Modelling

GA-011 - Principles of Modeling

Introduction (objectives and requirements); Methodologies of modeling; Model types; Quantities and unities; Notions of representation and physics-mathematics correspondence; General concepts of flux, constitution and state; Notions of equilibrium in physical (nature) – mathematics.

Bibliography:

Karam F., J. e Almeida, R. C., Introdução à Modelagem Matemática, Notas impressas - Pós Graduação, LNCC, 2003.
Karam F., J., Selected Notes.
C.L. Dym & E.S. Ivey - Principles of Mathematical Modeling, Academic Press, 1980.
T.L. Saaty & J.M. Alexander - Thinking with Models - Mathematical Models in Physical, Biological and Social Sciences, Pergamon Press, 1981.
R.B. Bird, W.E. Stewart & E.N. Lightfoot - Transport Phenomena, John Wiley & Sons, 1960.

GA-016 – Introduction to Molecular Biology

The cell and its organization; Structure and function of nucleic acids: DNA and RNA; DNA organization in prokaryotes and eucaryotes; DNA replication; Transcription and RNA processing; Genetic code and Translation; Regulation of gene expression; Recombinant DNA and genetic techniques; Sequencing; Amino acids proprieties, Protein structure; Structural proteins and Enzymes

Bibliography:

Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P. Molecular Biology of the cell. 4th Edition. 2002.
Cooper GM. The Cell - A Molecular Approach. 2nd Edition. Sinauer Associates, Inc. 2000.
Griffiths AJF, Miller JH, Suzuki DT, Lewontin RC and Gelbart WM. An Introduction to Genetic Analysis. 7th Edition. WH Freeman and Company. 2000.
Nelson DL, Lehninger C, Freeman WH. Lehninger Principles of Biochemistry. 4th Edition. 2004.
Lewin, B. Genes VII. Porto Alegre, Editora Artes Médicas, 2001.
Zaha, A. Biologia Molecular Básica. 4ªedição.2012
Voet, D., Voet, J.G. Bioquímica. 2006

GA-028 – Probability and Stochastic Processes

Set theory: sequences; liminf; limsup; set functions and measurability; random phenomenon; sampling space; events and probability measure; conditional probability and Bayes formula; discrete and continuous random variables and induced probability law, joint and marginal; distribution function; normal and binomial distribution; change of variables; expectation; variance; covariance and moments; independency; conditional expectation; geometry of the linear estimation problem: Kalman filter and applications to data transmission; Jensen's inequality and application to finance; Bernoulli and Poisson processes; Markov chains; Chapman-Kolmogorov formula and stationarity; law of large numbers; central-limit theorem; Chebychev's inequality; Borel-Cantelli lemma.

Bibliography:

A Second Course on Stochastic Processes - Karlin, S. e Taylor, H.M., Academic Press, New York, 1981.
Introduction to Probability Models - Ross, S.M., , 10ª, Associated Press , 2009
Introduction to Stochastic Processes - Çinlar, E, , Prentice-Hall Inc, 1975
Medida e Integração, Projeto Euclides - Fernandez, P. J, IMPA, 2002.
Probabilidade: Um Curso em Nível Intermediário, Projeto Euclides, IMPA - James, B.R., 1979.
Probability & Measure Theory - Ash, R.B. and Doléans-Dade, C., , 2ª, 2000.

GA-030 – Statistics

Probability Theory for one Random Variable; Bayes' Theorem; Discrete and Continuous Probability Distributions; Expectation, Variance and Moments; Conditional Probability; Probability theory for a Set of Random Variables; Independent variables; Law of Large Numbers; Central Limit Theorem; Covariance and correlation; Marginal Distribution and Conditional distribution; Expected value; Statistical inference; Classic and Bayesian Estimation Methods; Confidence intervals; Hypotheses Null and Alternative; Error Type I and II .; Hypothesis Tests (Parametric and Non Parametric); Parametric Estimation; Maximum Likelihood method; Method of Moments; Least Squares Method; Stochastic Processes; Poisson process; Markov chains.

