1997.

MATTOS, Edson Ezequiel de; FALCO, Reinaldo de. **Bombas industriais**. 2. ed. Rio de Janeiro: Interciência, 1998.

HENN, Érico Antônio Lopes. **Máquinas de fluido**. 3. ed. Santa Maria, RS: Ed. da UFSM, 2012.

SOUZA, Zulcy de; BRAN, Richard. **Maquinas de fluxo**: turbinas, bombas, ventiladores. São Paulo: Ao Livro Técnico, 1980.

COURSE: Hydraulic and Pneumatic Systems	
Effective: from 2018/1	**Academic period:** 4th year
Total course load: 90 h	**Code:** PF.EM.029
Syllabus: Introduction to hydraulics. Study of the general characteristics of hydraulic systems. Study of hydraulic fluids. Understanding of processes involving hydraulic pumps and motors. Study of hydraulic control valves. Analysis of hydraulic power elements. Understanding of hydraulic control techniques and applications to basic circuits. Introduction to pneumatics. Characterization of pneumatic systems. Study of compressed air generation processes. Understanding of compressor specification procedures. Study of compressed air distribution processes. Study of the sizing of compressed air distribution networks. Understanding of pneumatic control processes. Study of pneumatic actuators. Study of basic pneumatic circuits.	

Contents

UNIT I – Introduction to Pneumatics
      1.1 Historical background
      1.2 Applications
      1.3 Physical principles applied to pneumatics

UNIT II – Characteristics of Pneumatic Systems
      2.1 Flexibility
      2.2 Speed and effects of air compressibility
      2.3 Advantages and disadvantages

UNIT III – Compressed Air Generation
      3.1 Air compression
      3.2 Oil removal
      3.3 Filtration
      3.4 Moisture removal
      3.5 Compressed air storage

UNIT IV – Compressor Specification
      4.1 Construction types
      4.2 Operating characteristics
      4.3 Compressor sizing calculations
      4.4 Flow and pressure
      4.5 Air receiver tank sizing

UNIT V – Compressed Air Distribution
      5.1 Criteria for compressed air distribution

UNIT VI – Sizing of Compressed Air Distribution Networks
      6.1 Calculation of pressure losses in ducts and fittings
      6.2 Materials for compressed air networks

UNIT VII – Pneumatic Controls
7.1 Force (pressure) control
7.2 Speed (flow) control
7.3 Direction control (direction of motion)
7.4 Pneumatic pressure, flow and directional control valves; symbols

UNIT VIII – Pneumatic Actuators
8.1 Single-acting linear actuators
8.2 Double-acting linear actuators
8.3 Rodless linear actuators
8.4 Pneumatic linear guides
8.5 Pneumatic oscillators
8.6 Rotary actuators
8.7 Pneumatic motors
8.8 Construction types and operating principles

UNIT IX – Basic Pneumatic Circuits
9.1 Symbols
9.2 Pneumatic circuit diagrams
9.3 Intuitive method

UNIT X – Introduction to Hydraulics
10.1 Historical background
10.2 Applications
10.3 Physical principles applied to hydraulics
10.4 Pascal's principle

UNIT XI – General Characteristics of Hydraulic Systems
11.1 Construction aspects
11.2 Kinematic aspects
11.3 Dynamic aspects
11.4 Functional aspects
11.5 Advantages and disadvantages

UNIT XII – Hydraulic Fluids
12.1 Properties and characteristics of fluids used in hydraulic systems
12.2 Types of hydraulic fluids

UNIT XIII – Hydraulic Pumps and Motors
13.1 Positive displacement pumps
13.2 Rotodynamic pumps
13.3 Types and characteristics
13.4 Hydraulic motors: types and characteristics
13.5 Hydraulic power units

UNIT XIV – Hydraulic Control Valves
14.1 Pressure limiting valves
14.2 Safety and relief valves
14.3 Sequence valves
14.4 Directional control valves
14.5 Flow control valves
14.6 Check valves
14.7 Special valves

UNIT XV – Hydraulic Power Elements
15.1 Single-acting and double-acting linear hydraulic actuators
15.2 Hydraulic oscillators
15.3 Rotary actuators (hydraulic motors)
15.4 Hydraulic accumulators

UNIT XVI – Hydraulic Control Techniques and Applications to Basic Circuits
16.1 Intuitive method applied to hydraulic circuits
16.2 Force (pressure) control
16.3 Speed (flow) control
16.4 Sequential controls
16.5 Special controls

Basic Bibliography

BONACORSO, Nelso Gauze; NOLL, Valdir. **Automação eletropneumática**. 2/6. ed. São Paulo: Érica, 1998-2002
FIALHO, Arivelto Bustamante**. Automação hidráulica**: projetos, dimensionamento e análise de circuitos. 4. ed. São Paulo: Érica, 2006.
LINSINGEN, Irlan Von. **Fundamentos de sistemas hidráulicos**. Florianópolis UFSC, 2001.

Supplementary Bibliography

ATLAS, Copco. **Manual do ar comprimido**. São Paulo: Editora Mc Graw Hill, 1976.
AZEVEDO Netto, MARTINIANO, Jose. **Manual de hidráulica**. 8. ed. São Paulo: Edgard Blucher, 1998.
STEWART, H.L. **Pneumática e Hidraulica**. São Paulo: Editora Hemus, 1981.
FOX, R. W. E., MCDONALD, A. T. **Introdução à mecânica dos fluidos**. 4. ed. Rio de Janeiro: Editora LTC, 1998.
PROVENZA, F. **Projetista de máquinas**. São Paulo: Editora Francesco Provenza, 1996.

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COURSE: Vibrations	
Effective: from 2018/1	**Academic period:** 4th year
Total course load: 60 h	**Code:** PF.EM.031
Syllabus: Study of the fundamentals of vibrations. Study of free vibrations of single-degree-of-freedom systems. Analysis of vibrations under harmonic excitation. Analysis of vibrations due to arbitrary forces. Study of vibrations of multi-degree-of-freedom systems. Understanding of vibration processes in continuous systems.	

