PRODUCTION ENGINEERING PROGRAMME

FIRST YEAR

Course: Differential and Integral Calculus I
Class hours: 160
Syllabus: Intervals, inequalities and absolute values. Single variable functions: definition, elementary functions and invertibility. Limit and continuity. Fundamental limits. Derivatives: definition; geometric and kinematic interpretation. Derivative as a rate of change. Differentiation rules, and implicit differentiation. Applications of derivatives. Theorems involving differentiable functions. Analysis of function variation. Optimization problems. L'Hôspital´s rule. Taylor series and approximation error. Antiderivatives. Riemann integrals. Area between curves. Fundamental Theorem of Calculus. Integration techniques. Volumes of solids of revolution. Improper integrals.

Course: Vectors, Curves and Surfaces
Class hours: 80
Syllabus: Vectors in bi and three-dimensional geometric space: definition, addition, scalar multiplication and properties. Dot product, vector projection, cross and triple product. Lines and planes in three-dimensional spaces: equations, relative positions and applications to geometric problems. Definition of curves in two and three-dimensional spaces. Cartesian equations and parameterization of curves in two-dimensional spaces, with an emphasis on lines, circles and conics. Quadric Surfaces. Parameterization of curves in three-dimensional spaces such as intersection of cylindrical, spherical, quadratic and planar surfaces. Vector function ideas. Functions of two real variables: definition, graphical representation and contour lines. Tangent planes and normal lines to surfaces. Partial derivatives: definition and geometric interpretation.

Course: Physics I
Class hours: 160
Syllabus: Theory: physical quantities and their measures. Motion in two or three dimensions. Applied forces. Newton's laws. Equilibrium of particle. Dynamics of particle. Work and kinetic energy. Potencial energy and energy conservation. Power. Momentum, impulse and collisions. Center of mass. Equilibrium of rigid bodies. Laboratory: Physical quantities and their Measures. Measuring instruments. Experiments involving the topics of the subject matter.

Course: Drawing
Class hours: 80 horas
Syllabus: Basic geometric constructions; Projection systems, systems of representation. Reading and interpreting drawings. Technical standards. Sketch orthographic views. Parallel isometric perspective. Auxiliary views and sections, 3D visualization, solid modeling and effects of realism in 3D computer visualization.

Course: Algorithms and Programming
Class hours: 80 horas
Syllabus: Logic. Logic for Engineers. Computer Programming. Algorithm. Flowchart. Data: variables and constants. Numerical, logical, strings and user-defined types of data. Programming structures: sequential, conditional and repetitive. Subroutines. Programming language as a tool for logic development.

Course: General Chemistry
Class hours: 160 horas
Syllabus: Scientific Method; Magnetic Properties; Electronic Distribution; Ionic Bond; Metallic Bond; Molecular Orbitals; Band Theory; Semiconductors; Insulators; Physical-Chemical Properties; Covalent Bond; Lewis Theory; Molecular Geometry (VSEPR); Polarity; Intermolecular Forces; Ideal Gas Model; Real Gas Model (van der Waals); Compressibility Factor; Thermodynamics; Enthalpy, Entropy; Free Energy; Spontaneity; The Study of Chemical Reactions; Equilibria; Chemical Kinetics; Redox Reactions; Electrolysis; Electrochemical Cells; Corrosion.

Course: Engineering Fundamentals
Class hours: 160 horas
Syllabus: Fundamental dimensions. Significant figures. Dimensional analysis. Homogeneity of equations. Systems of units and conversions. Physical measurements and treatment of experimental data. Electronic spreadsheets. Tables and graphs. Curve fittings, linear and non-linear models. Linearization. Trusses, machines and gantries. Optimization. Making prototypes. Oral, written and graphic communication.

