Kingdom of Saudi Arabia
Ministry of Higher Education
King Saud University

Department of Statistics & Operations Research
College of Sciences

Department Handbook

1430/1431 H

Contents

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For more information about the Department, and to look at the home pages of faculty members, please visit the Department website
http://sciences.ksu.edu.sa/en/statestics

About the Department

The statistic department was founded in 1399 AH after it was part of the Mathematics Department since the founding of the Sciences College in 1378AH.

The department has evolved rapidly during the few years since its foundation where it began offering a Masters in Statistics in 1400AH also a significant increase in the number of students especially after the opening of the operations research specialty in 1406 AH. The female department was opened in 1408 AH as a supportive to serve other departments in college of Science but a Bachelor degree is not granted. The department now gives masters and doctorate degree in its two branches: statistics and operations research (in male and female sections).

The department provides services inside and outside the University; it offers courses in Statistics for students in Science College and other students in different departments such as engineering (for male only), computers, agriculture, social studies, medicine, applied medical science, dentistry and pharmacy. Also, department provides statistical advice to applied research projects within and outside the university, both in designing the research or in data analysis and interpretation of results. The department also provides through the branch of operations research, advice on programming and project planning and scheduling production and optimal use of resources of all kinds.

Department location, human recourses and financial capability

The Department of Statistics and Operations Research (male department) has two locations in college of Science building (4), one in the ground floor in front of the stairs (4), which includes offices of faculty members, halls and computer laboratories that accommodate a multitude of computers to facilitate the research needs and training students and teaching purposes, and to meet the needs of research projects for final year students and graduate students. The second location is on the second floor next to the Department of Physics and Astronomy and it includes department presidency and offices of faculty members and teaching assistants and the department library.

The department now includes 10 professors, 10 associate professors, 8 assistant professors and 16 lecturers and technicians and research assistants altogether. It is worth mentioning that more faculty members involved in the review and arbitration research presented for publication in scientific journals, some also involved in the deployment of a number of international journals. The number of books published in both Arabic and English to the faculty member's account for more than 50 books.

As for the students branch it shall hold the Department of Statistics and Operations Research at one site, which is based on building (9) in Faculty of Science – Malaz. The site includes the offices of members of faculty, classrooms, and three computer laboratories to accommodate a multitude of computers and

high-tech devices used for teaching purposes, the workshops to serve the rest of the posts in the Faculty of Science, and a dedicated lab to scientific research and graduate students. In addition department library includes a number of books and magazines.

In the female department, there is one professor, five assistant professors, and thirteen lecturers and researchers.

Vision

Leadership in the fields of Statistics and Operations Research for an effective and influential role in the developments and the culture of decision-making.

Mission

Fulfill the needs of society in the fields of Statistics and Operations Research by providing quality and effective educational programs. Also, to achieve the ambitions of development plans of the society, with continued efforts of improving these programs and to maintain the quality of the scientific research.

Objectives

The mission of the Department of Statistics and Operations Research in the context of the overall objectives of the Faculty of Science is to do the following:
Preparation of qualified cadres to participate in the service of comprehensively developing the development witnessed by the Kingdom in various fields, through:

1- Meet the needs of the labor market and to contribute to the developments witnessed by the Kingdom in all areas.
2- Keep abreast of global scientific issues and strengthen the relationship with government institutions and the private sector.
3- Shape the graduate programs to attract distinguished students for both applied and theoretical fields.
4- The delivery of training and consultation in the areas of statistics and operations research for public and private institutions.
5- Contribute in building the Arabic library through writing Arabic books and translating the popular and useful books in the Arabic language.
6- Contribution in scientific research, and devote them through innovative, hosting and participation in international conferences.
7- Achieve internal and external accreditation for the academic programs in the department.

Nature of the curriculum

The Department is witnessing developments in the curriculum so that it can fulfill the functions entrusted to it, while committed and consistent to the overall goals of the College and specific objectives of the department.

The Department has great vitality, and a persistent endeavor to meet these goals. Featuring curriculum section carefully and clearly on the balance between the theoretical and practical training so that graduates are able to assume his place in the labor market so that the superior student to pursue graduate studies in his or her place in the two sides both in the Kingdom's universities or any other well known universities outside the Kingdom. This is also in order to ensure that the budget is consistent with the objectives within both the theoretical and applied. In the theoretical approaches to the allocation of census statistics are given priority for the theoretical and statistical extrapolation, and draws the decisions of the possibilities to serve as best as possible the needs of statistical theory and at the same time constitute a succinct introduction to probability theory and its applications.

On the application, this approach is keen to strike a balance between the following main headings: statistical methods in general - Experimental Design - Methods of regression - Analysis of data - statistical sampling - Mathematical Statistics and the use of computers and statistical packages in the analysis of statistical data. The curriculum is all encompassing and provides students with a myriad of decisions to assist in stochastic processes and applications, time series and applications, and applications of statistics and operations research in the industry such as quality control and demography.

Approaches in the specialty operations research started from a strong base of decisions, assistance in statistics and probability, mathematics, computer science, which a student must be studied by this specialization first to be able to continue her studies in the decisions of specialization more efficiently. The focus of operations research methods is on the following major topics: All topics and applications of mathematical programming, written and numerical programming, dynamic programming and programming objectives and methods of optimization, theory and classroom applications, methods of control and inventory control, reliability, and applications - methods of prediction - analysis of networks and their applications - game theory and its applications in addition to some other special topics.