Bibliography:
Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health) - , 2a edição, Ed. SpringeP. L. Meyer. Probabilidade: Aplicações à Estatística. Livros Técnicos e Científicos Editora, Rio de Janeiro, 2o edição, 1983

GA-038 – Digital Signal Processing

Signal sampling; z-Transform; discrete Fourier analysis; Fast Fourier Transform (FFT) algorithms; digital filter design; power spectrum estimation; Kalman filter; applications of digital signal processing.

Bibliography:
Digital Signal Processing - Oppenheim, A.V. e Schafer, R.W., Prentice-Hall, 1975
Digital Signal Processing: Principles, Algorithms and Applications - Proakis, J.G. e Manolakis, D.G., 3rd edition, Prentice-Hall, 1987.
Discrete-time Signal Processing - Oppenheim, A.V. e Schafer, R.W., Prentice-Hall, 1989

GA-040 - Modeling of Continuum Systems
Short introduction to vectorial and tensorial calculus, Physical meaning of grad, div, curl an Laplacian operators. Characterization of properties associated to continuum systems and length scales. Motion and Kinematics Lagrangian and Eulerian descriptions. Conservation Laws. Mass, Momentum, Energy and Electric Charge. Unified representation of the conservation laws. Applications to transport phenomena. mass, heat, electric charge and fluid percolation in porous media; Extension to multiphase systems, Appications to multiphase flows in porous media, extraction of hydrocarbons from petroleum reservoirs, population dynamics, drug transport in the human body Stationary and equilibrium processes. Constitutive laws. diffusive motion of solutes in fluids. Constitutive Laws of Fourier, Darcy and Ohm. Potential flows, Electrostatics, Linear Elasticity, convection-diffusion equations, Wave equation in solids and fluids, Electromagnetism, Maxwell equations.

Bibliography:
A Concrete Approach to Matthematical Modelling - Masterton,M., Gibhons, J. Wiley, NY, 1995
Advanced Transport - Slattery, J.
Introduction to Continuum Mechanics - Gurtin, M., Academic Press, 1981
Introduction to Fluid Dynamics – Batchelov
Mechanics ot Continuos Media – Hunter
Thinking With Models - Saaty , Thomas and Alexander, Joyce
Transport Phenomena and Materials Processing - Landau, L. and Listshitz

GA-041- Modeling Fundamentals

Basic principles and methodology of modeling; qualitative and quantitative models; Lagrangean and Eulerian reference systems; physical (phenomenological) properties; continuous and discrete systems, scale concepts. Interpretation of mathematical operators; conservation/equilibrium principles; constitutive and state equations; deterministic, probabilistic and empirical models; evolution and adequacy analysis of mathematical models. Applications: Selected problems of general physical modeling (engineering), bio-systems, social-economic systems, ecosystems, etc.

Bibliography:
A Concrete Approach to Mathematical Modeling – Masterton, M., Gibhons, J. Wiley, NY, 1995;
Mathematical Modeling Techniques – Aris, R., Dover, NY, 1978;
Advanced Transport Phenomena – Slattery, J.;
Introduction to Continuum Mechanics – Gurtin, M., Academic Press, 1981;
Introdução à Modelagem Matemática – Karam F., J. e Almeida, R. C., 2003;
Mathematical Biology – Murray, J. D., 2ed., Springer, 1993
Thinking with Models – Saaty, Thomas and Alexander, Joyce.

GA-043 - Introduction to DNA and Proteins

DNA structure. Replication. Transcription and processing. Proteins structure; Translation and the genetic code; Organization of the coding regions of DNA; DNA / RNA, prokaryotes and eukaryotes, transcription and translation; Organization of non coding DNA regions (repeats), CpG islands, genomic techniques, PCR, ESTs, BAC / YAC, cosmid, genomic libraries, DNA chips, physical maps and genetic maps; Bioinformatics techniques; brief genome sequencing history; Acquisition and preliminary data analysis, DNA sequence assembly and analysis of DNA sequences; proteins; primary, secondary, tertiary and quaternary protein struc-

tures; Protein classes and functions; DNA / protein interaction; Bioinformatics application in proteomics (analysis of primary sequence, secondary and tertiary structures); Proteomic techniques; Interactions proteins / proteins

Bibliography:
An Introduction to Genetic Analysis - Anthony J. F. Griffiths, Jeffrey H.Miller, David T. Suzuki, 7th edition, W H Freeman & Co, 2000.
Genes VII - Benjamin Lewin Hardcover, Oxford Univ Press, 1999.
Lehninger Principles of Biochemistry - David L. Nelson, Michael M.Cox Hardcover, Third Edition Worth Publishing, 2000.
Molecular Biology of the Cell - Bruce Alberts (Editor), Bray Alberts, 3rd Bk&cdr edition Garland Pub, 1999.
Molecular Cell Biology - Harvey Lodish, Arnold Berk, S. Lawrence Zipursky, Paul Matsudaira, David Baltimore, James Darnell, 4th edition W H Freeman & Co, 1999.