Course: Projects and Special Activities I
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

SECOND YEAR

Course: Differential and Integral Calculus II
Class hours: 80
Syllabus: Partial derivatives: Tangent plane, normal straight. Differentiability. Chain rule and implicit differentiation. Directional derivative and gradient vector. Maximum and minimum values and Lagrange multipliers. Double integrals: definition, properties, polar coordinates and applications. Triple integrals: definition, cylindrical and spherical coordinates and applications. Variable changes in multiple integrals. Vector calculation: vector fields, conservative fields, line integrals, Green's theorem, rotational and divergent operators, surface integrals, Stokes¿s theorem and Gauss¿s theorem.

Course: Computational Mathematics
Class hours: 80
Syllabus: Computer arithmetic / Errors: Type and Propagation / Taylor Series; Matrices and Matrix Operations / Introduction to Linear Systems / Direct Method (Gaussian Elimination) / Iterative methods (Jacobi and Gauss-Seidel) / Stopping and Convergence Criteria / Notions on Conditioning; Algebraic and Transcendent equations / Bisection Method / Newton Method; Approximation of functions / Interpolation / Linear and Polynomial Fit / Transformations / Determination Coefficient; Numerical Integration (Trapezoidal Rule, First and Second Simpson Rules); Solution of Ordinary Differential Equations / Numerical Solution (Euler and Runge-Kutta Methods) / Notions of Stability of the Solution / Errors / Solution of Higher Order Ordinary Differential Equations as a System of First Order Ordinary Differential Equations; Notions of Partial Differential Equations.

Course: Mechanics
Class hours: 80
Syllabus: Frenet frame (Moving Trihedron). Rigid Bodies Kinematics: velocity and acceleration fields, moving reference frames. Rigid Bodies Dynamics: mass distribution, center of mass theorem, angular momentum and angular momentum theorem, kinetic energy and kinetic energy theorem.

Course: Physics II
Class hours: 160
Syllabus: THEORY: Electromagnetic interaction. Electric Field. Gauss´s Law. Electric potential. Eletrostactic energy. Electric current. Magnetic induction. Biot-Savart´s Law. Ampere´s Law. Faraday´s Law. Periodic and oscillatory motions. Simple harmonic motion. Physical concepts of forced oscillations, resonance and damped oscillations. Mechanical waves. Energy propagation. Standing waves. Maxwell´s equations. LABORATORY: D.C. generator. Eletric Field.Filiform conductors. Capacitors. Oscillatory motion. Biot-Savart´s Law. Earth Magnetic Field. Faraday´s Law. Photoelectric effect. Diffraction.

Course: Mechanical Construction Materials I
Class hours: 80
Syllabus: Materials science. Metal alloys. Equilibrium diagrams. Introduction to mechanical construction steels. Fe-C equilibrium diagram. TTT diagrams. Cast Iron. Aluminum alloys. Copper alloys. Ceramics. Polymers. Processing, degradation and recycling of polymers. LAB: Study and realization of the main mechanical tests: tensile, hardness, impact. Penetrant and magnetic particles. Metallography of steels and aluminum. Fatigue test. Mechanical tests polymers.

Course: Electricity
Class hours: 80
Syllabus: Electricity fundamentals. Electric circuits direct current and alternating current. Electric power in alternating current and power factor. Notions of logical expressions. Project using contact logic.

Course: Thermal Sciences I
Class hours: 80
Syllabus: Introduction to Thermal Systems. Thermodynamics: concepts and definitions. Properties of Pure Substances. The First and Second Laws of Thermodynamics for Systems and Control Volumes.

Course: Introduction to Production Engineering
Class hours: 80
Syllabus: Introduction to Production Engineering (Operations management) applied to large, medium and small companies. Production operations types. Production strategies. The five production objectives. Process design. Lay out and process flow. Operations procedures, time and methods. Enterprise Resource Planning (ERP): basic concepts. Technical improvement of iroduction. Case studies.

