
Course Description

Mathematics

1- Diploma

501ر: إحصاء وحزم إحصائية

2- **M501: Statistics and Statistical Packages**

This course will use statistical packages such as SAS and MINITAB to introduce commonly used statistical methods in a non-theoretical manner. Particular topics might include summary measures, calculation of probabilities associated with various discrete and continuous distributions, confidence intervals and hypothesis testing, analysis of variance, regression, and various non-parametric methods.

501حسب: أسس نظم قواعد البيانات وتطبيقاتها

Com501: Fundamentals of Database Systems and Applications

Database Concepts and Architecture, ER model, Relational model and Algebra, SQL, Normalization, Functional dependencies, Introduction to EER, Introduction to OODBMS
(Concepts, ODL, OQL). The student will deal with database schemas as well as user rights, database manipulations and querying. PLSQL, trigger and stored procedures will be introduced as a second step. Different design tools (forms, reports, etc.) will be introduced as a third step of the course.

502ر: عمليات ماركوف

M502: Markov Processes

The Markov property. Chapman-Kolmogorov's relation, classification of Markov processes, transition probability. Transition intensity, forward and backward equations. Stationary and asymptotic distribution. Convergence of Markov chains. Birth-death processes. Absorption probabilities, absorption time. Brownian motion and diffusion. Geometric Brownian motion. Generalized Markov models. Applications of Markov chains.

502حسب: تحليل وتصميم الخوارزميات

Com502: Algorithms Analysis and Design

Review of major data structures - Basic design techniques - Divide and conquer - Greedy method -
Backtracking - Dynamic programming - Heuristics - Parallel algorithms - Analysis of algorithms - Orders of magnitude - Lower bound theory - Time and space complexity - NP-hard and NPcomplete problems - applications and examples - Correctness of algorithms - Structure of algorithms.

503ر: عمليات عشوائية

M503: Stochastic processes

Conditional probability and conditional expectation, generating functions. Branching processes and random walk. Markov chains, transition matrices, classification of states, ergodic theorem, examples. Birth and death processes, queueing theory.

Com503: Digital Image Processing and Analysis **503حسب: معالجة وتحليل الصور الرقمية**

Introduction; Image Sensing and Acquisition; Some Basic Gray Level Transformations for Image Enhancement.; Image Contrast Enhancement Using Histogram Processing; Image Smoothing Using Spatial Filters; Image Sharpening Using Spatial Filters; Point, Line and Edge Detection; Basic Global and Adaptive Thresholding for Image Segmentation; Optimal Global and Adaptive Thresholding for Image Segmentation; Region-Based Image Segmentation and Edge-Based Segmentation; Image Restoration in the Presence of Noise-Spatial Filtering; Image Enhancement in Frequency Domain; Objects Representation and Description; Object Recognition.

M504: Statistics and Reliability **504 ر: الإحصاء و الموثوقية**

Principal methods of reliability analysis, including fault tree and reliability block diagrams; Failure Mode and Effects Analysis (FMEA); event tree construction and evaluation; reliability data collection and analysis; methods of modeling systems for reliability analysis. Focus on problems related to process industries, fossil-fueled power plant availability.

Com 504: Artificial Intelligence **504حسب: الذكاء الاصطناعي**

Introduction to AI problem solving - Knowledge representation - Automatic theorem proving - Learning by example - Learning by analogy - Learning by discovery - Self-reference and Selfproduction - Reasoning: causal reasoning - commonsense reasoning - default reasoning - measurebased approaches - reasoning with uncertainty - Confirmation theory - Belief theory - Necessity and possibility theory - Theory of endorsements - Spatial and temporal reasoning.

M505: Logic In Computer Science **505ر: المنطق في علوم الحاسب**

Introduction to computational logic, covering in depth the topics of syntax, semantics, decision procedures, formal systems, and definability for both propositional and first-order logic. The material is taught from a computer science perspective, with an emphasis on algorithms and computational complexity. The goal is to prepare the students for using logic as a formal tool in computer science.

M506: Operations research **506ر: بحوث عمليات**

Linear programming, Transportation, Assignment, and CPM/ MSPT techniques. Analytic techniques and computer packages will be used to solve problems facing business managers in decision environments.