GA-044 – Introduction do Evolution and Biology

Biological systems. What is life? Patterns and Processes in Biology. Evolutionary processes. Natural selection as an emergent property of life. Mutation. Genetic drift. Biological standards. Origin of life. Animal diversity. Historic: Darwin, Wallace, Mendel, Wright, Fisher and Haldane. Taxonomy: goal, past classifications, Linnaean classification and phylogeny. Hennig and phylogenetic systematics. New trends (monophyletic groups, bar code). Phylogenetic analysis. UPGMA and Maximum Parsimony. Phylogenetic systematics. Three axes of comparative analysis: space, time and form (biogeography, fossil record and morphology/molecular).

Bibliography:
Evolution - Monroe Strickberger, 3ª edição, Jones & Bartlett, Londres.

GA-046 - Modeling Techniques

Phenomena; Objects and their interactions; Change; Models; Observation methods, experiments; Observations, measures and scales; Precision and accuracy; Populations, recurrence, replication and repetition; Models, context and environment; Systems; General Systems; Attributes, Variables and Parameters; Systems as scientific framing method; State of a system; Systems perspective; Organizations; Mathematical and computational contexts; R. Rosen modeling relation; Building models; Adapting, extending and combining models; Dispersion, Dissipation and Transformation; Selected modeling problems: physico-chemical, biological, socio-economic, ecological and environmental.

Bibliography:
A Concrete Approach to Matthematical Modelling - Masterton,M., Gibhons, J. Wiley, NY, 1995.
Mathematical Modelling Techniques - Aris, R., Dover, NY, 1978
Probability Models - Ross, S.M., Academic Press, 1993

GA-047 - Bioinformatics I - Biological databases

Brief history: from *Atlas* of *Protein* Sequence and Structure (*Dayhoff,* 1968) to the web servers. The variety of current information sources, types, formats, methods, sizes and distributions. The databases of DNA and RNA sequences; History of GenBank, EMBL, DDBJ, study and format of GenBank / DDBJ and EMBL; Philosophy of databases and their redundancy; Problems of quality and heterogeneity of gene/protein annotations; complete genomes; Databases of protein sequences; Definition and description; Study of some proteins databases: RIP, MIPS, SWISS-PROT, TrEMBL etc., non-redundant sequences databases; Brief discussion of other proteins databases; The databases of domains and protein families. Definition and description; Detailed study of some databases: PROSITE, Pfam, PRINTS, PIRSF and BLOCKS. Automatically generated protein domain databases: PRODOM, DOMO; InterPro. Proteomic database; Definition and description; Detailed study of the SWISS-2DPAGE. The databases of three-dimensional structures; The PDB database: History and a brief description of its content; The derived database PDB (Swiss-3DImage, HSSP, DSSP, FSSP, etc.); The NDB database; The metabolic databases; Definition and description; Study EcoCyc, KEGG, etc. The databases of functional categories; Definition and description; APIASTER, IntAct, PhosSuit, GlycoSiteDB, etc .; The biological image databases; BioImage, Global Image Database; The databases of genomes; Definition, description; Ecoli, FlyBase, DGS, etc. AceDB etc. The database of mutations and polymorphisms; Definition and description; SNP (Single Nucleotide Polymorphisms); Bibliographic databases; Detailed study of the MEDLINE / ENTREZ.