Course: Information Systems I
Class hours: 80
Syllabus: Basic notions of Information System. Database systems: modeling, normalization and implementation of databases using the MySQL and Access database management system. Basics of the SQL language. ERP systems, basic concepts and module overview. Study and application of ERP in the company's main business processes: sales, purchasing, production planning, finance and accounting. Practice with ERP Odoo. Basic modeling in ERP for a small business.

Course: Strength of Materials
Class hours: 80
Syllabus: Statics applied to Strength of Materials. Trusses. Geometrical properties of a cross section. Internal forces and moments Diagrams. Axial load. Thermal stress. Pure shear stress: riveted and welded joints. Torsion of bars with circular and non-circular cross section. Stresses in symmetrical and unsymmetrical bending. Bending deformation of straight beams of constant and variable cross section. Buckling of columns. Stress transformation. Combined loadings.

Course: Special Projects and Activities II
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Production Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

THIRD YEAR

Course: Operations Research I - Deterministic models
Class hours: 160

Syllabus: What is Operations Research. Linear Programming Problem Formulation.Linear Programming Problem Solving.Sensitivity Analysis. Duality. Data Envelopment Analysis (DEA). Network Models.Transportation, Transshipment and Assignment Problems. Integer Programming Problem Formulation. Branch-and-Bound Algorithm. Deterministic Dynamic Programming. Nonlinear Programming. AHP Technique. Operations Research Applications.

Course: Probability and Statistics for Production Engineering
Class hours: 160
Syllabus: Type of variables and data description: data sampling concepts and experimental data treatment. Results interpretation and presentation of results (tabular and visual representations). Basic concepts of probability: axioms, conditional probability, independence of events. Total probability law and Bayes' theorem. Random variables and discrete distributions: Discrete uniform, Triangular, Bernoulli, Binomial, Poisson, Geometric and Hypergeometric. Random variables and continuous distributions: Continuous Uniform, Exponential, Weibull, Normal, Linear combination of Gaussian variables and Log-normal. Sampling and sampling distributions: point estimation and sampling distributions of the mean and proportion. Interval estimation for a population mean, a population proportion and for the variance of a normally distributed population. Confidence interval for the difference between two population means, two population proportions and for the ratio of the variance of two normally distributed populations. Hypothesis testing: concepts and procedure; testing a single population (mean, proportion and variance). Comparison of two populations e regression. Concepts of design of exp

Course: Information Systems II
Class hours: 80
Syllabus: Information Systems concepts and classification. Information Technology Concepts. Basics of hardware, software and computer networks. Modern information systems technologies. Strategic alignment of the company using Information Technology. Use of Visual Basic for Application (VBA) for Production Engineering. VBA integration with databases.

Course: Business Economics
Class hours: 80
Syllabus: FUNDAMENTAL ECONOMIC ISSUES. MACROECONOMICS: The national accounts. Income determination. Monetary and financial economics. Inflation and unemployement. The external sector of the economy. Macroeconomic policy instruments. Analysis of macroeconomic scenarios and situations. MICROECONOMICS: Concepts of supply, demand, market and elasticities. Prices in different market structures. Game theory and competitive strategy. Production costs. ACCOUNTING COSTS: Basic concepts. Methodology: FIFO, LIFO, PMP. Direct and indirect costs. Apportionment criteria. Fixed cost, profit and contribution margin, return on investment (ROI). ECONOMIC ENGINEERING: Value of money over time. Investment appraisal. Market study, Location, Technical and Financial Aspects.

Course: Product Design and Lifecycle Management
Class hours: 160
Syllabus: Product and services concept. The importance of new products in the organization. Innovation as a key survival factor for organizations. PLM concept - Product Lifecycle Management). Perceived value. Customers need. Customers¿ needs generation. The market concept. QFD (Quality Function Deployment). New products launching. Value Analysis: concept and application. Product design. Creativity: concept and application in the development of new products. Ergonomics: application in product development. Manufacturing processes. The supply chain and product development. Manufacturing strategy and product development. After-sales service. The PLM approach, supported by the CATIA, DELMIA and ENOVIA (Dassault Systèmes) software, includes the following steps: design; specification; design and validation of technical drawings; prototype validation; manufacturing planning; maintenance of the product in the after-sales; disassembly planning and final disposal.