The aim of the main topics of research and special operations are to identify to the student the theoretical underpinnings of these subjects, giving them the opportunity to learn how to address many of the problems that arise in scientific fact and provide the best solutions. It also provides an opportunity to train students in the use of computers to solve the models faced by the student during the study.

Graduates Job Opportunities

It is rare to find a ministry or department or government or private institution that does not have a Department of Statistics under different headings such as: Statistics, documentation, studies, planning, and research. Statistical working in these ministries or centers under various names, such as: functional and research department of Statistics prime, Statistician, Data Analyst specialist, in addition to the census scheme. As a graduate of operations research can be allocated to work in the planning, programming and production, distribution and control storage operations and scheduling of projects, business and regulation of telecommunications, transport and planning economic processes, military, security and resource utilization in any quarter.

Conclusion

The Department of Statistics and Operations Research as acquired through operations research of particular importance during the outstanding role played by the Statistics and Operations Research in the decision-making. The department also provides the best solutions to problems that arise in the real world and at different levels, from the optimal resolution on the system of feeding poultry on a farm and ending optimal decisions relating to all forms of planning and uses resources. And expand the functions of graduates and the nature of services they can offer to include many areas in industry, agriculture, trade and economy, transportation and military fields and all fields of planning and management.

Programs Offered by the Department

1. The department offers five programs
2. Bachelor's degree in Statistics, (For male students only)
3. Bachelor's degree in Operations Research, (For male students only)
4. Master’s degree in Statistics
5. Master’s degree in Operation Research.
6. PhD in Statistics.

A. Bachelor's Degree

The department offers the program of Bachelor's degree in statistic for boys from 1400 H, and it start offers program of B bachelor's degree in operation research for boys only from 1406 H, since then, many students

A- Bachelor's degree in Science (Statistics)

The plan of study for the Department of Statistics and Operations Research

Specialization: Statistics

Degree: Bachelor of Science

Preparatory Year (31 credit hours)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
ENG 140	English Language 1	8		
ENG 150	English Language 2	8		
MATH 140	Introduction to Mathematics	2		
MATH 150	Differential Calculus	3		
CT 140	Computer skills	3		
CI 140	Learning, Thinking and Research Skills	3		
CHS 140	Health and fitness	2		
MC150	Communication skills	2		
Total		**31**		

University requirements (8 credits hours)
A student chooses 8 credits hours from the Islamic Culture courses

Compulsory Requirements Within the Department (57 credits)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
STAT 100	Introduction to Statistics	3	MATH 150	
OPER 100	Introduction to Operations Research	4	MATH 150	STAT 100
STAT 105	Statistical Methods	4	STAT 100	
STAT 215	Probability (1)	4	STAT 100 + MATH 111	
STAT 223	Theory of Statistics (1)	3	STAT 215	
STAT 315	Probability (2)	3	STAT 215 + MATH 207	
STAT 326	Theory of Statistics (2)	3	STAT 222 + MATH 207	STAT 315
STAT 328	Statistical Packages	3	STAT 105	
STAT 333	Nonparametric Statistical Methods	3	STAT 105	
STAT 331	Sampling Techniques	3	STAT 223	
STAT 332	Regression Analysis	3	STAT 328 + MATH 244	
STAT 401	Econometrics	3	STAT 332	
STAT 436	Time Series and Forecasting	3	STAT 332	
STAT 437	Design and Analysis of Experiments	3	STAT 328	

STAT 438	Multivariate Statistical Methods	3	STAT 332	
STAT 439	Data Analysis	3	STAT 436 + STAT 438	
STAT 441	Quality Control	3	STAT 326	
STAT 497	Graduation Project (1)	1	STAT 332	Stat 436 + Stat 438
STAT 498	Graduation Project (2)	2	STAT 497	
Total		**57**		

Compulsory Requirements Outside the Department (17 credits)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
MATH 111	Integral Calculus	4	MATH 150	
MATH 207	Advanced Integral and Differential Calculus	3	MATH 111	
MATH 244	Linear Algebra	3	MATH 111	
CSC 201	Computer Programming	4		
CSC 202	Computer Programming using MATLAB	3	CSC 201	
Total		**17**		

Elective Requirements From Within the Department Group A (student selects 14 credit hours from this group)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
STAT 231	Population study "Demography"	2	STAT 100	
STAT 325	Decisions Theory	3	STAT 223	
STAT 362	Reliability Theory	3	STAT 223	
STAT 399	Longitudinal Data Analysis	3	STAT 332	
STAT 406	Survival Analysis	3	STAT 223	
STAT 431	Insurance Methods	3	STAT 326	
STAT 432	Survey Methods	2	STAT 331	
STAT 434	Linear Models	3	MATH 244	
OPER 213	Linear Programming	4	OPER 100	MATH 244
OPER 322	Inventory Control	3	OPER 213 + MATH 207	
OPER 351	Network Analysis	3	OPER 213 + CSC 202	
OPER 441	Modelling and Simulation	4	STAT 215 + CSC 201	
OPER 472	Stochastic Processes and Queues	4	OPER 213 + STAT 215	