M507: Numerical Analysis **507ر: تحليل عددي**

Series expansions: from calculus to computation. Integrals as sums and derivatives as differences. Interpolation, splines, and a second look at numerical calculus. Numerical methods for ODE, initialvalue problems. Root finding, Newton's method, boundary-value problems. Fourier transform, Fourier series, Shannon sampling theory. Bandlimited interpolation, spectral methods. Leastsquares approximation. Principal component analysis.

M508: Biomathematics **508ر: الرياضيات الحيوية**

Single species population dynamics: Models in discrete and continuous time: basic reproductive number, compensatory and depensatory competition, transcritical, tangent and period doubling bifurcations. Harvesting:maximum sustainable yield, yield effort curves. Population dynamics of interacting species: host parasitoid interactions: Nicholson Bailey mode, Jury conditions and Naimark-Sacker bifurcations. Predator prey models: Lotka Volterra model, phase plane analysis, Routh - Hurwitz conditions, Poincare - Bendixon theore. Infectious diseases: SIS epidemic models: basic reproductive number, threshold theorem. SIR epidemic and endemic models: threshold criterion, size of the epidemic. Vector borne diseases and sexually transmitted diseases.

M509: Sampling Theory **509ر: نظرية العينات**

Experiments and surveys, steps in planning a survey; randomization approach to sampling and estimation, sampling distribution of estimator, expected values, variances, generalization of probability sampling; prediction approach, inadequacies of approach, decomposition of population total, concomitant variables; regression through the origin, estimation by least squares, ratio estimation, variance formulae; balance and robustness; best fit sample; stratified sampling, estimation, allocation, construction of strata, stratification on size variables, post-stratification; twostage sampling, estimation, allocation, cluster sampling.

M508: Design and Analysis of Experiments **510ر: تصميم وتحليل التجارب**

This course is intended to acquaint students with such standard designs as one-way, two-way, and higher-way layouts, Latin-square and orthogonal Latin-square designs, BIB designs, Youdeen square designs, random effects and mixed effect models, nested designs, and split-plot designs.

M511: Estimation Theory and Hypothesis tests **511ر: نظرية التقدير واختبارات الفروض**

Methods of estimation (unbiasedness, equivariance, maximum likelihood, Bayesian, minimax), optimality properties of estimators, hypothesis testing, uniformly most powerful tests, unbiased tests, invariant tests, relationship between confidence regions and tests, large sample properties of tests and estimators, sequential methods, nonparametric regression, Bootstrap method.

M510: Statistical Inference **512ر: الاستدلال الاحصائى**

Point and interval estimation; methods of estimation including methods of moments, maximum likelihood and least squares method; hypothesis testing; simple and multiple linear regression; and one-factor and two-factor ANOVA. Some statistical packages such as SAS or MINITAB will be used extensively throughout the course.

M513: Nonparametric statistics **513ر: الإحصاء الغير بارامترى**

Computationally-based methods for exploring and drawing inferences from data. Resampling methods, nonparametric density estimation, nonparametric regression and classification. Specifically covers: bootstrap, Kernel methods, splines, local regression, orthogonal series estimators, minimax theory, Wavelets, VC Theory, support vector machines.

M512: Environmental Modeling **514ر: النمذجة البيئية**

The emphasis of this course will be on the application and development of models in the context of terrestrial ecosystems. The concepts of model development, model calibration, uncertainty analysis and validation will be introduced through lectures and practical classes.

M515: Time Series **515ر: السلاسل الزمنية**

Modeling univariate time series data with Autoregressive and Moving Average Models. Tools for model identification, model estimation, and assessment of the suitability of the model. Using a model for forecasting and determine prediction intervals for forecasts. Smoothing methods and trend/seasonal decomposition methods. Smoothing methods include moving averages, exponential smoothing, and Lowess smoothers. Relationships between time series variables, cross correlation, lagged regression models. Intervention Analysis. Longitudinal Analysis and Repeated Measures Models for comparing treatments when the response is a time series.Vector Autoregressive Models for Multivariate Time Series.