Course: Thermal Sciences II
Class hours: 80

Syllabus: Fluid properties. Fluid statics and manometry. Elementary fluid dynamics: Bernoulli equation. Mass conservation equation for steady state and transient regimes. Momentum and energy conservation equations for control volumes. Internal viscous flows: distributed and localized load loss; calculation of the friction factor. Heat transfer modes: conduction, convection and radiation. One-dimensional conduction in steady state regime with and without heat generation: flat, cylindrical and spherical walls. Electrical analogy. External forced convection: plates, cylinders and spheres. Internal forced convection: isothermal and constant flux case. Natural convection: vertical and horizontal plates, horizontal cylinders and spheres.

Course: System Management tools productive.
Class hours: 160
Syllabus: Productive systems: a systemic view of business. Toyota Production System TPS. Time Management as productivity tool. Productivity and kaizen: basic concepts for continuous improvement. Processes mapping. Kanban visual management. SMED Single Minute Exchange of Die. Theory of Constrains. 3P Production Preparation Process. Games.

Course: Special Projects and Activities III
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Production Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

FOURTH YEAR

Course: Operations Research II - Sthocastisc Models and Simulation
Class hours: 160
Syllabus: Decision-making in uncertainty environments. Stochastic Processes. Markov chains. Queueing theory. Simulation Definitions and Types. Simulation Modeling principles. Manual simulation. Data modeling in the simulation. Model verification and Validation. Case studies in simulation. Random number generation. Applied statistics to simulation (Probabilistic Distributions, confidence intervals, software for data analysis). Optimization in simulation. Simulation software. Monte Carlo simulation.

Course: Ergonomics
Class hours: 80
Syllabus: What is ergonomics?; Methods and techniques in ergonomics; Human body; Anthropometry, measures and applications; Occupational biomechanics, NIOSH method for calculating the recommended weight; workplace; controls and management; perception and information processing; information devices, product's ergonomics, human factors work, work organization, ergonomics applied to workplace safety; environment: lighting and colors; environment: temperature, noise and vibration; industrial and agricultural applications; services and application in daily life; prevention against Lesion of Repetitive Efforts.

Course: People Management
Class hours: 80
Syllabus: Traditional View of Human Resources. Leadership and Motivation. HR subsystems: the provision, implementation, reward, development, maintenance and monitoring. Organizational Culture. Organizational Development. Intellectual Capital and Knowledge Management. Employability, Entrepreneurship and Empresabilidade. Throughout the year students will develop their own career project: COACHING PROJECT.

Course: Quality
Class hours: 80
Syllabus: Conceptualization and Quality Indicators: in product and service projects, production and sales. Development and Management of an Organizational Quality Program. Statistical

Quality Control ¿ Capacity and Capability of a Production Process. Advanced Quality Techniques: APQP, FMEA, PPAP, IATF16949, IATF16949 Quality Audit.

Course: Methodology of Scientific and Technological Research
Class hours: 80
Syllabus: Methodology: basic concepts and implementation in professional life. Communicate appropriately in written and oral form. To do a critical views about assumptions, objectives and features of scientific and technological work, and its implications in academic and business environment. Search structure construction considering the stages: exact identification of the goal; elaboration of the project; conduction of research; interpretation of results; choose the appropriate instruments for the dissemination of the results: monograph; paper for publication; presentation in scientific and technological events; industrial application when this is the goal of the project. The main items discussed in the discipline: 1. Human knowledge; Scientific, philosophical, theological and Spontaneous; 2. Scientific research: methods and techniques; 3. Coping problems; 4. Social research methods and techniques; 5. Organization and management of research data; 6. The monograph: conceptualization and elements; 7. Scientific dissemination tools; 8. Case study.