Elective Requirements From Outside the Department Group B (student choose 9 credit hours from this group)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
MATH 160	Computational Mathematics	2	CT 140 & MATH 111	
MATH 225	Introduction to Differential Equations	4	MATH 207	
MATH 352	Numerical Analysis	4	MATH 160 & MATH 244	
MATH 382	Real Analysis I	4	MATH 207	
MGT 101	Principles of Management and Business	3		
MGT 102	Human Resources Management	3	MGT 101	
MGT 103	Entrepreneurship	3	MGT 101	
MGT 104	Principles of Public Administration	3		
MGT 319	Management of Small and Medium Size Businesses	3	MGT 101	
MGT 371	Operations Management	3	MGT 101	
MIS 201	Management Information Systems	3	MGT 101	
ACCT 201	Principles of Accounting and Financial Reporting	3		
ACCT 202	Principles of Cost Managerial Accounting	3	ACCT 201	
ACCT 311	Accounting for Government and Non-Profit Organizations	3	ACCT 201	
ACCT 317	Intermediate Accounting (1)	3	ACCT 201	
ACCT 318	Intermediate Accounting (2)	3	ACCT 317	
ECON 101	Principles of Microeconomics	3		
ECO N 102	Principles of Macroeconomics	3	ECON 101	
ECO N 201	Microeconomics Analysis	3	ECON 102	
ECON 202	Macroeconomics Analysis	3	ECON 102	
ECON 211	Money and Banking	3	ECON 102	
ECON 314	Islamic Economics	3	ECON 102	
ECON 317	Managerial Economics	3	ECON 102	
ECON 318	Transportation and Insurance Economics	3	ECON 102	
MKT 201	Principles of Marketing	3	MGT 101 & Econ 101	
FIN 200	Principles of Finance	3	ACCT 201	
FIN 210	Corporate Finance	3	FIN 200	
FIN 220	Investment Essentials	3	FIN 200	
FIN 230	Financial markets and institutions	3	FIN 200	
FIN 240	Principles of Risk & Insurance	3	FIN 200	
FIN250	International Finance	3	FIN 200	
QUA 127	Mathematics of Finance	3	MATH 140	

Study Plan

Level I		
Course Code	**Title**	**Credit Hours**
ENG 140	English Language (1)	8
MATH140	Introduction to Mathematics	2
CI 140	Learning ,Thinking and Research Skills	3
CHS 140	Health and Fitness	2
Total		**15**

Level II		
Course Code	**Title**	**Credit Hours**
ENG150	English Language (2)	8
MATH150	Differential Calculus	3
CT140	Computer Skills	3
MC150	Communication Skills	2
Total		**16**

Level III		
Course Code	**Title**	**Credit Hours**
STAT100	Introduction to Statistics	3
OPER100	Introduction to Operations Research	4
MATH111	Integral Calculus	4
	University requirement	2
	University requirement	2
	Optional decision from Group B	3
Total		**18**

Level IV		
Course Code	**Title**	**Credit Hours**
STAT105	Statistical Methods	4
CSC 201	Computer Programming	4
MATH244	Linear Algebra	3
MATH207	Advanced Integral and Differential Calculus	3
	University requirement	2
	University requirement	2
Total		**18**

Level V		
Course Code	**Title**	**Credit Hours**
CSC 202	Computer programming using MATLAB	3
STAT215	Probability(1)	4
STAT223	Theory of Statistics(1)	3
STAT328	Statistical Packages	3
	Optional decision from Group B	3
Total		**16**

Level VI		
Course Code	**Title**	**Credit Hours**
STAT315	Probability (2)	3
STAT326	Theory of Statistics (2)	3
STAT333	Nonparametric Statistical methods	3
STAT331	Sampling techniques	3
STAT332	Regression analysis	3
	Optional decision from Group B	3
Total		**18**

Level VII		
Course Code	**Title**	**Credit Hours**
STAT436	Time Series and Forecasting	3
STAT437	Design and Analysis of Experiments	3
STAT438	Multivariate Statistical Methods	3
STAT 498	Graduation Project (1)	1
	Optional from Group A	7
Total		**17**

Level VIII		
Course Code	**Title**	**Credit Hours**
439STAT	Data Analysis	3
441 STAT	Quality Control	3
499 STAT	Graduation Project (2)	2
401STAT	Econometrics	3
	Optional from Group A	7
Total		**18**

Analyzing the Statistics Curriculum					
Course Type		**Credit Hours**		**Percentage**	
Preparatory Year			31		23%
University Requirements			8		6%
Required Courses Inside Dept.	Statistics	53	57	39%	42%
	Operations Research	4		3%	
Required Courses Outside Dept.	Mathematics*	10	17	7%	12%
	Comp. Programming	7		5%	
Elective Courses Inside Dept.	Statistics and Operations Research		14		10%
Elective Courses Outside Dept.			9		7%
Total			**136**		**100%**

*** In addition to two courses given in preparatory year.**

Statistics Course Description:

Compulsory Requirements within the Department

STAT 100: Introduction to Statistics **Credit hours: 3 (2+1)**

Descriptive statistics - Measures of central tendency - Measures of dispersion - Basic probability concepts - Conditional probability - Expectation - Variance - Bayes law- Random variables - Probability distribution - Binomial distribution - Poisson distribution - Hypergeometric distribution - Normal distribution – Applications by Excel.

Prerequisite: Math 150

Co-requisite : None

OR100: Introduction to Operations Research **Credit hours: 4 (3+1)**

History and nature of Operations Research. Introduction to system analysis - Problem investigation and formulation - Linear programming models and graphical solutions - Sensitivity analysis - Transportation problem - Assignment problem. Introduction to graph theory and optimization in networks: The shortest path problem - Introduction to stochastic models in operations research.