M514: Theory of Elasticity and its application **516ر: نظرية المرونة وتطبيقاتها**

Algebra of cartesian tensors, Theory of stress, Navier equations, Theory of strain, Strain deviator, Compatibility conditions, (Strain-Stress relations), Newtonian and non-Newtonian fluid, General equations of theory of elasticity, Solution of some elasticity problems, Biharmonic function.

M517: ANOVA **517ر: تحليل التباين**

Least-squares estimators and their properties. Linear models with general covariance. Multivariate normal and chi-squared distributions; quadratic forms. General linear hypothesis: F-test and t-test. Prediction and confidence intervals. Transformations and residual plot. Balanced designs.

M516: Mathematical logic **518ر: المنطق الرياضي**

This is a course in mathematical logic that will introduce important aspects of the first-order predicate logic (and its extensions), set theory, and recursion. First-order predicate logic is the most powerful system of deductive inference that is provably complete. The extensions of first order logic include axiom systems formulated within it, such as the Peano Axioms for the natural numbers. A number of important facts have been proven about first-order logic and its extensions, and we will examine some of them.

M519: Applied Numerical Analysis **519ر: التحليل العددي التطبيقي**

A study and analysis of important numerical and computational methods for solving engineering and scientific problems. The course will include methods for solving linear and nonlinear equations, doing polynomial interpolation, evaluating integrals, solving ordinary and partial differential equations, and determining eigenvalues and eigenvectors or matrices. The student will be required to write and run computer programs.

M518: Applied Statistics **520ر: إحصاء تطبيقي**

Organizing and displaying data. Measures of Central tendency and measures of dispersion. Basic probability concepts. Probability distributions: Binomial - Poisson - Normal. Sampling distributions. Interval and point estimation, hypothesis testing, regression and correlation. Data analysis will be conducted using statistical software such as MINITAB, or SPSS, or Microsoft Excel.

M521: Environmental Fluid Mechanics **521ر: ميكانيكا الموائع البيئية**

Brief review of basic laws of fluid motion. Cartesian tensor convention. Scaling and approximations. Slow flows: Stokes' flow past a particle. Oseen's improvement for a cylinder. Spreading and gravity current on a slope. Selective withdrawal from a stratfied fluid. Boundary layers in high speed flows: Jets. Thermal plumes in pure fluids and in porous media.Similarity method of solution.Transient boundary layers.Buoyancy driven convection in porous media.Dispersion in steady or oscillatory flows.Introduction to hydrodynamic instability.Linearized analysis of Kelvin-Helmholtz instability.Effects of shear and stratifcation. Geophysical fluid dynamics of coastal waters.Effects of earth rotation on coastal flows.

M523: Statistical Analysis **523ر: تحليل احصائي**

Sampling, estimation, hypothesis testing, linear regression, analysis of variance, categorical data analysis, and nonparametric statistics.

M525: Rough Sets **525ر: النظرية الاستقرابية**

Theory of rough sets is a fundamental mathematical methodology for modeling classification or decision problems involving imprecise or uncertain information. Its implications include pattern classification, data mining, machine learning, control algorithm acquisition from data, circuit design and others. The course will provide the basics of methodology and will include the study of the above applications of rough sets.

M527: Differential Equations and Their Applications **527ر: المعادلات التفاضلية وتطبيقاتها**

Existence and uniqueness theorem. Autonomous and non- Autonomous Differential Equations and systems. Solving Differential Equations by Laplace transform. Differential Equations with piecewise continuous coefficients. Solving integro-Differential Equations. Applications on linear and non-linear Differential Equations.

M529: Topology and its Applications **529ر: التوبولوجى وتطبيقاته**

Partially ordered relations, totally partially ordered relations. Complete and distributive lattices, closure operators and compact lattices. Equivalence and congruence relations, direct product and isomorphism theorem.