Contents

UNIT I – Fundamentals of Vibrations
      1.1 Basic concepts
      1.2 Classification of vibrations
      1.3 Components of a vibrating system

UNIT II – Free Vibrations of Single-Degree-of-Freedom Systems
      2.1 Undamped system
      2.2 Damped system
      2.2.1 Viscous damping
      2.2.1.1 Underdamped, critically damped and overdamped systems
      2.2.1.2 Logarithmic decrement
      2.2.2 Coulomb damping (dry friction)

UNIT III – Vibrations under Harmonic Excitation
      3.1 Undamped system
      3.2 Damped system
      3.3 Base harmonic motion
      3.4 Unbalanced rotating masses
      3.5 Vibration and shock isolation

UNIT IV – Vibrations Due to Arbitrary Forces
      4.1 Response to a general periodic force
      4.2 Response to an irregular periodic force
      4.3 Convolution integral
      4.3.1 Response to an impulse
      4.3.2 Response to an arbitrary excitation force
      4.3.3 Response to base excitation

UNIT V – Vibrations of Multi-Degree-of-Freedom Systems
      5.1 Mass, stiffness and damping matrices
      5.2 Modal analysis of natural frequencies and mode shapes
      5.3 Forced vibrations under harmonic excitation
      5.4 Vibration neutralizer or absorber

UNIT VI – Vibrations of Continuous Systems
      6.1 Free vibrations
      6.2 Forced vibrations

Basic Bibliography

RAO, Singiresu. **Vibrações Mecânicas**. 4. ed. São Paulo: Pearson, 2009.
GROEHS, Ademar Gilberto. **Mecânica vibratória**. 3. ed. São Leopoldo: Editora Unisinos, 2012.
LARANGEIRA, Jorge Ledo. **Mecânica vibratória**: volume um. Porto Alegre: CEUE, 1970.

Supplementary Bibliography

ALMEIDA, Marcio Tadeu de. **Vibrações mecânicas para engenheiros**. São Paulo: Edgard Blücher, 1987.
BALACHANDRAN, Balakumar; MAGRAB, Edward B. **Vibrações mecânicas**. São Paulo, SP: Cengage Learning, 2011..
FONSECA, Adhemar. **Vibrações**: vibrações unidimensionais; isolamento das vibrações; vibrações multidimensionais. Rio de Janeiro, RJ: Ao Livro Técnico, 1964.
FRANÇA, Luis Novaes Ferreira; SOTELO JÚNIOR, José. **Introdução às vibrações mecânicas**. 1. ed. São Paulo: Edgard Blücher, 2006.
KURKA, Paulo R. G. **Vibrações de sistemas dinâmicos**: análise e síntese. 1. ed. Rio de Janeiro: Elsevier, 2015.

COURSE: Metallurgical Processes	
Effective: from 2018/1	**Academic period:** 4th year
Total course load: 150 h	**Code:** PF.EM.077
Syllabus: Introduction to extractive metallurgy and unit operations employed in the production of the main metals used in the metal-mechanical sector. Technological fundamentals of casting and welding processes. Introduction to powder metallurgy processes.	

Contents

UNIT I – Steelmaking Processes
      1.1 Coke making (coking plant)
      1.2 Sintering
      1.3 Pelletizing
      1.4 Blast furnace
      1.5 LD steelmaking (basic oxygen steelmaking)
      1.6 Electric steelmaking
      1.7 Secondary metallurgy
      1.8 Other steelmaking processes
      1.9 Casting (continuous and conventional)

UNIT II – Casting Processes
      2.1 Introduction to the casting process
      2.2 Solidification principles and metallurgy applied to casting
      2.3 Techniques and basic nomenclature of casting processes
      2.4 Casting processes using expendable molds
      2.5 Casting processes using permanent molds
      2.6 Casting design
      2.7 Foundry sands
      2.8 Core making
      2.9 Foundry equipment
      2.10 Applications of cast products
      2.11 Special casting processes

UNIT III – Welding Processes
      3.1 Introduction to the welding process
      3.2 Solidification principles and metallurgy applied to welding
      3.3 Techniques, standards, symbols and basic nomenclature of welding processes
      3.4 Arc welding processes
      3.5 Gas welding and cutting processes
      3.6 Non-conventional welding processes
      3.7 Applications of welded products

UNIT IV – Powder Metallurgy Processes
      4.1 Introduction to the powder metallurgy process
      4.2 Metallurgical principles applied to powder metallurgy
      4.3 Powder metallurgy processing techniques
      4.4 Applications of products obtained by powder metallurgy

Basic Bibliography

ABREU, Alírio Gerson da Silva. **Alimentação e enchimento de peças fundidas vazadas em moldes de areia**. 2. ed. Itaúna, MG: Ed. Senai, 2007.
MACHADO, Ivan Guerra. **Soldagem e Técnicas Conexas**: Processos. Porto Alegre: Editado Pelo autor, 1996.
ROMANUS, Arnaldo. **Moldagem em Areia Verde**: Manual de defeitos e Soluções. São Paulo: Ed.Global Market, 2005.

Supplementary Bibliography

RIZZO, Ernandes Marcos da Silveira. **Introdução aos processos de refino primário dos aços nos convertedores a oxigênio.** São Paulo: Ed. ABM, 2006.
FONSECA, Marco Túlio da. **Geração de defeitos em peças de alumínio obtidas pelo processo de fundição sob pressão**. Belo Horizonte: Ed. Senai, 2004.
FONSECA, Marco Túlio da. **Teoria fundamental do processo de fundição sob pressão**. Belo Horizonte, MG: Editora SENAI, 2001.
GARCIA, Amauri; Spim, Jaime Alvares; Santos, Carlos Alexandre dos. **Ensaios dos materiais**. Rio de Janeiro, RJ: LTC, 2000.
CHIAVERINI, Vicente. **Aços e ferros fundidos**: características gerais, tratamentos térmicos, principais tipos. 7. ed. São Paulo: Associação Brasileira de Metalurgia e Materiais, 1996.

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COURSE: Heat Transfer	
Effective: from 2018/1	**Academic period:** 4th year
Total course load: 90 h	**Code:** PF.EM.078
Syllabus: Introduction to the fundamental concepts of heat transfer. Physical origins. Energy conservation. Introduction to conduction and convection. External and internal flows. Natural convection. Introduction to heat exchangers. Radiation: processes and properties. Introduction to mass transfer: Fick's law of diffusion.	

Contents

UNIT I – Introduction
    1.1 Physical origins and rate equations
    1.2 Requirement of energy conservation
    1.3 Analysis of heat transfer problems
    1.4 Dimensions and units

UNIT II – Introduction to Conduction
    2.1 Conduction rate equation
    2.2 Thermal properties of matter
    2.3 Heat diffusion equation
    2.4 Boundary and initial conditions

UNIT III – One-Dimensional Steady-State Conduction
    3.1 Plane wall
    3.2 Alternative conduction analysis
    3.3 Radial systems

UNIT IV – Two-Dimensional Steady-State Conduction
    4.1 Alternative approaches
    4.2 Method of separation of variables
    4.3 Shape factor
    4.4 Dimensionless heat conduction rate
    4.5 Finite-difference equations
    4.6 Some solution techniques

UNIT V – Transient Conduction
    5.1 Lumped capacitance method
    5.2 Plane wall with convection

UNIT VI – Introduction to Convection
    6.1 Convection boundary layers
    6.2 Local and average convective heat-transfer coefficients
    6.3 Laminar and turbulent flow
    6.4 Boundary-layer equations

UNIT VII – External and Internal Flow
    7.1 Flat plate in parallel flow
    7.2 Methodology for convection calculations
    7.3 Fluid-dynamic considerations
    7.4 Thermal considerations in internal flow