Prerequisite: None

Co-requisite : STAT 100

STAT 105 Statistical Methods **Credit hours: 4 (3+1)**

Some Statistical distributions - Sampling distributions - Central limit theorem - Chebychev's inequality - Interval estimation - Testing hypotheses (two populations case) - Introduction to experimental designs (CRD and RBD)- Analysis of variance (one and two ways) - Regression (simple) - Correlation (Pearson and Spearman) - Chi square tests and application - Some nonparametric tests.

Prerequisite: STAT 100

Co-requisite : None

STAT 215: Probability (1) **Credit hours: 4 (3+1)**

Random variables and probability distributions (Discrete and continuous) - Famous discrete and continuous probability distributions – Random vectors - Expectation and variation - Discrete bivariate probability distributions - Marginal and conditional probability distributions - Independence - correlation and covariance - Moments and moment generating function - Distributions of Function of one and two random variable

Prerequisite: STAT 100 + MATH 111

Co-requisite : None

STAT 223: **Theory of Statistics (1)** **Credit hours: 3 (2+1)**

Sampling distributions - Central limit theorem - Point Estimation - Properties of estimator: unbiasedness - mean square error - consistency - sufficiency - minimal sufficiency - Exponential family - Uniformly Minimum Variance Unbiased Estimator - Cramer-Rao inequality - Fisher's information - Rao-Blackwell theorem - sufficiency and completeness - Lehmann-Sheffe theorem - Methods of Estimation: Method of Moments - Maximum Likelihood estimators and their properties including asymptotic properties - The Baysian Approach: Use of a prior density - Bayes estimators

- Bayes estimators with mean square error loss function - invariant methods: Location invariant and scale invariant classes of estimators - Interval estimation (one population case): Confidence interval estimators - Pivotal methods - Bayesian credible intervals

Prerequisite: STAT 215

Co-requisite : None

STAT 315: **Probability (2)** **Credit hours: 3 (2+1)**

Sequence of Events – Continuous random vector - Joint probability distribution - marginal and conditional probability functions - Conditional expectation and variation - Joint probability distributions of functions of random variables- Joint moment generating functions - Order statistics- Probability inequalities- Sequences of random variables and modes of convergences - Central limit theorem and proof - normal approximation.

Prerequisite: STAT 215 + MATH 207

Co-requisite : None

STAT 326: Theory of Statistics (2) **Credit hours: 3 (2+1)**

Interval estimation (two population cases): Confidence interval estimators - Pivotal methods - Hypotheses Testing: Type I and Type II error - power of the tests - Most powerful test - Neymann-pearson lemma - asymptotic tests - unbiased test - uniformly most powerful test. Monotone tests – Neymann Pearson theorem - power curves - Likelihood ratio tests - asymptotic distribution of likelihood ratio statistics - The Sequential Probability Ratio Test - Goodness of-fit Tests - Bayesian testing hypotheses.

Prerequisite: STAT 223 + MATH 207

Co-requisite : STAT 315

STAT 328: Statistical Packages **Credit hours: 3 (2+1)**

Using program code in a statistical software package (Excel – Minitab – SAS – SPSS - R - Maple - Matlab) to write a program for data and statistical analysis. Topics include creating and managing data files - graphical presentation - and Monte Carlo simulations.

Prerequisite: STAT 105

Co-requisite : None

STAT 333: Nonparametric Statistics Methods **Credit hours: 3 (2+1)**

Concept of nonparametric statistics -Statistical tests based on the binomial distribution (binomial test and estimation of ratio - quantile test - tolerance limits) - Contingency tables in (median tests - measures of dependence - chi-square tests - Cochran test for related observations) - Some nonparametric tests that depend on ranks (two independent samples -several independent samples -test for equal variances - measures of rank correlations-nonparametric regression methods - several related samples - tests of randomization) -Tests of the Kolmogorov-Smirnov type (the Kolmogorov goodness of fit tests - goodness of fit tests for families of distributions).

Prerequisite: STAT 105

Co-requisite : None

STAT 334: Sampling Techniques **Credit hours: 3 (2+1)**

Definition of Population and sample - Types of surveys - sampling methods - Parameters

estimation- Estimation of (population mean - Estimation of population ratios - Population total). Confidence intervals for population parameters - Selecting the sample size for estimating population mean and total number.

Prerequisite: STAT 223

Co-requisite : None

STAT 335: Regression Analysis **Credit hours: 3 (2+1)**

Simple linear regression model - Multiple linear regression - Analysis of residuals and predictions. - Stepwise regression - Some nonlinear regression models and data transformations - Student will use statistical computer packages such as SAS - SPSS - Minitab - …etc.

Prerequisite: STAT 328 + MATH 244

Co-requisite : None

STAT 401: Econometrics **Credit hours: 3 (3+0)**

Simple and Multiple regression models - Non-Linear regression models - Dummy Variables - Multicollinearity Problem-Identification Errors - Generalized Least Square Method – Heteroscedasticity Problem - Autocorrelation Problem - Time series models- Simultaneous Equations-Errors in variables.

Prerequisite: STAT 332

Co-requisite : None

STAT 436: **Time Series and Forecasting** **Credit hours: 3 (2+1)**

Data sources: Historical data- the Web. Checking time series components: trend – seasonality - cyclical. Transformation: Differences method - Seasonal adjustment. Forecasting: How to forecast future - adequacy of a forecast - regression forecasting against time series forecasting - some adequacy measures (MAD - MSE - MAPE). Decomposition and smoothing of times series: moving averages - exponential smoothing. Box-Jenkins models ARIMA(p -d -q): Autocorrelation and partial autocorrelation functions - identification of appropriate model - dealing with seasonal time series - fitting models to real and simulated data sets. Diagnostic checks on the residuals. Case studies: training on how to analyze real life data sets using the statistical package MINITAB - write reports.