2- Master

M601: Algebra	**601ر: جبر**
Sylow theorems, composition series, nilpotent groups, solvability of groups, super solvability of groups, Galois theorems.	
M602: Functional analysis	**602 ر: تحليل دالي**
Basic Principles of Functional Analysis (review). Locally convex spaces. The Krein-Milman theorem. Weak topologies. The Banach-Alaoglú theorem . Weak convergence and compactness. Geometry and structure of Banach spaces. Banach algebras. Series and summability in Banach spaces.	
M603: Theory of Differential and Integral Equations	**603ر: نظرية المعادلات التفاضلية والتكاملية**
Rigorous existence and uniqueness theory; qualitative theory of systems of ordinary differential equations including Poincaré and Liapunov stability; periodic orbits; Poincaré-Bendixson theory; bifurcations; stable, unstable and centre manifold theorems. Additional topics may include: averaging and perturbation methods, chaos, Melnikov method, Hamiltonian systems. Volterra and Fredholm equations, Fredholm theory, the Hilbert-Schmidt theorem; Wiener-Hopf Method; Wiener-Hopf Method and partial differential equations; the Hilbert Problem and singular integral equations of Cauchy type; inverse scattering transform.	
M604: Topology	**604ر: توبولوجي**
Fiber bundles. Homology with local coefficients. Fibration and cofibrations. Homotopy and relative homotopy groups. Obstruction theory. Bordism. Spectral Sequences. Group homology.	
M605: Numerical Analysis	**605ر: تحليل عددي**
State-of-the-art algorithms for solving ordinary differential equations, nonlinear systems, and optimization problems. Moreover, the analysis of these algorithms and their efficient implementation will be discussed in some detail.	
M606: Mathematical Logic	**606 ر منطق رياضي**
Elements of logic, systems of Quantifiers, statements, composition of statements, Algebraic properties of normal logic operations, semigroups, Algebraic methods of proofs.	
M607: Complex Analysis	**607ر: تحليل مركب**
Examples of conformal mappings. Schwarz reflection principle. Univalent functions. Spaces of Analytic functions. Riemann mapping theorem. Infinite products and Weierstrass factorisation theorem. Gamma function, Riemann Zeta function, prime number theorem. Elliptic functions.	
M608: Real Analysis	**608ر: تحليل حقيقي**

The Radon-Nikodym theorem, Radon measure on locally compact spaces and Riesz' representation theorem. Applications to Fourier analysis and probability theory: Heisenberg's inequality, the Prime Number Theorem, ergodic theory. Hausdorff measures.

M609: Differential Geometry **609ر: هندسة تفاضلية**

Vector fields and integral. Curves in Euclidean space. The tangent space. Orientation. Parallel transport. Geodesics the Weingarten map curvature. Parameterized surfaces. Local equivalence. Surface area and volume. Minimal surfaces. The Gauss – Bonnet Theorem.

M610: Nonlinear Dynamical Systems **610ر: الأنظمة الديناميكية غير الخطية**

Nonlinear ordinary differential equations; planar autonomous systems; fundamental theory: Picard iteration, contraction mapping theorem, and Bellman-Gronwall lemma; stability of equilibria by Lyapunov's first and second methods; feedback linearization; and application to nonlinear circuits and control systems.

M611: Operations Research **611ر: بحوث عمليات**

Linear Programming, Primal-Dual Methods, The Central Path, Mehrota's Predictor-Corrector Algorithm, Karmarkar's Algorithm, Primal-Dual Methods: Development of the Fundamental Ideas, Complexity Theory, Primal-Dual Potential-Reduction Algorithm, Path-Following Algorithms: Predictor-Corrector Method, Infeasible-Interior-Point Algorithms, Superlinear Convergence and Finite Termination.

M612: Statistics and Reliability **612ر: الإحصاء والموثوقية**

The reliability assessment of mechanical/electrical components, as well as simple structures and redundant systems. The course also considers elements of statistics; Bayesian methods in engineering; methods for reliability and risk assessment of complex systems (event-tree and faulttree analysis, common-cause failures, human reliability models); uncertainty propagation in complex systems (Monte Carlo methods, Latin Hypercube Sampling); and an introduction to Markov models. Examples and applications are drawn from nuclear and other industries, waste repositories, and mechanical systems.