Bibliography:
Bioinformatics : A Practical Guide to the Analysis of Genes and Proteins - Andreas D. Baxevanis, B. F. Francis Ouellette, John Wiley & Sons, 2001
Bioinformatics : Databases and Systems - Stanley Letovsky (Editor), Kluwer Academic publishers, 1999
Bioinformatics : Sequence, Structure, and Databanks : A Practical Approach - Des Higgins (Editor), Willie Taylor (Editor), 1st edition, Oxford Univ Press, 2000
Introduction to Bioinformatics - Teresa K.Attwood and David J.Parry-Smith, Addison Wesley Longman, 1999

GA-050 – Introduction to the Modeling and Simulation of Physiological Systems

Historical Review, Basic Physiological Aspects of Blood Circulation: Structure of Circulatory System; Basic Characteristics of Arterial Walls; Basic Notions of Solid Mechanics: Arterial Wall Behavior (Constitutive Equations); Basic Notions of Fluid Mechanics: Blood Behavior (Constitutive Equations); Preliminary Concepts of Modeling; Introduction to Numerical Simulations: Lumped (0D) Models for the Cardiovascular System: Models of Systemic Arteries and Coupling to Left Ventricle; Closed-Loop Model; Models for Cardiac Valves; Computational Simulation using MatLab; Distributed (1D) Models for the Cardiovascular System: Conservation Laws; Pressure Pulse; Arterial Structure; Boundary Conditions; Computational Simulation using HeMoLab System.

Bibliography:
F.C. Hoppensteadt and C. S. Peskin. Modeling and Simulation in Medicine and the Life Sciences. Texts in Applied Mathematics, Springer, Second Edition, 2002
Y.C. Fung. Biomechanics. Mechanical Properties of Living Tissues. Springer-Verlag, N.Y., 1981.
Y.C. Fung. Biodynamics Circulation. Springer Verlag, 1984.

GA-051 - Biochemistry

Biochemistry fundaments. Structure and catalysis. Water, amino acids, peptides and proteins. Three-dimensional structure of proteins. Function of proteins. Enzymes. Carbohydrates and glycobiology . Nucleotides and nucleic acids. Lipids. Biological membranes and transport. Biosignals; Bioenergetics and metabolism. Principles of bioenergetics. Glycolysis, gluconeogenesis, and pentose phosphate pathway. Fundaments of metabolic regulation: glucose and glycogen. Citric acid cycle. Oxidative phosphorylation and photophosphorylation.

Bibliography:
Chemistry: An introduction to organic, inorganic & physical chemistry - Housecroft, C.E. & E.C. Constable Pearson, 3rd, Pretince Hall, 2005.
Lehninger Principles of Biochemistry - David L. Nelson, Michael M.Cox Hardcover, Third Edition Worth Publishing, 2000.
The organic chemistry of biological pathways - John E. McMurry and Tadhg Begley P., 1st, Roberts & Company Publishers, 2005.

GA-054 – Network Science

Complex networks: Introduction and motivation. Fundamentals of network theory: network representation; random walk; network metrics;centralities. Computational algorithms for network analysis: Degree;clustering; shortest-paths; search; partitioning. Network models:G(n,p) model of random networks (Erdös-Réyni); small-world model Watts-Strogatz); scale-free model (Barabási-Albert). Processes onnetworks: Resilience; diffu-sion. Dynamic and multi-layer networks: time-varying graphs; multi-layer networks; multi-aspect graphs.

Bibliography:
Dynamic Processes on Complex Networks, Alain Barrat, Marc Barthélemy
and Alessandro Vespignani, Cambridge University Press, 2008;
Network Science: Theory and Application, Ted G. Lewis, John Wiley & Sons, 2009;
Networks, Crowds, and Markets, D. Easley and J. Kleinberg, Cambridge
University Press, 2010;
Networks: An Introduction, Mark E. J. Newman, Oxford University Press, 201
Network Science, Albert-László Barabási, Cambridge University Press, 2015;
Recent papers in the area.

Mathematics

GA-008 - Introduction to Numerical Modeling

Review of mathematical concepts of limit, derivative and integral and their uses in solving scientific problems. Computer arithmetic, round-off errors, numerical stability and approximation concepts.

