University of Technology of Troyes

Coursework description

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SY01 - Probability

Program:

- Probability fundamentals
  - Sets, events and probabilities
  - Equiprobability and geometric probability
  - Exclusivity, condition and Independence
- Discrete and continuous variables
  - Random variable
  - Probability distribution
  - Probability mass function and density function
  - Distribution function
  - Expected value and variance
  - Moments, median and moment-generating function
  - Convolution and inequality
  - Sum of two random variables
  - Probabilistic inequalities
- Multivariate random variable
  - Couple of discrete random variables
  - Random variables vector
  - Random vector transformation
  - Gaussian random vector
  - Conditional probability distribution inequalities
- Stochastic convergence
  - Types of convergence
  - Continuity theorem
  - Monte-Carlo method

SY02 - Statistics

Program:

- Descriptive statistics
- Estimation theory
  - Sampling
  - Central-Limit theorem
  - Estimators
  - Point estimation methods
  - Interval estimation
  - Optimal estimation
- Testing
  - Hypothesis test
  - Conformity test
  - Comparison test
  - Fit test
- Analysis of variance
- Linear regression
- Logistic regression

MT01 - Analysis and Calculus I - *Mandatory*

Program:

- Logic and reasoning methods
- Structures of real and complex numbers
- Numerical functions
- Derivation
- Limited development
- Integration
- Polynomial arithmetic
- Linear differential equations

MT02 - Analysis and Calculus II - *Mandatory*

Program:

- Numerical sequences and series
- Development of series and Fourier series
- Multi-variable functions
- Multi-dimensional modelling methods and vector analysis
- Multi-dimensional integration

MT03 - Linear algebra

Program:

- Vector space and potential geometrical representation
- Linear applications and matrix representation
- Customary matrix operators
- Determinants and linear systems resolution
- Reduction of an endomorphism - diagonalization
- Euclidean spaces and quadratic forms
- Matrix tools and linear differential equation systems

MT04 - Advanced analysis

Program:

- Holomorphic functions
- Generalized integration
    - Cauchy theory
    - Residue theorem
- Functional convergence
    - Complex sequences
    - Complex series
    - Functions sequences
    - Functions series
    - Power series
    - Convergence categories
- Continuous transforms
    - Fourier transform
    - Laplace transform

NF04 - Algorithmics

Program:

- Algorithm notations and analysis
- Algorithm design and complexity
- Randomized algorithms
- Data structures
- Sorting algorithms
- Management of database structures
- Sub-problems definition and stages of resolution

MT14 - Operations research

Program:

- Linear Programming
  - Graphical and numerical solving
  - SIMPLEX method
  - SIMPLEX dual
  - SIMPLEX matrix notation
  - Sensitivity analysis
  - Modern algorithms
  - Interior point methods
- Integer Linear Programming
  - Total unimodularity
  - Exact algorithms
    - Cutting plane methods
    - Branch and bound
    - Branch and cut
  - MILP modelling techniques
  - Bottleneck optimization
  - Multi-Objective optimization
- Non-Linear Programming
  - Convexity
    - Geometric interpretation
    - Gradient and Hessian matrix methods
    - Quadratic functions
  - Optimality conditions
  - Kuhn-Tucker condition
  - NLP Algorithms
    - Newton-Raphson method
    - Cyclic coordinates method
    - Hooke & Jeeves method
    - Gradient descent method
    - Newton descent method
    - SUMT method
- Dynamic Programming
  - Optimal path problems
  - Graph and path problems translation
  - Matrix multiplication

SY15 - Computer simulation

Program:

- Modelling of discrete event systems
- Modelling of continuous systems
- Evolutionary dynamics
- Monte Carlo method
- Stochastic phenomenon
    - Descriptive laws of probability
    - Algorithms for their simulation
- Optimization methods using simulation
- Simulation software ARENA

SY18 - Modelling tools

Program:

- Stochastic Petri networks
- Stochastic processes
- Poisson process
- Markov chains
- Queueing theory
- Queueing networks
- Graph theory
- Graph algorithms

GP27 - Forecasting methods and inventory control

Program:

- Time series forecasting
    - Time series analysis
    - Linear prediction
    - Exponential smoothing model
    - Moving average models
    - Autoregressive integrated moving average models
    - Forecasting accuracy
- Valuation of stocks
- Storage policies optimization

NF02 - Computer systems

Program:

- Logic
    - Boolean algebra and circuits
    - Memory matrix
- Micro-program and micro-instructions layer
- Instruction set architecture layer
- Operating system layer
- Networks
    - Physical, linkage, and network layers
    - Protocols