M613: Analytical Mechanics **613ر: ميكانيكا تحليلية**

Theory of rotating axes, Motion of particle on a twisted curve, Motion of rigid body, Euler's equation of motion (Lagrange-Poisson's case), generalized coordinates, D'alembert's principle (Non harmonic systems).

M614: Theory of Elasticity and Material Science **614ر: نظرية المرونة وعلم المواد**

Algebra of cartesian tensors, Theory of stress, Navier equations, Theory of strain, Strain deviator, Compatibility conditions, (Strain-Stress relations), Newtonian and non-Newtonian fluid, General equations of theory of elasticity, Solution of some elasticity problems, Biharmonic function.

M615: Quantum Mechanics **615ر: ميكانيكا الكم**

Angular momentum, Hydrogen atom, Perturbation theory, Ground state of helium, Linear vector space in quantum mechanics, The harmonic oscillator, the heizenberg

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uncertainty principle, the Schrodinger picture of quantum mechanics, The theory of scattering, Scattering by a centre of force.

M616: General Relativity — **616ر: النسبية العامة**

Tensor Calculus, Covariant differentiation, Geodesic, Riemann space, The principle of equivalent, Red shift of spectral lines, Curvature tensor, Riemann Christoffel tensor, Ricci tensor, Spherically symmetrical metric.

M617: Mechanics of Continuous Media — **617ر: ميكانيكا الأجسام المتصلة**

Equation of continuity, Reynolds theorem, Law of conservative mass and conservative momentum, Stocks and non-newtonian fluid dynamics. Equation of energy and Bernoulli theorem, Navier stocks equation, The physical components, The three fundamental types of the surfaces and relation between them. The equation of plane surface, cylindrical surfaces and spherical surfaces.

M618: Mechanics of a Rigid Body — **618ر: ميكانيكا الجسم الجاسئ**

Motion of a rigid body in space, the equation of motion of a rigid body in the space, Hamilton equations, Hamilton-Jacob's equations, the equation of the motion of the rigid body rotates about a fixed point General motion of a rigid body, Euler's angles Solution of Euler's equation, Gyroscopic precession, Lagrange's equations, Generalized dynamical system.

M619: Electrodynamics — **619ر: الكتروديناميكا**

Basic concepts of Electromagnetic field, Steady currents, Magnetic effects of current, Rapidly varying fields, Maxwell's equations, Electromagnetic waves, Radiation.

M620: Partial Differential Equations and Solitions — **620ر: معادلات تفاضلية جزئية والسوليتونات**

The focus of the course is the concepts and techniques for solving the partial differential equations (PDE) that permeate various scientific disciplines. The emphasis is on nonlinear PDE. Applications include problems from fluid dynamics, electrical and mechanical engineering, materials science, quantum mechanics.

M621: Electromagnetic Theory — **621ر: نظرية المجالات الكهرومغناطيسية**

Maxwell's equations, EM Potentials, Equations of motion of particles in electromagnetic fields, Green's functions, Lienard-Weichert potentials, Spectral distribution of electromagnetic energy from an arbitrary moving charge.

M622: Systems Stability and Control of Mechanical — **622ر: الاستقرار والتحكم فى الأنظمة الميكانيكا**

Existence, Uniqueness and stability theory, initial-value problems, numerical solutions (one step methods, polynomial interpolation, multistep methods, stability and instability and siff equations), boundary value problem, A Diffusion problem, the finite difference method for linear problem, solution of linear equations.

M623: Regression Analysis — **623ر: تحليل الانحدار**

Simple linear regression, Multiple linear regression, Model adequacy checking, Transformation to correct model inadequacies, Generalized least squares, Leverage and influential points diagnostics, Polynomial regression models, Dummy variable

models, Variable selection and model building, Logistic regression model, Poisson regression model, Generalized linear model.

M624: Statistical mechanics **624ر: ميكانيكا إحصائية**

What is statistical mechanics, Distribution law, Indistinguishable particle, Statistical mechanics and thermodynamic laws, Applications of Maxwell-Boltzman statistics, Paramagnetic system, Applications of Fermi-Dirac statistics, Applications of Bose-Einstein statistics.