Course: Logistics
Class hours: 80
Syllabus: Logistics decision hierarchy. Service level. Logistics costs. Transportation planning and operation. Inventory and Storage. Supply chain project. Logistic operators.

Course: Production Planning & Scheduling I
Class hours: 80
Syllabus: Production Planning, Schedulling and Control (PPSC) problem definition. Theory of Constrains. Information for PPCP. Demand forecast. Inventory deterministic and esthocastic models. Material Requirements Planning (MRP).

Course: Factory Project
Class hours: 80
Syllabus: Basic principles of plant design. Industrial types of physical arrangements. Systematic planning of industrial physical arrangement.SLP System. Analytical methodology for process flow preparation. Production process flow chart execution. Methodologies for direct resources calculation and dimensioning (raw material, equipment and manpower). From/to Chart and Graphs application. The Man/Machine Diagram. Virtual Factory application. Micro layout and jobs organization in the plant. Time and Motion (TM). TM studies applied in the plant. Plant management based on Overall Equipment Effectiveness (OEE). Methods and tools applied in the plant management.

Course: Production Systems Management
Class hours: 160
Syllabus: Basic manufacturing processes principles consumer goods (food, cosmetics, medicines, plastics, mechanical parts, among others) and application of the main KPIs in the production management. Main indicators of efficiency, effectiveness and productivity. Case studies.

Course: Special Projects and Activities IV
Class hours: 160
Syllabus: Development of competencies, skills and attitudes relevant to the formation of future Production Engineer, through electives and student-centered practical activities. Training of interpretation and analysis skills. Problem solving methodologies. Development of engineering projects. Technical visits, lectures, workshops, seminars and technological competitions. Participation In undergraduate monitoring programs, scientific projects and technological research, as well as participation in social responsibility projects.

FIFITH YEAR

Course: Business Law
Class hours: 40
Syllabus: Fundamentals of Law. Civil Law. Business Law. Trademarks and patent. Labor Law. Tax Law. Environmental Law. Consumer Law. System CONFEA/CREA.

Course: Hygiene and Work Safety
Class hours: 40
Syllabus:
Prevention; Accidents at work; Diseases of work; Notions of occupational hygiene; Specific themes; FOODS: biological agents: assessment and control measures; biosafety; security in cold rooms; AUTOMATION AND CONTROL: ionizing and non-ionizing radiation; dangerousness; ELECTRICAL: low, medium and high voltage, electrical and fire safety. MECHANICS: occupational vibration: evaluation and measures control; safety in machinery and equipment; safety in boilers and pressure vessels; safety in welding; PRODUCTION: ransportation safety and handling; warehousing and material handling; safety in layout; risk management; accident investigation. CHEMISTRY: chemical agents: assessment and control measures; safety in laboratories and transportation of hazardous materials; safety signage and labeling; Hazard and Operability Study - HAZOP.

Course: Intelligent Productive Systems Management
Class hours: 80
Syllabus: The future 4.0 is coming. A little bit of futurism. People´s present and future activities. The future of employment and the employment of the future. Competitiveness 4.0. Management of intelligent production systems: basic concepts. The journey towards Industry 4.0: an overview. The methodology of the Mauá Competitiveness Bureau. The ACATECH route towards Industry 4.0. Tools to support the journey towards Industry 4.0. Case studies.

Course: Production Planning & Scheduling II
Class hours: 80
Syllabus: Production Aggregated Planning. Intermittent Production Scheduling. Project Planning and Scheduling. Line Balancing. Orders Sequencing.

Course: Supply Chain Management
Class hours: 80
Syllabus: The fundamentals and strategies in managing the supply chain. The concepts, definitions and values involved along the chain supplies. A systemic view of the supply chain. A chain management supplies as competitive in the global market. The characteristics of the logistics supply chain type push (producer driven) and supply chains pull type (buyer driven). The management of inventories throughout the supply chain. Add value to the product via customer service and aggregate productivity via the company reduces costs. The means of transport. Information technology in supply chain management supplies. The results management of the supply chain. Management and governance supply chain and leading companies in the market globalized. Case studies.