Prerequisite: STAT 332

Co-requisite : None

STAT 437: Design and Analysis of Experiments **Credit hours: 3 (2+1)**

Introduction: Review of statistical inference. Main principals of experimental design: Replication – Randomness – Blocks – Simple comparisons experiments: t-test and alike tests. Single Factor Experiments: Completely randomized desing – Model adequacy checking – Contrasts and orthogonal contrasts – Comparing pairs of treatment means. Block designs: Randomized complete block design – Latin square design – Graeco-Latin square design. Factorial designs : Two-Factor factorial design – Three-Factor factorial design – General factorial designs. Designs with two-level factors: Two factors with two levels designs – Three factors with two levels designs – General two-level factors designs. Confounding. Fractional factorial designs

Prerequisite: STAT 328

Co-requisite : None

STAT 438: Multivariate Statistical Methods **Credit hours: 3 (2+1)**

Matrix algebra and Random Vector- The multivariate normal distribution -Inferences about a Mean vector- Hotelling's T and comparisons of several multivariate Means –MANOVA (One and two way) - Principle components --Discrimination and classification Application using computer packages. SAS-SAS/IML -SPSS – Minitab.

Prerequisite: STAT 332

Co-requisite : None

STAT 439: Data Analysis **Credit hours: 3 (2+1)**

Introduction to Data Analysis. Introduction to software. Introduction to types of Data: study of qualitative and quantitative variable. Graphical representation of data. Sample studies for paired data. Correlation for qualitative and quantitative data. ANOVA - Regression Analysis: Logistic regression. K means - Time series Analysis.

Remark: This course is based on SAS or SPSS or MINITAB.

Prerequisite: STAT 436 + STAT 438

Co-requisite : None

STAT 441: Quality Control **Credit hours: 3 (2+1)**

Historical background of Quality Control - What is Quality? - the formation of Quality Control - Quality Planning - Quality Improvement - Quality Assurance and Total Quality Management - Modeling Process Quality - Review of statistical distributions used in Quality Control - Statistical inference and test of hypotheses - Statistical Process Control (SPC) - Magnificent Seven - Introduction of Control Charts - Statistical process in Quality Improvement - Pareto Chart - Cause and Effect Diagram - Scatter Diagram - Types of control charts - Control Charts for Variables - Process Capability Ratios - Process Capability Cpk - Control Charts for Attribute data - Acceptance Sampling - Operating Characteristic Curve.

Prerequisite: STAT 326

Co-requisite : None

STAT 497: Graduation Project (1) **Credit hours: 1 (1+0)**

Recognition of the problem (chosen from real- world problems) under study. Gathering of references and collection of data for problem investigation under the supervision of a faculty member.

Prerequisite: STAT 332

Co-requisite : STAT 436 + STAT 438

STAT 498: Graduation Project (2) **Credit hours: 2 (2+0)**

The student build and solve the model of the problem previously investigated in STAT 498 under the supervision of a faculty member.

Prerequisite: STAT 497

Co-requisite : None

Compulsory Requirements Outside the Department

MATH 111:Integral Calculus **Credit hours: 4 (3+1)**

Definition of Definite Integral and its Properties - The Anti-derivative - Indefinite Integral and the Fundamental Theorem of Calculus. Change of Variables. Integrals of natural and general exponential functions. Integrals of natural and general Logarithmic functions. Derivatives and Integrals of Hyperbolic and Inverse-Hyperbolic functions. Techniques of Integration: by parts - Trigonometric substitutions - Completing the square - Integrals of rational functions - Miscellaneous Substitutions. Indeterminate forms - Improper Integrals. Applications of Integration: Area - Solids of Revolutions - Arc length and Surface of Revolution - Linear Motion - Work - Momentum and Center of Mass. Numerical Integration. Polar coordinates - relation between polar and Cartesian coordinates - Graphs of polar curves - Area in polar coordinates. Parametric Equations.

Prerequisite: MATH 150

Co-requisite : None

MATH 207: Advanced Differential and Integral Calculus **Credit hours: 3 (3+0)**

Cartesian coordinates - functions of two or several variables - limits and continuity - partial derivatives - chain rule - maxima and minima for functions of two and several variables - Lagrange multipliers - double integrals and their applications - triple integrals and their applications - sequences - infinite series - geometric series - convergence tests - alternative series - absolute convergence - conditional convergence - functions representation by power series - Taylor' series - Maclaurin' series - Binomial series - first order differential equations.

Prerequisite: MATH 111

Co-requisite : None

MATH 244: Linear Algebra **Credit hours: 3 (2+1)**

Matrices and their operations - types of matrices. Elementary transformations. Determinants - elementary properties. Inverse of a matrix. Linear systems of equations. Vector spaces - linear independence - finite dimensional spaces - linear subspaces. Inner product spaces. Linear transformations - kernel and image of a liner transformation. Eigen values and Eigen vectors of a matrix and of a linear operator.

Prerequisite: MATH 111

Co-requisite : None

CSC 201:Computer Programming **Credit hours: 4 (3+1)**

Introduction: Introduction to C programming. Structured program development. Program control. Functions. Recursion. Arrays. Pointers. Strings. Structures and enumerations. File processing. Data structures.