CL10 - Urban mobility optimization

Program:

- Time-dependent shortest path problem
    - Modified version of Dijkstra algorithm
- Covering tour problems
- Pick-up and Delivery problems
- Car-pooling problems
- Dynamic dial-a-ride problems
- Routing problem with time windows
    - Constructive approaches
    - SPLIT algorithm
    - Dantzig-Wolfe decomposition
    - Slack method
    - Local search moves with time windows
- Clustering methods
    - Multi-depot vehicle routing problem
    - Cluster-first route-second methods
    - Route-first cluster second methods
    - Multi-layer vehicle routing problem
- Genetic programming
- Machine Learning for different types of problems
- AI and Big Data processing for traffic management

MS11 - Measurement - *Mandatory*

Program:

- Results analysis and errors measurement
- Uncertainties calculation
- Standardized presentation of a measurement
- Analysis of a periodic signal and Fourier series
- Transport of information and noise
- Measurement techniques

CL02 - Warehousing optimization

Program:

- Handling optimization
    - Queueing optimization
    - Scheduling optimization
    - Common heuristics
    - Stochastic Petri networks
- Packaging optimization
- Covering/Packing Problems
    - Classification
    - Two-dimensional bin packing
    - Two-dimensional strip packing
    - Guillotine cutting
    - Partial conflicts
    - Three-dimensional bin packing
    - Solution algorithms

CL03 - Transportation optimization

Program:

- Location problems
  - Facilities location problems
  - Covering problems
  - K-Means and K-Medians problems
  - Location-allocation problems
- Network flow problems
  - Optimal paths problems
    - Dijkstra algorithm
    - Bellman algorithm
  - Transportation problem
    - Stepping-stone algorithm
  - Transshipment problem
  - Assignment problem
  - Max-flow problem
    - Max-flow min-cut theorem
    - Ford and Fulkerson algorithm
  - Minimum-cost flow problem
- Routing problems
  - Travelling salesman problem
    - Optimal methods
    - Lower bound
    - Heuristics
    - Local search
  - Vehicle routing problem
    - Clarke and Wright heuristic
    - Gillet and Miller heuristic
    - Beasley heuristic
    - Local search

GP06 - Production management

Program:

- Classification methods
  - Pareto method
  - ABC method
- Project management
  - PERT diagram
  - Metra potential method
  - Critical path method
  - GANTT diagram
  - Scheduling optimization
- Production planning
  - MRP method
  - Job-shop scheduling problem
    - Johnson algorithm
  - Flow-shop scheduling problem
  - Open-shop scheduling problem
  - Kanban method

GE21 - Organizations and the law

Program:

- Legal institutions: French legal institutions, legal vocabulary, courts, competence
- Civil law: physical and moral personalities, civil liability
- Penal law: penal responsibility
- Employment law: hiring, discipline, layoff, contracts

GE28 - Business and commercial law

Program:

- Legal structure of organizations:
  - Partnerships (eg : SNL)
  - Joint stock company (eg: commercial partnership)
  - Mixed compagnies (eg: limited liability company)
- Legal structure of contracts related to the activities of the company (sale contracts, etc.)
- Companies in difficulty (rectification and bankruptcy)
- Legal requirements of e-business

GE31 - Accounting

Program:

- Themes covering every aspects of the daily life of a industrial or commercial company: VAT, sale and purchase invoices, depreciation, commercial drafts, disposals, provisions, income statement, balance sheet, annex, Management Information System, internal financing capacity, working capital, working capital needs

GE32 - Corporate finance

Program:

- Treasury and its short-term management
- Financial analysis and the concept of financial risk
- Profitability of a company and the impact of its investments
- Evaluation criteria for an investment project and the choice of financing
- Analyses of real practical cases of French companies in various industrial sectors

GE34 - Strategy

Program:

- Key factors for success (Michael Porter)
- The company growth phases (E. FLAMHOLZ,1991)
- Development of crisis diagnostic methods
- View of strategic reorganization tools (Mac Kinsey)

GE36 - Marketing

Program:

- Marketing steps and frameworks
- Market studies: basics, techniques, applications
- Marketing: product, price, distribution, communication.
- New marketing tools for the 21st century
- Industrial marketing

GE41 - Technology management

Program:

- Comparison of management approaches between business and engineering school: convergence and divergence
- From technology to marketing: reconcile a technology approach with a commercial and marketing approach
- Case studies: automotive area, nano technology, micro-electronics, aerospace
- Particularities with biotechnologies:
  - The different markets (health, agro food industry, industry)
  - Markets structure
  - Products (impacts on markets, innovations)
  - Ethic problems