UNIT VIII – Natural Convection
8.1 Physical considerations
8.2 Natural convection equations
8.3 Natural convection over a vertical surface
8.4 Turbulent effects

UNIT IX – Heat Exchangers
9.1 Types of heat exchangers
9.2 Overall heat-transfer coefficient
9.3 Heat exchanger analysis: log mean temperature difference (LMTD) method
9.4 Heat exchanger analysis: effectiveness–NTU method

UNIT X – Radiation: Processes and Properties
10.1 Fundamental concepts
10.2 Radiation intensity
10.3 Blackbody radiation
10.4 Emission from real surfaces
10.5 Radiation exchange between surfaces: view (shape) factor

UNIT XI – Mass Transfer by Diffusion
11.1 Physical origins and rate equations
11.2 Fick's law of diffusion
11.3 Mass diffusivity

Basic Bibliography

INCROPERA, P.F.; DE WITT, D. P. **Fundamentos de Transferência de Calor e Massa.** 6. ed. Rio de Janeiro: LTC, 2008.
YUNNUS A. ÇENGEI, Afshin Ghajar **Transferência de calor e massa**. 4. ed. Rio de Janeiro: LTC, 2009.
SISSON I. E., PITTS D.R. **Fenômenos de Transporte**. Rio de Janeiro: Guanabara Dois, 1996.

Supplementary Bibliography

BOHN, Mark S.; KREITH, Frank. **Principios de Transferencia e Calor**. Thomson Heinle: São Paulo, 2003.
BIRD, r. B.; steward, w. E. & LIGHTFOOT, e. N. **Fenômenos de Transporte.** 2. ed. Rio de Janeiro: LTC, 2004.
FIGUEIREDO, Rui. **Transmissão de Calor** - Fundamentos e Aplicações. São Paulo: Editora Lidel-Zamboni, 2007.
FOX, Robert W.; McDonald, Alan T.; Pritchard, Philip J**. Introdução À Mecânica Dos Fluídos**. 8. ed. Rio de Janeiro: LTC, 2014.
CENGEL, Yunus A. **Transferência de Calor e Massa:** Uma abordagem prática. 4. ed. São Paulo: Amgh Editora, 2012.

COURSE: Social Sciences Applied to Mechanical Engineering	
Effective: from 2018/1	**Academic period:** 5th year
Total course load: 30 h	**Code:** PF.EM.032
Syllabus: Introduction to General Management Theory; understanding of administrative management processes; study of quality management; understanding of marketing processes. Study of human relations in the workplace with regard to intra- and interpersonal relationships. Analysis and understanding of fundamental human rights in contemporary society. Study of entrepreneurship: vision, goals, strategies, planning, business plan, company start-up, and franchising.	

Contents

UNIT I – Introduction to Management
      1.1 Management and sciences
      1.2 The main schools of management
      1.3 Human relations in management
      1.4 Contemporary management

UNIT II – Administrative Management
      2.1 Basic concepts of management
      2.2 Market and the world of work
      2.3 Organizational structure

UNIT III – Human Relations
      3.1 Interpersonal and intrapersonal relationships
      3.3 Motivation, creativity and change
      3.4 Leadership and organization
      3.6 Fundamental human rights in contemporary society
      3.7 Ethnic–racial relations and the world of work

UNIT IV – Quality Management
      4.1 Concepts and historical overview
      4.2 Quality management system
      4.3 5S
      4.4 ISO 9001
      4.5 ISO 14001
      4.6 Environmental management system
      4.7 Inventory and cost management

UNIT V – Principles of Marketing
      5.1 Definition of marketing
      5.2 Marketing plan
      5.3 Marketing strategies

UNIT VI – Entrepreneurship
      6.1 Concepts, importance and purposes
      6.2 Entrepreneurial profile
      6.3 Types of companies, legal structure and registration
      6.4 Technology incubators
      6.5 Franchising

UNIT VII – Planning
        7.1 Business plan
        7.2 Business plan development model
        7.3 Company structuring and organization in the field of Mechanical Engineering

Basic Bibliography

DORNELAS, J.C.A. **Empreendedorismo**: Transformando Ideias em Negócios. Rio de Janeiro: Campus, 2001.
CHIAVENATO, Idalberto**. Introdução à Teoria geral da administração**. 7. ed. Rio de Janeiro: Elsevier, 2010.
CHIAVENATO, Idalberto. **Iniciação à Administração de Recursos Humanos**. 4. ed. São Paulo: Manole, 2010.

Supplementary Bibliography

CHIAVENATO, I**. Empreendedorismo:** Dando Asas ao Espírito Empreendedor. São Paulo: Saraiva, 2004.
DORNELAS, J.C.A. **Empreendedorismo Na Prática**: Mitos e Verdades do Empreendedor de Sucesso. Rio de Janeiro: Campus, 2007.
DORNELAS, J.C.A. **Empreendedorismo Corporativo**: Como ser empreendedor, inovar e se diferenciar na sua empresa. Rio de Janeiro: Campus, 2008.
MINICUCCI, Agostinho. **Relações Humanas**: psicologia das relações interpessoais. 6. ed. São Paulo: Editora Atlas, 2001
TANNENBAUM, A.S. **Psicologia social da organização do trabalho**. São Paulo: Atlas, 1973.
WEILL, P. **Relações humanas na família e no trabalho**. Petrópolis: Vozes, 1989.

COURSE: Occupational Safety and Environmental Engineering	
Effective: from 2018/1	**Academic period:** 5th year
Total course load: 60 h	**Code:** PF.EM.033
Syllabus: Introduction to occupational safety. Statistical analysis of accidents. Study of workplace environmental control: physical and chemical risks. Analysis of statistics and preventive programs. Study of personal protection. Analysis of safety in engineering design. Introduction to legislation in the area of occupational safety and health. Introduction to social security legislation related to occupational accidents and occupational diseases. Study of fire protection. Introduction to first aid. Analysis of occupational diseases. Study of ecology and environmental transformation. Analysis of water, soil and air pollution. Study of environmental planning and protection.	

Contents

UNIT I – Identification of Safety-Related Conditions
    1.1 Causes of accidents: personal unsafe factors, unsafe acts, and unsafe environmental conditions
    1.2 Consequences of accidents: personal injury and material damage
    1.3 Accident agent and source of injury
    1.4 Risks of the main occupational activities

UNIT II – Human–Machine System
    2.1 Immediate environment
    2.2 General environment
    2.3 Internal environment
    2.4 Anthropometric measurements and their applications

UNIT III – Application of Ergonomics in Design
    3.1 Workstation design
    3.2 Equipment design
    3.3 Design of commands and controls

UNIT IV – Study of Working Conditions
    4.1 Physical agents
    4.2 Chemical agents
    4.3 Biological agents
    4.4 Social agents

UNIT V – Legislation and Technical Standards
    5.1 Accidents: concepts and classification
    5.2 Legislation
    5.3 Technical standards

UNIT VI – Personal Protective Equipment (PPE)
    6.1 Use
    6.2 Technical specifications

Basic Bibliography

COUTO, Hudson Araújo. **Ergonomia Aplicada ao Trabalho**: Manual técnico da Máquina Humana. Belo Horizonte: ERGO, 1996, vol. 1 e 2.
DUL, Jan & WEERDMEESTER Bernard. **Ergonomia prática**. 1. ed. São Paulo: Edgar Blücher Ltda, 1995.
GRANDJEAN, Etienne. **Manual de ergonomia** - adaptando o trabalho ao homem. 4. ed. Porto Alegre: Bookman, 1998.