Bibliography:
KINCAID, David; Cheney .E.W.Numerical analysis: mathematics of scientific computing. 3rd ed Providence, R.I: American Mathematical Society, 2009 xiv,788p. (The Sally series) ISBN 9780821847886.
BURDEN, Richard L; FAIRES, J. Douglas. Análise numérica. 8 ed. São Paulo: Cengage Learning, 2009. xiii,721 p.ISBN 978-85-221-060-1.
WILLIAM E. & RICHARD C, DIPRIMA BOYCE, Equacoes Diferenciais Elementares E Problemas De Valores De Contorno, LTC EDITORA; First Edition edition (2002), ISBN-13: 978-8521613121

GA-001 – Linear Algebra

Vector spaces; Finite-dimensional vector spaces; Linear transformations; Eigenvalues and eigenvectors; Inner-product spaces; Normal matrices

Bibliography:
Álgebra Linear com Aplicações - H. Anton & C. Rorres, Décima Edição, Bookman, 2012
Álgebra Linear - E. L. Lima, Terceira Edição, IMPA, 1999
Álgebra Linear - Exercícios e Soluções - R. C. Teixeira, Terceira Edição, IMPA, 2014
Linear Algebra and Its Applications - G. Strang, Fourth Edition, Brooks Cole, 2006
Linear Algebra Done Right - S. Axler, 2 ed, Springer, 1997

GA-005 - Real Analysis

Enumerability: Concepts of Infimum and Supremum; Construction of the Real Numbers. Sequences and Infinity Series: Limit Theorems; Cauchy Theorem; Bolzano Weierstrass Theorem; Convergence Criteria. Topology in R: Characterization of Compact Subsets; Limits and Continuity of Real Functions and their relations with the Topology in R; Heine and Weirestrass Theorems. Differentiation: The Derivative; The Mean Value Theorem; Taylor's Theorem. The Riemann Integral: Riemann Integrability; Properties of The Riemann Integral; The Fundamental Theorem of Calculus; The Mean Theorem for Integrals.

Bibliography:
Introduction to Real Analysis – Robert G. Bartle, Donald R. Sherbert
Curso de Análise - Elon Lages Lima , Volume I
The Elements of Real Analysis – Robert G. Bartle

GA-007 - Functional Analysis

Banach spaces, the Hanh-Banach theorem. Strong, weak and weak start topologies. The Alaougu - Bourbaki Theorem, Reflexive Spaces. Hilbert spaces: The Lions-Stampacchia's theorem, the Lax - Milgram's Lemma. Compact operators, Riesz Fredholm theory, the Fredholm alternative. The L^p Spaces. Sobolev's Spaces. Approximations by smooth functions, the Trace Theorem.

Bibliography
Functional Analysis, Haim Brezis

GA-010 - Mathematical Methods I: Ordinary Differential Equations - Concentration in Mathematics

Existence and uniqueness of solutions; Linear differential equations; Classical solutions and Transforms; Sturm-Liouville theory; Spectral Analysis; Qualitative theory; Phase Space; Nonlinear Equations; Singularities; Stability of equations, bifurcations and chaos; Geometric theory; Vector fields, fluxes and orbits; Liapunov stability; Applications in classical, orbital and particle dynamics.

Bibliography:
From Equilibrium to Chaos: Practical Bifurcation and Stability Analysis - Seydel, R., Elsevier, 1988
Lições de Equações Diferenciais Ordinárias - Sotomayor, J., , Projeto Euclides, IMPA, 1979
Nonlinear Differential Equations and Dynamical Systems - Verhulst, F., Springer, 1997

GA-014 – Mathematical Methods III: Partial Differential Equations – Classic solutions

Functional Analysis; Banach spaces, Hilbert spaces. Sobolevs' spaces. Differential operators, symmetries and self adjoint operators. Spectral analysis. Elliptic equations. Evolutions equations: Parabolic and hyperbolic systems. Energy method. Non Linear equations. Applications to conduction and thermal difusion. Wave propagations.

Bibliography
Elliptic Partial Differential Equations of Second Order - Gilbarg, D. e Trundiger, N.S., 2ed, Springer, 1983.
Introductory Functional Analysis with Applications - Kreysig, E., John Wiley - Resnardy, M. and Rogers, 1989

GA-015 - Introduction to the Calculus of Variations

Variarional Methods, Weighted Residual Methods, Collocation Methods, Galerkin Method, Non-Homogeneous Boundary Conditions, Ritz Method, Minimum of a Functional, Minimizing Sequences, Variational Basis for the Finite Element Method, Least Square Method

Bibliography:
Calculus of Variation - Gelfand, I.M. e Fomin, S.V., Prentice-Hall, Englewood, 1963
Direct Methods in the Calculus of Variations - Dacorogna, B., Springer Verlag, Berlin, 1989
Variational Methods in Mathematical Physics - Mikhlin, S.G., Pergamon Press, NY, 1964

GA-018 - Numerical Methods

Mathematical preliminaries: errors, floating-point numbers, convergence. Polynomial interpolation and approximation. Solution of nonlinear equations. Numerical integration and differentiation. Solving systems of linear equations: direct and iterative methods. Numerical solution of ordinary differential equations. Numerical solution of partial differential equations: finite-differences.