Prerequisite: None

Co-requisite : None

CSC202:Computer Programming Using MATLAB **Credit hours: 3 (2+1)**

Interacting with MATLAB - program design and algorithm development - M-files - designing GUI (graphical user interface) - calculus with MATLAB - vectors and matrices - strings - functions - 2-D and 3-D graphics - MATLAB programming - data analysis operations - errors - applications: (randomness - simulation - Markov process - linear equations - some numerical methods) -

integrating MATLAB based algorithms with external applications and languages - such as C - C++ - Fortran - Java - COM - and Microsoft Excel.
Prerequisite: CSC 201
Co-requisite : None

Optional Courses

STAT 231: Population Study "Demography" **Credit hours: 2 (2+0)**

Introduction - The Nature of Demography - Rates and Ratios - Relative numbers - The use of ratios in demography - Vital statistics rates - Types of ratios - Sex ratio - Child-Woman ratio - Territorial distribution - Density of population - The rate of population growth - Crude birth and death rate - Age-Specific death rate - Infant death rate - Age-Specific birth rate - General fertility ratio - Total fertility rate - Gross reproduction rate - Accuracy and Error - Life Tables - The smoothing of data. - The Study of Mortality - Measurement of Fertility - Growth of Population - Migration and the Distribution of Population.
Prerequisite: STAT 100
Co-requisite : None

STAT 325: Decision Theory **Credit hours: 3 (3+0)**

The elements of making decision problem without data: Utility - Actions Space - State of nature space- Pure actions - MinMax and Bayes actions - MinMax mixed actions - Using data for making decisions (Decision Rule)- MinMax pure and mixed decision rules- Bayes decision rule - Estimation as a decision problem: for instance Bayes Estimate - Testing hypothesis as a decision problem: for instance - Most powerful - MinMax and Bayes tests - Comparing between tests.
Prerequisite: STAT 223
Co-requisite : None

STAT 362: Reliability Theory **Credit hours: 3 (3+0)**

Concept of reliability - structural properties of Coherent systems - Reliability of coherent systems - Joint Structural and Reliability importance - Some parametric lifetime models (continuous and discrete) - Classes of lifetime distributions (notions of aging) - Reliability operation - Specialized models (competing risks - accelerated models - ..) - Life data analysis.
Prerequisite: STAT 223
Co-requisite : None

STAT 399: Longitudinal of Data Analysis **Credit hours: 3(2+1)**

Exploring longitudinal data. Analysis of variance for repeated measures. Single-Group Repeated Measures. Crossover Designs and Parallel Group. General Linear Mixed Models. Generalized Linear Models for Longitudinal Data. MLE and Restricted/Residual Maximum Likelihood Estimation(REML). Multilevel Models. ;Using GLM - MIXED and GENMOD in SAS
Prerequisite: STAT 332
Co-requisite : None

STAT 406: Survival Analysis **Credit hours: 3 (3+0)**

Description of survival distributions - survival and hazard function - their relationship - Problems

of inference - Estimation and comparison of survival curves (Kaplan-Meier and life-table estimates - …) - Estimation under complete and censored data (typre I - type II - progressive - …). Hypothesis testing - Life testing - Parametric regression models - Cox proportional models.

Prerequisite: STAT 223

Co-requisite : None

STAT 431: Insurance Methods **Credit hours: 3 (2+1)**

Survival Distributions: Future lifetime - life tables; fundamental theorems for calculating moments of actuarial functions - Other actuarial functions; 3 assumptions for fractional ages; analytical laws of mortality - Net Single Premiums for Life Insurance Contracts: Definition using a stochastic approach - distribution of the actuarial - present value function for different insurance contracts - Life Annuities: Actuarial accumulation function; aggregate payment and current payment techniques - life annuities with monthly payments - complete annuities (immediate) - apportionable annuities (due) - recursive equations - Net Annual Premiums: Actuarial equivalence principle; basic contracts; monthly premiums; life insurance with accumulation type benefits - Reserves: Definition of prospective loss - basic contracts - monthly premiums reserves: recursive equations for discrete reserves - reserves at fractional durations - allocation of the loss to the policy years.

Prerequisite: STAT 326

Co-requisite : None

STAT 432: Survey Research **Credit hours: 2 (2+0)**

Research Methodology (Choosing Research Problems - and Methods) - Ethical issues in scientific research - An introduction if Survey Methodology - Inference and Error in Surveys - Research problem - goals - questions - and hypotheses for quantitative and qualitative studies - Target Population - Sampling frames - Coverage - Sampling Design and Sampling Error - Non-response in sampling surveys - Data collection methods - Types of Variables - data and measures - Method of Data collection - Computerized Data Descriptive - and Analysis

Prerequisite: STAT 331

Co-requisite : None

STAT 434: Linear Models **Credit hours: 3 (3+0)**

Review of necessary concepts of matrix algebra - Normal distribution with n-variables - Quadratic forms and their distributions - The general linear model of full rank - Estimation and hypothesis testing in the full rank model-Estimation and hypothesis testing in the less than full rank model - Computational methods - Applications in regressions - experimental design and ANOVA using statistical packages.

Prerequisite: STAT 332 + MATH 244

Co-requisite : None

OPER 213: Linear Programming **Credit hours: 4 (3+1)**

Definitions and formulation of linear programs - Graphical solution. Review of linear algebra and convex analysis - Algebra of the simplex method - The simplex method - The revised simplex method - Duality theory and economic interpretation of duality. Sensitivity analysis - Some applications of linear programming

Prerequisite: OPER 100

Co-requisite : MATH 244

OPER 322: Inventory Control **Credit hours: 3 (2+1)**

Definitions and models of inventory control - The simple economic order quantity (EOQ) model - The EOQ model with shortages - The economic production quantity (EPQ) model - The (EPQ) model with shortages - Single or multiple items constrained inventory control models - Some dynamic inventory control models with deterministic or probabilistic demand - Inventory control models with continuous demand rate - Some probabilistic inventory control models.