Supplementary Bibliography

IIDA, I. Ergonomia, **Projeto e Produção**. São Paulo: Edgar Blucher, 1990.
NORMAS REGULAMENTADORAS. **Segurança e medicina no trabalho**. São Paulo: Atlas, 1989.
DEJOURS, C. **A loucura do trabalho**. São Paulo: FTD, 1987.
DELTA COLETA. José Augusto. **Acidentes do Trabalho**. São Paulo: Atlas, 1989.
MILARÉ, Édis. **Direito do Ambiente**. 8 ed. São Paulo, SP. Revista dos Tribunais, 2013.

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COURSE: Internal Combustion Engines	
Effective: from 2018/1	**Academic period:** elective
Total course load: 30 h	**Code:** PF.EM.084
Syllabus: Introduction to Otto-cycle and Diesel engines. Definition of cooling systems and valve train systems. Analysis of fuel supply systems. Definition of lubrication systems. Definition of electrical systems and pollutant emissions. Application of torque and power measurement. Internal combustion engines. Cycles and characteristic curves. Fuels. Lubricants and lubrication systems. Cooling, intake, injection and ignition systems. Large engines and special engines. Engine maintenance.	

Contents

UNIT I – Introduction to Internal Combustion Engines
　　　　1.1 Introduction
　　　　1.2 Types of engines: spark-ignition engines and compression-ignition engines
　　　　1.3 Operating parameters

UNIT II – Gas Cycles (Air-Standard Cycles)
　　　　2.1 Constant-volume heat addition
　　　　2.2 Constant-pressure heat addition
　　　　2.3 Dual cycle
　　　　2.4 Finite-rate heat release – differential engine model
　　　　2.5 Ideal intake and exhaust processes: volumetric efficiency and residual gas fraction

UNIT III – Fuels, Air and Combustion Thermodynamics
　　　　3.1 Ideal gas equations of state
　　　　3.2 Stoichiometry and low-temperature combustion modeling
　　　　3.3 Non-stoichiometric combustion: chemical equilibrium
　　　　3.4 Combustion and the first law of thermodynamics

UNIT IV – Fuel–Air Cycles and Real Engine Cycles
　　　　4.1 Comparison of first-law and second-law efficiencies
　　　　4.2 Otto cycle
　　　　4.3 Four-stroke Otto cycle
　　　　4.4 Limited-pressure cycle of injected fuel
　　　　4.5 Comparison between fuel–air cycles and real spark-ignition engine cycles
　　　　4.6 Comparison between fuel–air cycles and real compression-ignition engine cycles

UNIT V – Friction
　　　　5.1 Friction mean effective pressure
　　　　5.2 Measurement of friction mean effective pressure
　　　　5.3 Estimation of friction mean effective pressure of engine components
　　　　5.4 Overall engine friction mean effective pressure

UNIT VI – Air, Fuel and Exhaust Gas Flows
  6.1 Flow through valves
  6.2 Intake and exhaust flows
  6.3 Fluid flow into and out of the cylinder
  6.4 Turbulent flow
  6.5 Air flow in two-stroke engines
  6.6 Superchargers and turbochargers
  6.7 Fuel injectors
  6.8 Basic concepts of carburetion

UNIT VII – Heat and Mass Transfer
  7.1 Engine cooling systems
  7.2 Energy balance in the engine
  7.3 Heat transfer modeling
  7.4 Heat transfer correlations
  7.5 Radiative heat transfer
  7.6 Mass loss or blow-by

UNIT VIII – Combustion and Emissions
  8.1 Combustion in spark-ignition engines
  8.2 Abnormal combustion in spark-ignition engines
  8.3 Combustion in compression-ignition engines
  8.4 Thermodynamic analysis
  8.5 Emissions
  8.6 Emission control

UNIT IX – Fuels and Lubricants
  9.1 Hydrocarbon chemistry
  9.2 Refining
  9.3 Gasoline fuels
  9.4 Diesel fuels
  9.5 Alternative fuels
  9.6 Engine oils

UNIT X – Overall Engine Performance
  10.1 Engine size
  10.2 Ignition timing and injection timing
  10.3 Piston speed and engine speed
  10.4 Compression ratio
  10.5 Part-load performance
  10.6 Performance maps
  10.7 Vehicle performance simulation

Basic Bibliography

BRUNETTI, Franco. **Motores de Combustão Interna**. Vol. I e II. São Paulo: Editora Blucher, 2012.
GIACOSA, Dante. **Motores endotérmicos**. 3. ed. Dossat. Madrid,1986.
PENIDO FILHO, Paulo. **Os motores de combustão interna**: para cursos de máquinas térmicas, engenheiros, técnicos e mecânicos em geral que se interessam por motores. Belo Horizonte: Editora Lemi., 1996.

Supplementary Bibliography

FERGUSON, C. R. & KIRKPATRICK, A. L. **Internal Combustion Engines**. 2nd edition, John Wiley & Sons Inc., .New York, 2000.

HEYWOOD, John B. **Internal combustion engine fundamentals**. New York: McGraw-Hill, 1988.

LUMLEY, J. L. **Engines an Introduction**, Cambridge University Press, New York, 1999.

SONNTAG, Richard E.; BORGNAKKE, Claus; VAN WYLEN, Gordon J. **Fundamentos da Termodinâmica**. 7.ed. São Paulo: Edgard Blucher, 2009.

STONE, Richard. **Introduction to internal combustion engines**.3.ed. Warrendale: Societyof Automotive Engineers, 1999.

STONE, R. **Introduction to Internal Combustion Engines**, 3rd edition Society of Automotive Engineers, New York, 1999.

TAYLOR, C. F. **The Internal Combustion Engine in Theory and Pratctice**, Vol. 1: Thermodynamics, Fluid Flow, Performance, 2nd Edition, The M.I.T. Press, Cambridge, 1985.

COURSE: Refrigeration and Air Conditioning	
Effective: from 2018/1	**Academic period:** elective
Total course load: 30 h	**Code:** PF.EM.083
Syllabus: Refrigeration cycles: vapor compression, absorption, and adsorption. Refrigeration equipment. Refrigerants. Principles of psychrometrics. Thermal comfort parameters. Analysis of cooling and heating loads in buildings. Energy efficiency analysis. Air-conditioning system design. Practical activities in installation and maintenance of air-conditioning systems.	