Bibliography:
Introduction to Numerical Methods - Stark, P., Macmillan, 1970
Matrix Computations - Golub, G. e Van Loan, C., The John Hopkins University Press, 1993
Scientific Computing: An Introduction to Parallel Computing - Golub, G. e Ortega, J., Academic Press, 1993

GA-020 – Numerical Solution of Differential Equations

Ordinary differential equations. Euler's method. Multi steps methods and Runge-Kutta; Finite difference schemes: Difference operatord; Application to the Poisson equation; Finite element methods: Variational formulations; Weak forms; Ritz's Method; Galerkin method; Discretization; Approximation spaces; Kinematic formulations and Mixed methods; Discrete model for elliptic equations; Semi-discrete models for parabolic equations.

Bibliography:
Carey, G. and Oden, J., "Finite Elements" vol.I-An Introduction; vol.II-A Second Course; vol.III-Computational Aspects; vol.IV-Mathematical Aspects, Printice Hall, 1981.
Hughes, T., "The Finite Element Method: Linear Static and Dynamic Finite Element Analysis", Printice Hall, 1987.
Iserles, A., "A First Course in the Numerical Analysis of Differential Equations", Cambridge University Press, 1966.

GA-021 - Finite Element Method: Basic Theory

Continuous formulation: Variational Formulation of PDE: The Poisson Equation, Existence and Uniqueness: Lax-Milgram Theorem, Recalling the Sobolev Spaces, other Examples of Variational Formulations, Discrete Formulation: Variational Approximation, Galerkin Method, Best approach: Céa's lemma, Finite Element Method: Motivation, Definition and an 1D Example, Lagrangian Finite Element (Triangles), Notions of Reference
Element, Local and Global Approximations: Interpolation, Error Estimation: Aubin-Nitsche Lemma, Other Examples of Finite Element.

Bibliography:
Basic: Class notes,
Numerical Solution of Partial Differential Equations by the Finite Element Method, Claes Johnson, Dover Publication, 2009.

The Finite Element Method for Elliptic Problems, Philippe Ciarlet, Classics in Applied Mathematics, SIAM, 2002.
Aide-Mémoire Eléments Finis, Alexandre Ern, Dunod, 2005. (em Francês)
Advanced:
The Mathematical Theory of Finite Element Methods, Susanne Brenner and L. Ridgway Scott, Springer, 2002.
Theory and Practice of Finite Elements, Alexandre Ern and Jean-Luc Guermond, Springer, 2004

GA-032 – Linear Systems

Linear spaces; mathematical models; dynamic equations; norms of signals and systems; responses of linear systems; controllability; stabilizability; observability; detectability; duality; Kalman decomposition; realizations: minimal and canonical; stability: input-output and in the sense of Lyapunov.

Bibliography:
Linear System Theory - Rugh, W.J., 2ed., Prentice-Hall.
Linear System Theory - Chen, C.T., Holt, Rinehart and Winston, 1984

GA-034 - Optimization Methods

Definition of the general problem of nonlinear programming; Optimality conditions for problems with and without constraints; Convexity; Fundamental properties of algorithms and solutions; Linear search algorithms; Classic descent methods; Penalty and barrier methods; and Direct search methods (derivative-free methods).