M625: Advanced Stochastic Processes **625ر: عمليات عشوائية متقدمة**

Analysis and modeling of stochastic processes. Measure theoretic probability, martingales, filtration, and stopping theorems, elements of large deviations theory, Brownian motion and reflected Brownian motion, stochastic integration and Ito calculus and functional limit theorems. In addition, the class will go over some applications to finance theory, insurance, queueing and inventory models.

M626: ANOVA **626ر: تحليل التباين**

Least-squares estimators and their properties. Linear models with general covariance. Multivariate normal and chi-squared distributions; quadratic forms. General linear hypothesis: F-test and t-test. Prediction and confidence intervals. Transformations and residual plot. Balanced designs.

M627: Time Series **627ر السلاسل الزمنية**

Vector autoregression models, vector error correction models, state-space models, dynamic factor models, controversies in the use of error correction models, count time series, change-point models, dynamic conditional correlation models, and forecast evaluation.

M628: Reliability and Life Testing **628ر: الموثوقية واختبارات الحياة**

Reliability concepts and measures, Components and systems, Coherent systems, Cuts and Paths, Modular decomposition, Bounds on system reliability; Life distributions, Survival functions,
Hazard rate, Residual life time, Mean residual life function, common life distributions, Proportional Hazard models; Notions of aging, Aging properties of common life distributions, closure under formation of coherent structures, Convolutions and mixture of these cases; Univariate and bivariate shock models, Notions of bivariate and mulvariate and dependence; Maintainance and replacement policies, Availability of repairable systems, Optimization of system reliability with redundancy.

M629: Advanced Sampling Theory **629ر: نظرية العينات المتقدمة**

Simple Random Sampling. Probability Proportional to Size and with Replacement (PPSWR) Sampling. Probability Proportional to Size and Without Replacement (PPSWOR) Sampling. MultiPhase Sampling. Systematic Sampling. Stratified and Post-Stratified Sampling. Non-Overlapping, Overlapping, Post, and Adaptive Cluster Sampling. Multi-Stage, Successive, and Re-Sampling Strategies.

Randomized Response Sampling: Tools For Social Surveys. Non-Response and Its Treatments.

M630: Advanced Estimation Theory **630ر: نظرية التقدير المتقدمة**

Linear and nonlinear models, dynamics, and phenomenon. Optimal filters and predictors. Kalmanbased filtering. Robust estimation and filtering strategies. Nonlinear applications.

M631: Nonparametric statistics **631ر: الإحصاء الغير بارامترى**

Teaches modern, computationally-based methods for exploring and drawing inferences from data. The course covers resampling methods, nonparametric density estimation, nonparametric regression and classification. Specifically covers: bootstrap, Kernel methods, splines, local regression, orthogonal series estimators, minimax theory, Wavelets, VC Theory, support vector machines.

M632: Logistic Regression **632ر: الانحدار اللوجيستى**

Odds ratios as a means of comparing binary outcomes between two groups. How logistic regression allows for other factors within this comparison. The basics of logistic regression. Model selection and goodness-of-fit with applied examples. Interpretation of SPSS output. Discussion of extension to the analysis of nominal and ordinal outcomes.

M633: Statistical Inference **633ر: الاستدلال الإحصائي**

This course will examine various statistical methods and applications such as point and interval estimation; methods of estimation including methods of moments, maximum likelihood and least squares method; hypothesis testing; simple and multiple linear regression; and one-factor and twofactor ANOVA. Some statistical packages such as SAS or MINITAB will be used extensively throughout the course.

M634: Order Statistics **634ر: الإحصاءات المرتبة**

Basic Distribution Theory. Discrete Order Statistics. Order Statistics from Some Specific Distributions. Moment Relations, Bounds, and Approximations. Characterizations Using Order Statistics. Order Statistics in Statistical Inference. Asymptotic Theory.

M636: Queuing Theory **636ر: نظرية الطوابير**

Modeling and analysis of queueing systems, with applications in communications, manufacturing, computers, call centers, service industries and transportation. Topics include birth-death processes and simple Markovian queues, networks of queues and product form networks, single and multiserver queues, multi-class queueing networks, fluid models, adversarial queueing networks, heavytraffic theory and diffusion approximations.