Course: Industrial Projets
Class hours: 160
Syllabus: INDUSTRIAL PROJECTS: Review of Industrial Cost and Financial Mathematics. Funding sources and systems. Economic criteria for project evaluation. Effect of depreciation, amortization and interest on income tax. Working capital. Effect of income tax on industrial projects. Weighted average cost of capital and other sources of long term financing. Modeling manufacturing systems and solutions aimed at increasing productivity problems. Advanced models of production scheduling in repetitive and non-repetitive processes. Project planning and scheduling in cellular manufacturing. INTEGRATED DESIGN: Project Management: planning, control and procurement. Division of labor (WBS- Work Breakdown Structure). Simultaneous engineering. Acceleration projects. Manufacturing systems: The new and the old. Cell design manuals. Rapid tools. Integration and computerization in manufacturing operations: quality

control, preventive maintenance, production control and inventory. Integration of suppliers. Leveling, balancing and automation of manufacturing systems.

Course: Energy and Environmental Management
Class hours: 80
Syllabus: Energy: Concepts and Definitions - Energy consumption evolution. Energy crises: Causes and effects. Searching for efficiency. Sources of Energy: Renewable and Non-renewable Energy; Reserves and Resources. Energy supply vs. Development vs. Environment. Energy and economic assessment of fuel and emissions. Economic evaluation of projects in generation energy and consumption. Model of Trading Energy in Brazil. Fees and Charges for energy consumption. National energy policy and the use of energy in Brazil. Alternative forms of power: economic, environmental and energy. Environmental and resource degradation by the production and use of energy. The environmental issue: Sustainability. Panorama world for social and political issues. Control and prevention of environmental pollution. Environmental Management Systems (EMS). Environmental standards: ISO14000 series - Environmental Certification. Life Cycle Assessment: ISO14040. Environmental labeling. Cleaner Production (CP) and Clean Technologies. Pollution Prevention (P2). Ecoefficiency. Sustainability in Business.

Course: Undergraduate Thesis
Class hours: 160
Syllabus: Practical project development on Production Engineering topics according to ABEPRO areas. Text preparation following ABNT standards. Professor weekly attendance to the groups. Paper presentation at Scientific Congress.Project exposition at EUREKA (IMT event).

Course: Supervised Internship
Class Hours: 160

ELECTIVE COURSES

Course: B2B Marketing
Class Hours: 80
Syllabus: Marketing as a business, with a focus on marketing B2B. Key concepts will be approached:
- Building brands and brand perception
- Value creation: for consumers and industrial customers
- Market segmentation and positioning
- Product life cycle
- Products, services and brand management
- The marketing plan in companies and in a business plan
- Planning, research and marketing information systems
- Product and services development
- Brand and price perception
- Marketing communications: from advertising in the mass market to
relationship marketing in B2B
- Marketing planning with a focus on sustainability and prosperity

Course: Advanced Topics in Logistics.
Class Hours: 80
Syllabus: Concepts of Logistics Systems and Supply Chains. Technology and innovation in the management and operation of logistics systems. Hierarchy of logistical decisions. Service levels. Logistical costs. Transport Planning and Operation. Logistic Operators. Behavior of the logistics professional.

Course: Principles of Financial Management
Class Hours: 80
Syllabus: Efficient management of funds. Principles of Strategic Planning. Strategic planning: its role and importance in Financial Management. The Budget Business as economic and financial translation of Strategic Planning. Capital structures and cost of capital. Risk and

Return. Plans and financial management of short and long term. Financial management tools. Evaluation of financial planning: indicators of performance analysis. Processes and leverage Theory of Capital Structure. Decision making.

Note: The student may apply for enrollment in any course offered by the CEUN-IMT, as an elective to complement the required workload, provided it has the approval of the Course Coordinator.