Bibliography:
Nonlinear Programming, Theory and Algorithms. Bazaraa, M.S. e Shetty, C.M..
John Wiley and Sons, New York, 3th edition, 2006.
Linear and Nonlinear Programming. David G. Luenberger & Yinyu Ye.
Springer, 3th edition, 2008.
Numerical Optimization. Jorge Nocedal & Stephen J. Wright.
Springer, 2sd edition, 2006.
The Mathematics of Nonlinear Programming. Anthony L. Peressini, Francis E. Sullivan, J.J Uhj, Jr. Springer, 1993

Computing

GA–009 - Databases

The discipline covers the following topics: Conceptual Modeling, Entity Relationship Model, Unified Modeling Language, Mapping Techniques between Entity Relationship Model and Relational Model, The Relational Model, Operations on the Relational Model using Relational Algebra and Relational Calculus, Relational Database Design, Data Dependency, Normalization Theory, other Data Models: Graph, Multidimensional, Columnar, Structure Query Language, Database Physical Project, Data Layout, Data Partition, Views and Materialized Views, Index Structures, Database System Services, Database System Architecture, Database Query Processing, Transaction Management and Concurrency Control

Bibliography:
Systems Databases - A. Silberschatz et al, Terceira Edição, Pearson, 2005.

GA-013 - Introduction to Computer Programming

Basics of how compilers and computers work. Programming Fundamentals: data types, operators and expressions; control flow and loop structures; arrays and pointers; functions and abstract data types. The course is mostly taught in ANSI C, but other languages, such as FORTRAN, JAVA and PERL, can be used by the students at the laboratory as well.

Bibliography:
Schildt, H. (1997) C Completo e Total, Makron Books, ISBN: 8534605955
Kernighan, B. W.; Ritchie, D. M. (1989) C A Linguagem de programação Padrão ANSI, Campus, ISBN: 8570015860.

Rangel Netto, J. L. M.; Cerqueira, R. F. de G.; Celes Filho, W. (2004) Introdução à Estruturas de Dados, Campus, ISBN: 8535212280

GA-022 – Introduction to Multimedia Systems and Virtual Reality

Media representation, Digitization: text, audio, Image and video. Data compression: text, audio, image, video; Data compression standards; Multimedia communication; Network protocols; Local and wireless networks; Bluetooth. Media synchronization; Quality of service; Advanced Topics: Cryptography, Watermarking, Virtual Reality, Multimedia Services, On-Demand Video, Videoconferencing, Advanced multimedia systems, Collaborative Virtual Environments.

Bibliography:

Halsall, F. (2000) Multimedia Communications: Applications, Networks, Protocols, and Standards, Addison-Wesley Publishing, ISBN: 0201398184.
Bojkovic, Z. S.; Milovanovic, D. A.; Rao, K. R. & Milovanovic, D. A. (2002) Multimedia Communication Systems: Techniques, Standards, and Networks, Prentice Hall, ISBN: 013031398X.
Steinmetz, R. & Nahrstedt, K. (2002) Multimedia Fundamentals, Volume 1: Media Coding and Content Processing, 2a. Edição, Prentice Hall, ISBN 0130313998.
Effelsberg, W. & Steinmetz, R. (1999) Video Compression Techniques, dpunkt Verlag/Morgan Kaufmann Publishers, ISBN: 3920993136.
Packer, R.; Jordan, K. & Gibson, W. (2001) Multimedia: From Wagner to Virtual Reality, W.W. Norton & Company, ISBN: 0393049795.
Sayood, K. (2000) Introduction to Data Compression, 2a. Edição, Morgan Kaufmann Publishers; ISBN: 1558605584.
Jain, A. K. (1988) Fundamentals of Digital Image Processing, Prentice Hall, ISBN: 0133361659.
Chapman, N. P. & Chapman, J. (2000) Digital Multimedia, John Wiley & Sons, ISBN: 0471983861.
Soares, L.F.G.; Tucherman, L.; Casanova, M.A. & Nunes, P.R.R.L. (1992) Fundamentos de Sistemas Multimídia, VIII Escola de Computação da SBC, UFRGS.