Prerequisite: OPER 213 and MATH 207

Co-requisite : None

OPER 351: Network Analysis **Credit hours: 3 (2+1)**

Introduction to Graph theory - Network models - Mathematical formulation of network problems - Shortest path problem: Bellman algorithm, Dijkstra's algorithm, Bellman-Ford algorithm - Maximum Flow Problem: Ford and Fulkerson algorithm, Max-flow min-cut theorem - Minimum cost flow problem. Project scheduling: CPM and PERT

Prerequisite: OPER 213 and CSC 202

Co-requisite : None

OPER 441: Modeling and Simulation **Credit hours: 4 (3+1)**

Random number generators - Monte Carlo techniques - Simulation design - Input modeling - Model validation - Analysis of simulation output - Evaluation of alternatives - Applications to various operations research models using simulation languages such as SLAM, GPSS and Arena

Prerequisite: STAT 215 and CSC 202

Co-requisite : None

OPER 472: Stochastic Processes and Queuing Models **Credit hours: 4 (3+1)**

Definition of stochastic processes - Finite Markov chains. One step and multi-steps transition probability matrices - Chapman-Kolmogorof equation. State classification. Long run distribution of Markov chains - Continuous-time Markov processes (Birth-and-death processes, Poisson process) - Queuing theory and models: Cumulative diagrams of queues. Performance measures - Basic Markovian queuing models (single server queue, multi-server queue, finite capacity queues) - Some Non-Markovian queues - Some Non-Markovian queues with bulk arrival and service.

Prerequisite: OPER 213 and STAT 215

Co-requisite : None

A-Bachelor's degree in Science (Operations Research)

The plan of study for the Department of Statistics and Operations Research

Specialization: Operations Research

Degree: Bachelor of Science

Preparatory Year (31 credit hours)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
ENG 140	English Language 1	8		
ENG 150	English Language 2	8		
MATH 140	Introduction to Mathematics	2		
MATH 150	Differential Calculus	3		
CT 140	Computer skills	3		
CI 140	Learning, Thinking and Research Skills	3		
CHS 140	Health and fitness	2		
MC150	Communication skills	2		
Total		**31**		

University requirements (8 credits hours)
A student chooses 8 credits hours from the Islamic Culture courses

Compulsory Requirements Within the Department (59 credits)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
OPER 100	Introduction to Operations Research	4	MATH 150	STAT 100
OPER 213	Linear Programming	4	OPER 100	MATH 244
OPER 322	Inventory Control	3	OPER 213, MATH 207	
OPER 331	Non-Linear Optimization	4	OPER 213, MATH 207	
OPER 351	Network Analysis	3	OPER 213, CSC 202	
OPER 382	Decision and Game Theory	4	OPER 213	
OPER 435	Numerical Methods in Operations Research	3	OPER 331, OPER 351	
OPER 441	Modeling and Simulation	4	STAT 215, CSC 202	
OPER 472	Stochastic Processes and Queuing Theory	4	OPER 213, STAT 215	
OPER 497	Graduation Project (1)	1	OPER 351	OPER 435 OPER 441 OPER 472
OPER 498	Graduation Project (2)	2	OPER 497	

STAT 100	Introduction to Statistics	3	MATH 150	
STAT 105	Statistical Methods	4	STAT 100	
STAT 215	Probability (1)	4	STAT 100, MATH 111	
STAT 223	Theory of Statistics (1)	3	STAT 215	
STAT 328	Statistical Packages	3	STAT 105	
STAT 332	Regression Analysis	3	STAT 328, MATH 244	
STAT 436	Time Series and Forecasting	3	STAT 332	
Total		**59**		

Compulsory Requirements Outside the Department (17 credits)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
MATH 111	Integral Calculus	4	MATH 150	
MATH 207	Advanced Integral and Differential Calculus	3	MATH 111	
MATH 244	Linear Algebra	3	MATH 111	
CSC 201	Computer Programming	4		
CSC 202	Computer Programming using MATLAB	3	CSC 201	
Total		**17**		

Elective Requirements From Within the Department Group A (student selects 12 credit hours from this group)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
OPER 313	Integer Programming	3	OPER 213	
OPER 453	Scheduling and Sequencing	3	OPER 213	
OPER 490	Special Applications in Operations Research	3	OPER 331, OPER 351	
OPER 492	Prices and Revenue Management	3	OPER 331, STAT 215	
STAT 315	Probability (2)	3	STAT 215, MATH 207	
STAT 326	Theory of Statistics (2)	3	STAT 223, MATH 207	STAT 315
STAT 325	Decisions Theory	3	STAT 223	
STAT 333	Nonparametric Statistical Methods	3	STAT 105	
STAT 331	Sampling Techniques	3	STAT 223	
STAT 362	Reliability Theory	3	STAT 223	
STAT 401	Econometrics	3	STAT 332	
STAT 431	Insurance Methods	3	STAT 326	
STAT 434	Linear Models	3	MATH 244	
STAT 437	Design and Analysis of Experiments	3	STAT 328	
STAT 441	Quality Control	3	STAT 326	