Contents

UNIT I – Refrigeration
    1.1 Psychrometrics and thermodynamics
    1.2 Theoretical cycles
    1.3 Thermal load
    1.4 Refrigeration equipment: compressors, expansion devices, auxiliary equipment
    1.5 Installed power
    1.6 Refrigerants

UNIT II – Air Conditioning
    2.1 Air-conditioning systems
    2.2 Reversible cycle (heat pump operation)
    2.3 Control equipment and devices
    2.4 Installed power
    2.5 Air distribution systems and ducts

UNIT III – Air-Conditioning System Design
    3.1 Cold room design
    3.2 Indoor air-conditioning system design

UNIT IV – Practical Classes
    4.1 Installation of air-conditioning units
    4.2 Maintenance of equipment

Basic Bibliography

STOECKER, W. F; J. M. SAIZ JABARDO. **Refrigeração industrial**. 2. ed. Edgar Blucher. São Paulo, 2002.
COSTA, Ênnio Cruz da. **Refrigeração**. 3. ed. São Paulo, SP: Edgard Blücher, 1982.
MILLER, Rex; MILLER, Mark R. **Refrigeração e ar condicionado**. Rio de Janeiro: LTC, 2008.

Supplementary Bibliography

ABNT-NBR 16401, 2008, **Norma de Ar Condicionado e Ventilação Mecânica** da Associação Brasileira.

ABNT-NBR 15220, 2003, **Desempenho térmico de edificações**.

COSTA, Ênnio Cruz da. **Física industrial**: refrigeração. Porto Alegre: PUCRS, 1975.

CREDER, Hélio. **Instalações de ar condicionado**. 6. ed. Rio de Janeiro, RJ: LTC, 2004.

SILVA, Napoleão F. **Compressores alternativos industriais**: teoria e prática. Rio de Janeiro, RJ: Interciência, 2009.

COURSE: Economic Engineering and Appraisals	
Effective: from 2018/1	**Academic period:** 5th year
Total course load: 60 h	**Code:** PF.EM.034
Syllabus: Introduction to Economic Engineering and Financial Mathematics. Formulation of simple and compound interest. Application of interest rates (nominal, effective, real and accumulated). Study of amortization, models of financing of goods and services. Understanding of cash flow processes, uniform, arithmetic and geometric series. Application of minimum attractiveness rate; Study of alternative evaluation methods: NPV, IRR and PayBack (simple and discounted). Study of financial indicators for Analysis of Investment Projects, Risks and Uncertainty (sensitivity analysis).	

Contents

UNIT I – Introduction
      1.1 Introduction: Economic Engineering as a Tool for Analysis and Decision Making
      1.2 Management Models: Cash Flow Diagram (CFD)
      1.3 Cash Flow (CF)
      1.4 Economic Decision-Making Formulation
      1.5 Estimation of Economic Elements

UNIT II – Financial Mathematics
      2.1 Interest
      2.2 Interest Rate
      2.3 Simple Interest
      2.4 Compound Interest
      2.5 Equivalent Rates
      2.6 Time Value of Money
      2.7 Interest and Equivalent Value Calculations
      2.8 NPV – Net Present Value
      2.9 FV – Future Value
      2.10 Amortization and financing models for goods and services
      2.11 Use of Calculators and Spreadsheets

UNIT III – Evaluation of Economic Alternatives
      3.1 Interest and Economic Equivalence
      3.2 Methods for Comparing Alternatives
      3.3 Evaluation of Replacement Alternatives

UNIT IV – Estimation, Risk and Uncertainty
      4.1 Estimation Treatment
      4.2 Decision-Making Involving Risk
      4.3 Decision-Making Involving Uncertainty

UNIT V – Economic Decision Models
      5.1 Economic Models
      5.2 Break-Even Decision Models
      5.3 Minimum Cost Decision Models

UNIT VI – Project Analysis and Development
  6.1 IRR – Internal Rate of Return
  6.2 Payback
  6.3 MARR – Minimum Attractive Rate of Return
  6.4 Revenue and Expense Analysis
  6.5 Qualitative Models: Qualitative Decision-Making Models Applied to Economic Engineering

Basic Bibliography

FERREIRA, Roberto G. **Engenharia Econômica e Avaliação de Projetos de Investimento** – Critérios de Avaliação, Financiamentos e Benefícios Fiscais e Análise de Sensibilidade e Risco. São Paulo: Editora Atlas S. A., 2009.
HIRSCHFELD, Henrique. **Engenharia Econômica e Análise de Custos.** São Paulo. Ed Atlas, 2000
SAMANEZ, Carlos Patrício. **Engenharia Econômica**. São Paulo. Editora Prentice Hall, 2009.

Supplementary Bibliography

BRUNI, Adriano Leal; FAMA, Rubens. **Matemática Financeira com HP 12 e Excel**. São Paulo. Ed. Atlas, 2004.
BRUNSTEIN, Israel. **Economia de empresas**. São Paulo. Ed. Atlas, 2005.
PILÃO, Nivaldo Elias; HUMMEL, Paulo Roberto Vampré. **Matemática Financeira e Engenharia Econômica**. São Paulo. Ed. Thomson, 2004.
Woiler, Samsão; Mathias, Washington F.: **Projetos – Planejamento, Elaboração e Análise.** 2. ed. São Paulo: Editora Atlas S.A., 2010.
ROSS, S. **Probabilidade:** um curso moderno com aplicações. Porto Alegre: Bookman, 2010.

COURSE: Maintenance	
Effective: from 2018/1	**Academic period:** 5th year
Total course load: 30 h	**Code:** PF.EM.079
Syllabus: Understanding the characteristics and applications of studies aimed at supporting a production system, including its administration, organization, planning, scheduling, control and execution of services in equipment and facilities.	

Contents

UNIT I – Introduction
      1.1 History of maintenance
      1.2 Maintenance terminology
      1.3 Basic maintenance rules
      1.4 Types and occurrences of failures

UNIT II – Objectives of Maintenance
      2.1 Basic functions
      2.2 The service life problem
      2.3 Efficiency and efficiency levels

UNIT III – Maintenance Administration and Organization
      3.1 Registration of facilities
      3.2 Facilities history
      3.3 Equipment documentation
      3.4 Equipment service requests
      3.5 Inspection forms

UNIT IV – Maintenance Warehouse Management
      4.1 Records and forms
      4.2 Specification and coding of materials
      4.3 Standardization and normalization
      4.4 Receiving and inspection of materials
      4.5 Inventory sizing

UNIT V – Maintenance Planning
      5.1 Logical sequence for system implementation
      5.2 Equipment selection by priority
      5.3 Predetermined time
      5.4 Service scheduling
      5.5 Tools used
      5.6 Equipment cleaning