GA-023 - Elements of Image Processing

Topics:Introduction, 2D Graphics Devices, Digital Image Representation. Linear Systems and Fourier Transform, Random Signals, Stochastic Models for Images, Estimation Theory, Entropy and Data Compression. Color Theory. Sampling and Quantization: Nyquist Frequency e Aliasing, Sampling Theorem and Reconstruction, Image Quantization. Discrete Image Transforms: Discrete Fourier Transform, Cosine and KL Transforms. Image Enhancement and Filtering. Image Observation Models and Restoration: Inverse and Wiener Filtering. Segmentation and Image Analysis

Bibliography:

Jain, A.K. - Fundamentals of Digital Image Processing, Prentice Hall Inf. and Sciences Series, 1989.
Rogers, D. F.- Procedural Elements for Computer Graphics, McGraw-Hill Int. Editions, 1985.
Rogers, D.F. e Adams, J. A. - Mathematical Elements for Computer Graphics, McGraw-Hill International Editions , 2ed, 1990.
Foley, J.D.; Dam, A.; Feiner, S.K. e Hughes, J.F. - Computer Graphics, Principles and Practice, 2ed, Addison Wesley, 1990.
[Rosenblum at al.(1994)] Scientific Visualization: Advances and Challenges, L. Rosenblum at al. (eds.), Academic Press (1994).
[Schroeder at al. (1998)] W. Schroeder, K. Martin e B. Lorensen, The Visualization Toolkit, 2ed, Prentice Hall[Schroeder at al. (2000)] W. Schroeder, K. Martin, L.S. Avila and C. C. Law, The Visualization Toolkit-User's Guide, 2000, Kitware, Inc.

GA-024 - Computer Science: Data Structures and Applications)

Elementary Data Structures: matrices, sparse matrices and their computational implementation, stacks and queues, linked lists, trees, implementation using recursive techniques; Hash Tables: direct access tables, hash functions, computational implementation and applications; Binary Search Trees: binary trees, methods for node searching, insertion and removal, computational implementation and applications; Spatial Data Structures and Graphs: octrees, k-d trees, graph concepts, depth- and breadth-first search in graphs, computational implementation; Applications: mesh generation, solution of systems of linear equations, out-of-core techniques for data analysis, graph otimization.

Bibliography:

Introduction to Algorithms - T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, MIT Press, 2009
Estruturas de dados e seus algoritmos - J. L. Szwarcfiter, L. Markenzon, Livros tecnicos e científicos, Rio de Janeiro, 1994 (Portuguese only)

External Algorithms, DIMACS: Series in Discrete Mathematics and Theoretical Computer Science - J. M. Abello, J. S. Vitter, American Mathematical Society, 1998.
The Art of Computer Programming - Fundamental Algorithms - D. E. Knuth, Third Edition, Addisson Wesley, vol. 1, 1997
The Design and analysis of spatial data structures - H. Samet, Reading Addison- Wesley, 1990

GA-025 - Computer Science: Foundations

Computing models. Logic. Recursion and computability. Mathematical, models of computation; Finite representation of infinite objects; Symbolic and "numerical" computing. Turing machines, automatons, grammars and formal languages. Decision tables; Predicate calculus and classical and non-classical; Well-ordered and induction. Total and partial recursion; Recursive and recursively enumerable logic sets; Computability, intractability and completeness. Computational complexity and algorithmic complexity; Exponential and polynomial algorithms. Parallel computing models and non-deterministic automata; PRAM's and Shared RAM's, interconnection networks; communication complexity; Models based on the orientation of objects.

Bibliography:
Dewdney, A.K. - The Turing Omnibus: 61 excursions in Computer Science, Computer Science press, Rockville, 1989.
Korfhage, R.R. - Discrete Computational Structures, 2ed, Academic Press, Orlando, 1984.
Minsky, M. - Computation: Finite Infinite Machines, Prentice-Hall, 1967.

GA-026 - Computer Science: Algorithms I

Mathematical foundations: Induction, recursion. asymptotic analysis; Ordering: insertion, selection, quicksort, mergesort, heapsort, radix sort; Search: Sequential, binary, hashing, binary tree search, balanced trees; Graphs: Minimum paths, Dijkstra's algorithm, Greedy Algorithm; Dynamic programming; Linear Algebra Equations Systems; Random Numbers.

Bibliography:
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GA-031 – Architecture, Design and Implementation of Software-Intensive Systems

Introduction: historic; basic definitions; relationship between architecture, design, and implementation of software-intensive systems; Software Architecture: notations for software architecture; architecture view models; architecture styles/patterns; Software Design: notations for software design; design patterns; Software Implementation: object-oriented programming, software components, aspect-oriented programming, concurrency-oriented programming; Examples of architecture and design application for software-intensive systems that model/simulate complex natural and artificial phenomena.

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