UNIT VI – Maintenance Control System
      6.1 Efficiency control index
      6.2 Records and information charts
      6.3 Results verification
      6.4 Alert levels for evaluation and control
      6.5 Costs

UNIT VII – Lubricants and Lubrication
>   7.1 Origin of petroleum
>   7.2 Functions of lubricants
>   7.3 Classification of lubricants
>   7.4 Application of lubricants
>   7.5 Lubricant analysis
>   7.6 Additives
>   7.7 Lubrication systems

UNIT VIII – Lubrication Planning
>   8.1 Importance of lubrication
>   8.2 Elements to be considered
>   8.3 Planning steps
>   8.4 Automation and centralization
>   8.5 Filters and purifiers
>   8.6 Symbols
>   8.7 Verification and correction of the program

UNIT IX – Mechanical Vibrations
>   9.1 Basic concepts
>   9.2 Causes of vibrations
>   9.3 Instruments used
>   9.4 Vibration measurement

UNIT X – Mechanical Balancing
>   10.1 Concept and importance
>   10.2 Causes of unbalance
>   10.3 Types of balancing
>   10.4 Balancing machines
>   10.5 Balancing methods

UNIT XI – Corrosion
>   11.1 Basic concept
>   11.2 Corrosive processes
>   11.3 Effects of corrosion
>   11.4 Prevention methods

UNIT XII – Preventive Maintenance of Equipment
>   12.1 Bearings and bearing housings
>   12.2 Gears and gear reducers
>   12.3 Couplings
>   12.4 Belts, chains and wire ropes
>   12.5 Sealing elements
>   12.6 Pumps
>   12.7 Compressors
>   12.8 Machine tools

UNIT XIII – Techniques Used in Predictive Maintenance
13.1 Monitoring of pressure and temperature
13.2 Visual inspection
13.3 Magnetic particle testing
13.4 Liquid penetrant testing
13.5 Radiographic testing
13.6 Ultrasonic testing
13.7 Eddy current testing
13.8 Thermographic inspection
13.9 Atomic absorption spectrophotometry testing
13.10 Failure detection by acoustic emission
13.11 Failure detection and analysis by ferrography
13.12 Fractography
13.13 Vibrometry testing

Basic Bibliography

FOGLIATTO, Flávio Sanson; RIBEIRO, José Luis Duarte. **Confiabilidade e manutenção industrial**. Rio de Janeiro: Elsevier, 2009. 265 p. ISBN 978-85-352-3353-7
PEREIRA, Mário Jorge. **Técnicas avançadas de manutenção**. Rio de Janeiro: Ciência Moderna, 2010. 80 p. ISBN 9788573939361
SANTOS, Valdir Aparecido dos. **Prontuário para manutenção mecânica**. São Paulo: Ícone, 2010. 175 p. ISBN 9788527411028

Supplementary Bibliography

FILHO, Gil Branco. **Dicionário de termos de manutenção, confiabilidade e qualidade**. Rio de Janeiro: Ciência Moderna Ltda, 2004.
SCAPIN, Carlos Alberto. **Análise sistêmica de falhas**. Nova Lima: INDG Tecnologia e Serviços, 2007. 168 p. ISBN 9788598254326
VIANA, Herbert Ricardo Garcia. PCM **planejamento e controle da manutenção**. Rio de Janeiro: Qualitymark, 2002. 167 p. ISBN9788573037913
XENOS, Harilaus Georgius d`Philippos. **Gerenciando a manutenção produtiva.** Belo Horizonte: Editora de Desenvolvimento Gerencial, 1998.
ZEN, Milton Augusto Galvão. **Fator humano na manutenção**. Rio de Janeiro: Editora Qualitymark, 2009.

COURSE: Machining Practice I	
Effective: from 2018/1	**Academic period:** elective
Total course load: 90 h	**Code:** PF.EM.045
Syllabus: Study of the characteristics and applications of conventional machining manufacturing processes. Analysis and application of the planning and execution of manufacturing processes, selecting machine tools and applying the appropriate cutting conditions.	

Contents

UNIT I – Metrology
      1.1 Measurement systems
      1.2 Definition of measurement systems
      1.3 Conversion between measurement systems
      1.4 Measuring instruments: caliper, micrometer and dial indicator
      1.5 Identification of nomenclature and resolution
      1.6 Identification of instrument types and their applications
      1.7 Interpretation of readings in the metric and imperial systems
      1.8 Identification of measurement errors
      1.9 Identification of proper care during use

UNIT II – Fitting and Bench Work
      2.1 Proper posture for bench work
      2.2 Personal protective and safety equipment
      2.3 Bench vise
      2.4 Hacksaw
      2.5 Layout and marking instruments: scriber, caliper, height gauge (scriber gauge), precision square, angle protractor, dividers
      2.6 Types of files: flat file, knife file, half-round file, square file, round file and triangular file (second-cut and bastard)
      2.7 Taps: metric and Whitworth, and respective tap wrench
      2.8 Dies: metric and Whitworth, and respective die holder
      2.9 Vertical and horizontal band saws
      2.10 Bench and column drilling machines

UNIT III – Turning
      3.1 Nomenclature
      3.2 Characteristics and applications
      3.3 Accessories (chucks, live center, tool holders, steady rests)
      3.4 Cutting tools
      3.5 RPM and cutting speed calculations and interpretation of tables
      3.6 Care in clamping workpieces and tools
      3.7 Turning operations: external cylindrical turning and facing
      3.8 Turning operation: drilling
      3.9 Turning operation: taper turning
      3.10 Turning operation: knurling
      3.11 Turning operation: threading
      3.12 Turning operation: internal machining

UNIT IV – Milling
      4.1 Nomenclature
      4.2 Operation
      4.3 Characteristics and applications
      4.4 Accessories (chucks, live center, tool holders, etc.)
      4.5 Cutting tools
      4.6 RPM and cutting speed calculations and interpretation of tables
      4.7 Care in clamping workpieces and tools
      4.8 Milling operations: end milling, V-slot milling, T-slot milling, dovetail slot milling
      4.9 Gear tooth cutting using a dividing head

UNIT V – Grinding
      5.1 Surface and cylindrical grinding machines
      5.2 Nomenclature
      5.3 Personal protective and safety equipment
      5.4 Operation
      5.5 Characteristics and applications
      5.6 Accessories
      5.7 Grinding wheels
      5.8 Classification and identification
      5.9 Grinding wheel balancing
      5.10 RPM and cutting speed calculations and interpretation of tables
      5.11 Care in clamping workpieces

Basic Bibliography

DINIZ, A. E., MARCONDES, F. C., COPPINI, N. L. **Tecnologia da Usinagem dos Materiais**. São Paulo: Artliber, 2000.
FERRARESI, D. **Fundamentos da Usinagem dos Metais**. São Paulo: Edgard Blücher,1977.
ROSSI, M. **Máquinas-Operatrizes Modernas**, v. I e II. Rio de Janeiro: Livro Ibero-americano, 1970.

Supplementary Bibliography

STEMMER, C. E. **Ferramentas de Corte I**. Florianópolis: Editora da UFSC, 1992.
STEMMER, C. E**. Ferramentas de Corte II**. Florianópolis: Editora da UFSC, 1992.
CHIAVERINI, V. **Tecnologia mecânica**: processos de fabricação e tratamento. 2. ed. São Paulo: McGraw Hill, 1987. 2v.
SUGA, N. **Metrologia dimensional**: a ciência da medição. São Paulo: Mitutoyo, 2007. 247 p.
WITTE, H. **Máquinas ferramenta**. São Paulo: Hermus, 1998. 389 p

COURSE: Machining Practice II	
Effective: from 2018/1	**Academic period:** elective
Total course load: 90 h	**Code:** PF.EM.065
Syllabus: Programming of CNC machines (lathe) using Siemens language, preparing them for machining operations, including simulation and execution.	

Contents

UNIT I – CNC Lathe
        1.1 Introduction
        1.2 Historical background
        1.3 Coordinate systems – absolute and incremental
        1.4 Types of functions – positioning and special functions
        1.5 Preparatory functions
        1.6 Workpiece profile
        1.7 Basic and automatic threading cycles
        1.8 Roughing and finishing cycles
        1.9 Simulation of part execution on the CNC lathe
        1.10 Programming of part drawings for execution on the CNC lathe
        1.11 Tool presetting on the CNC lathe
        1.12 Practical execution of parts on the CNC lathe

Basic Bibliography

SILVA, Sidnei Domingo. CNC - **Programação De Comandos Numéricos Computadorizados – Torneamento**. São Paulo: Editora Erica, 2009.
Machado, Aryoldo. **Comando Numérico Aplicado às Máquinas-Ferramenta**, São Paulo: Ícone, 1990.
DINIZ, A. E.; MARCONDES, F. C.; COPPINI, N. L. **Tecnologia da Usinagem dos Materiais**. São Paulo: Artliber, 2000.

Supplementary Bibliography

CHIAVERINI, V. **Tecnologia mecânica**: processos de fabricação e tratamento. 2. ed. São Paulo: McGraw Hill, 1987. 2v.
SUGA, N. **Metrologia dimensional**: a ciência da medição. São Paulo: Mitutoyo, 2007.
WITTE, H. **Máquinas ferramenta**. São Paulo: Hermus, 1998.
STEMMER, C.E. **Ferramentas de Corte I**. Santa Catarina: Editora UFSC, 2005.
FERRARESI, D. **Fundamentos da Usinagem dos Metais**. São Paulo: Edgard Blücher,1977.

COURSE: Fundamentals of Industrial Automation	
Effective: from 2018/1	**Academic period:** elective
Total course load: 90 h	**Code:** PF.EM.055
Syllabus: Study of the fundamentals of automation. Analysis of combinational logic elements and Boolean algebra. Study of sensor and actuator technologies for industrial automation. Study of the programming of programmable logic controllers and dedicated controllers. Analysis of supervisory systems and human–machine interfaces. Study of basic concepts of industrial networks.	

Contents

UNIT I – Fundamentals of Automation
    1.1 Retrospective and historical background
    1.2 Concepts of automation and control
    1.3 Industrial automation architecture
    1.4 Principles and strategies of automation and control
    1.5 Industrial control systems

UNIT II – Combinational Logic
    2.1 Analog and digital signals and systems
    2.2 Number systems
    2.3 Logic functions and Boolean algebra

UNIT III – Sensors
    3.1 Fundamentals of instrumentation
    3.2 Magnetic and electromagnetic sensors
    3.3 Thermal sensors
    3.4 Sensors for mechanical quantities
    3.5 Proximity, passage, presence, and limit sensors

UNIT IV – Actuators
    4.1 Linear actuators
    4.2 Relays
    4.3 Motors
    4.4 Stepper motors
    4.5 Servo motors

UNIT V – Controllers
    5.1 Programmable Logic Controllers (PLCs)
    5.2 Programming languages
    5.3 Timers
    5.4 Counters
    5.5 Specific (dedicated) controllers

UNIT VI – Supervisory Systems
    6.1 Introduction and concepts
    6.2 Human–machine interface (HMI)
    6.3 Interface specification and design

UNIT VII – Industrial Networks
   7.1 Introduction to industrial networks
   7.2 RS-232, RS-485
   7.3 Ethernet
   7.4 Profibus
   7.5 Fieldbus
   7.6 CAN

Basic Bibliography

FRANCHI, C. M.; CAMARGO, V. L. A. **Controladores lógicos programáveis**: sistemas discretos. 2 .ed. São Paulo: Érica, 2013.
SILVEIRA, P. R. da; SANTOS, W. E. dos. **Automação e controle discreto**. 9 ed. São Paulo: Érica, 2009.
THOMAZINI, D.; ALBUQUERQUE, P. U. B.de. **Sensores Industriais** - Fundamentos e Aplicações. 5 ed. São Paulo: Érica, 2008.

Supplementary Bibliography

FIALHO, A. B. **Instrumentação Industrial** - Conceitos, Aplicações e Análises. 7. ed. São Paulo: Érica, 2010.
GEORGINI, M. **Automação aplicada**: Descrição e implementação de sistemas sequenciais com PLCs. 9. ed. São Paulo: Érica, 2009.
OGATA, Katsuhiko. **Engenharia de controle moderno**. 5. ed. São Paulo, SP: Pearson, 2010.
OPPENHEIM, Alan V.; Willsky, Alan S; Nawab, Syed Hamid (colab.). **Sinais e Sistemas**. 2. ed. São Paulo: Pearson, 2014.
ROSÁRIO, J. M. **Princípios de Mecatrônica**. 1. ed. São Paulo: Prentice Hall, 2005.

COURSE: Basic English I	
Effective: from 2018/1	**Academic period:** elective
Total course load: 90 h	**Code:** PF.EM.080
Syllabus: Study of the English language with a communicative focus, oriented toward knowledge and use of the language at the second basic level, exploring the four language skills: reading, writing, speaking and listening comprehension.	

Contents

Unit 1 – Friends and Family
> Vocabulary: Greetings and introductions; family members; adjectives to describe people.
> Grammar: Present tense (to be); questions with be and short answers.
> Listening, speaking, reading and writing.

Unit 2 – Jobs around the World
> Vocabulary: Jobs; numbers; words to describe the weather; continents, countries and cities.
> Grammar: Contractions with be (negative); indefinite articles.
> Listening, speaking, reading and writing.

Unit 3 – Houses and Apartments
> Vocabulary: Places in a home; furniture and household objects.
> Grammar: There is / there are; prepositions of place: in, on, under, next to.
> Listening, speaking, reading and writing.
> Video strategy: using visual cues.

Unit 4 – Possessions
> Vocabulary: Personal possessions; electronic products.
> Grammar: Demonstrative adjectives; possessive nouns.
> Listening, speaking, reading and writing.

Unit 5 – Daily Activities
> Vocabulary: Daily activities; telling time; work and school activities; time expressions.
> Grammar: Simple present tense: statements, negatives, what time…?, questions and short answers; adverbs of frequency.
> Listening, speaking, reading and writing.

Unit 6 – Getting There
> Vocabulary: City landmarks, directions, ground transportation.
> Grammar: Prepositions of place; imperatives.
> Listening, speaking, reading and writing.
> Video comprehension.

Unit 7 – Free Time
>   Vocabulary: Pastimes; games and sports.
>   Grammar: Present continuous tense; can for ability.
>   Listening, speaking, reading and writing.

Unit 8 – Clothes
>   Vocabulary: Colors; clothes.
>   Grammar: Can; could (for polite requests); likes and dislikes.
>   Listening, speaking, reading and writing.

Unit 9 – Eat Well
>   Vocabulary: Food types; meals; quantities; countable and
>   uncountable nouns.
>   Grammar: Some, any, how much, how many.
>   Listening, speaking, reading and writing.
>   Video strategy: using visual cues.

Unit 10 – Health
>   Vocabulary: Parts of the body; common illnesses; remedies.
>   Grammar: Review of simple present tense; look + adjective; feel +
>   adjective; should (for advice).
>   Listening, speaking, reading and writing.

Unit 11 – Making Plans
>   Vocabulary: Special plans; American holidays; professions.
>   Grammar: Be going to; would like to (for wishes).
>   Listening, speaking, reading and writing.

Unit 12 – On the Move
>   Vocabulary: Verbs + prepositions of movement; preparing to move.
>   Grammar: Simple past tense.
>   Listening, speaking, reading and writing.

Basic Bibliography

RICHARDS, J. C. **Interchange Intro Students Book**. 3rd ed. Cambridge
University Press, 2005.
RICHARDS, J.C**. Interchange Intro Workbook**. 3rd ed. Cambridge University
Press, 2005.
RICHARDS, J. C. **Interchange Intro Self-study CD**. 3rd ed. Cambridge
University Press, 2005.

Supplementary Bibliography

DICIONÁRIO Oxford escolar para estudantes brasileiros de inglês. Portuguêsinglês/ inglês-português. Oxford: Oxford University Press, 2007.
MARQUES, A. **Dicionário Inglês – Português / Português – Inglês**. São Paulo: Ática, 2009.
MARQUES, A., DRAPER, D. **Dicionário Inglês – Português / Português – Inglês**. São Paulo: Ática, 2007.
DUNKLING, L. **The Battle of Newtown Road**. Essex: Pearson, 2008.
TWAIN, M. **The Adventures of Tom Sawyer**. Essex: Pearson, 2008.

COURSE: Basic English II	
Effective: from 2018/1	**Academic period:** elective
Total course load: 90 h	**Code:** PF.EM.081
Syllabus: Study of the English language with a communicative focus, exploring the four language skills: reading, speaking, writing and listening comprehension. Vocabulary and specific structures of the English language, basic expressions for communication. Verb tenses, conditional sentences, comparatives and superlatives.	

Contents

Unit 1 – People
　　　　Vocabulary: Occupations; countries; nationalities; descriptive adjectives.
　　　　Grammar: Review of present tense; be + adjective (+ noun); possessive adjectives.
　　　　Listening, speaking, reading and writing.

Unit 2 – Work, Rest, and Play
　　　　Vocabulary: Daily activities; party-related words; celebrations and festivals.
　　　　Grammar: Review of the simple present tense; prepositions of time; adverbs of frequency.
　　　　Listening, speaking, reading and writing.

Unit 3 – Going Places
　　　　Vocabulary: Travel preparations and stages; ordinal numbers; travel documents and money.
　　　　Grammar: Possession; imperatives and should for advice.
　　　　Listening, speaking, reading and writing.
　　　　Video strategy.

Unit 4 – Food
　　　　Vocabulary: Food; food groups; diets.
　　　　Grammar: Count and non-count nouns; quantifiers.
　　　　Listening, speaking, reading and writing.

Unit 5 – Sports
　　　　Vocabulary: Practicing sports; present-time activities; team sports and individual sports.
　　　　Grammar: Present continuous tense; stative verbs.
　　　　Listening, speaking, reading and writing.

Unit 6 – Destinations
　　　　Vocabulary: Travel activities; emphatic adjectives.
　　　　Grammar: Simple past tense; to be in the past tense.
　　　　Listening, speaking, reading and writing.
　　　　Video comprehension.

Unit 7 – Communication
Vocabulary: Communication, electronics, the senses.
Grammar: Verbs with direct and indirect objects; irregular past tenses; sensory verbs.
Listening, speaking, reading and writing.

Unit 8 – Moving Forward
Vocabulary: Short- and long-term plans; weather conditions; weather-specific clothing.
Grammar: Future tense (be going to); will for predictions and immediate decisions.
Listening, speaking, reading and writing.

Unit 9 – Types of Clothing
Vocabulary: Clothing; descriptive adjectives; clothing materials.
Grammar: Comparatives and superlatives.
Listening, speaking, reading and writing.
Video comprehension.

Unit 10 – Lifestyles
Vocabulary: Healthy and unhealthy habits; compound adjectives.
Grammar: Modal verbs; questions with how.
Listening, speaking, reading and writing.

Unit 11 – Achievements
Vocabulary: Chores; personal accomplishments.
Grammar: Present perfect tense vs. simple past tense.
Listening, speaking, reading and writing.

Unit 12 – Consequences
Vocabulary: Personal finance; animals; animal habits.
Grammar: Real conditionals.
Listening, speaking, reading and writing.

Basic Bibliography

RICHARDS, Jack C.; HULL, Jonathan; PROCTOR, Susan. **Interchange student's book** 1. 3. ed. New York: Cambridge, 2005. 113 p. ISBN 9780521601719
RICHARDS, Jack. **Interchange 1 workbook**. 3 ed. New York: Cambridge, 2005.
SMALZER, William R. **Grammar in Use Intermediate Workbook**. 3 ed. New York: Cambridge University Press, 2009. 199 p. ISBN 9780521734783

Supplementary Bibliography

DEAN, Michael. **A Christmas Carol**: Charles Dickens. England: Pearson
education, 2008. 41 p. ISBN 9781405842822

DICIONÁRIO Oxford Escolar: para estudantes brasileiros de inglês. Oxford
University Press, 2007.

MARQUES, Amadeu. **Dicionário inglês-português, português-inglês**. 2.
ed. São Paulo: Ática, 2009.

REVELL, Jane. **Batman Begins**. London: Scholastic, 2005. 56 p. (Richmond
Readers ; 2) ISBN 9788466818698

RICHARDS, Jack C. **Interchange Intro Workbook**. 3. Ed. New York:
Cambridge University Press, 2005. 96 p. ISBN 97805216601559