Elective Requirements From Outside the Department Group B (student choose 9 credit hours from this group)				
Course Code	**Title**	**Credit Hours**	**Pre-requisite(s)**	**Co-requisite(s)**
MATH 160	Computational Mathematics	2	CT 140 & MATH 111	
MATH 225	Introduction to Differential Equations	4	MATH 207	
MATH 352	Numerical Analysis	4	MATH 160 & MATH 244	
MATH 382	Real Analysis I	4	MATH 207	
MGT 101	Principles of Management and Business	3		
MGT 102	Human Resources Management	3	MGT 101	
MGT 103	Entrepreneurship	3	MGT 101	
MGT 104	Principles of Public Administration	3		
MGT 319	Management of Small and Medium Size Businesses	3	MGT 101	
MGT 371	Operations Management	3	MGT 101	
MIS 201	Management Information Systems	3	MGT 101	
ACCT 201	Principles of Accounting and Financial Reporting	3		
ACCT 202	Principles of Cost Managerial Accounting	3	ACCT 201	
ACCT 311	Accounting for Government and Non-Profit Organizations	3	ACCT 201	
ACCT 317	Intermediate Accounting (1)	3	ACCT 201	
ACCT 318	Intermediate Accounting (2)	3	ACCT 317	
ECON 101	Principles of Microeconomics	3		
ECO N 102	Principles of Macroeconomics	3	ECON 101	
ECO N 201	Microeconomics Analysis	3	ECON 102	
ECON 202	Macroeconomics Analysis	3	ECON 102	
ECON 211	Money and Banking	3	ECON 102	
ECON 314	Islamic Economics	3	ECON 102	
ECON 317	Managerial Economics	3	ECON 102	
ECON 318	Transportation and Insurance Economics	3	ECON 102	
MKT 201	Principles of Marketing	3	MGT 101 & Econ 101	
FIN 200	Principles of Finance	3	ACCT 201	
FIN 210	Corporate Finance	3	FIN 200	
FIN 220	Investment Essentials	3	FIN 200	
FIN 230	Financial markets and institutions	3	FIN 200	
FIN 240	Principles of Risk & Insurance	3	FIN 200	
FIN250	International Finance	3	FIN 200	
QUA 127	Mathematics of Finance	3	MATH 140	

Operations Research Course Description

Compulsory Courses within the Department

OPER 100: Introduction to Operations Research **Credit hours: 4 (3+1)**

History and nature of Operations Research. Introduction to system analysis. Problem investigation and formulation. Linear programming models and graphical solutions . Sensitivity analysis. Transportation problem. Assignment problem. Introduction to graph theory and optimization in networks: The shortest path problem . Introduction to stochastic models in operations research

Prerequisite: MATH 150
Co-requisite : STAT 100

OPER 213: Linear Programming **Credit hours: 4 (3+1)**

Definitions and formulation of linear programs . Graphical solution. Review of linear algebra and convex analysis. Algebra of the simplex method. The simplex method. The revised simplex method. Duality theory and economic interpretation of duality. Sensitivity analysis. Some applications of linear programming

Prerequisite: OPER 100
Co-requisite : MATH 244

OPER 322: Inventory Control **Credit hours: 3 (2+1)**

Definitions and models of inventory control. The simple economic order quantity (EOQ) model. The EOQ model with shortages. The economic production quantity (EPQ) model. The (EPQ) model with shortages. Single or multiple items constrained inventory control models. Some dynamic inventory control models with deterministic or probabilistic demand. Inventory control models with continuous demand rate. Some probabilistic inventory control models.

Prerequisite: OPER 213 and MATH 207
Co-requisite : None

OPER 331: Nonlinear Optimization **Credit hours 4 (3+1)**

Models of nonlinear optimization. Basic concepts of optimization. Optimality conditions for unconstrained problems. Optimality conditions for constrained problems: Lagrange Multipliers, KKT conditions. Quadratic Programming: Wolf's method. Computational methods for unconstrained problems: Optimal search algorithms for univariate and multivariate problems. Computational methods for constrained problems: Graphical method, Feasible directions methods, Gradient projection methods, Penalty and Barrier function methods.

Prerequisite: OPER 213 and MATH 207
Co-requisite : None

OPER 351: Network Analysis **Credit hours: 3 (2+1)**

Introduction to Graph theory. Network models. Mathematical formulation of network problems. Shortest path problem: Bellman algorithm, Dijkstra's algorithm, Bellman-Ford algorithm. Maximum Flow Problem: Ford and Fulkerson algorithm, Max-flow min-cut theorem. Minimum cost flow problem. Project scheduling: CPM and PERT.

Prerequisite: OPER 213 and CSC 202
Co-requisite : None

OPER 382: Decision and Game Theory **Credit hours: 4 (3+1)**

Introduction to Decision theory. Utility and expected utility. Decision under risk seeking and risk averse. Dynamic Programming (Principle of Optimality, Dynamic Programming and Decision Theory, various applications). Concepts and terminology of Game theory. Zero sum games. Solutions of two persons zero sum games. Two persons nonzero sum games. Solutions of two persons nonzero sum games. N-person games

Prerequisite: OPER 213

Co-requisite : None

OPER 435: Computational Methods in Operations Research **Credit hours: 3 (2+1)**

This course provides a comprehensive introduction to the standard numerical techniques commonly used in obtaining solutions to operations research problems such as: Solving single variable equations and multi-variable equations. Numerical integration. Solving differential equations. Solving systems of nonlinear equations. Iterative techniques in matrix algebra. Implementation of numerical techniques for solving various types of problems using computing software.

Prerequisite: OPER 331 and OPER 351

Co-requisite : None

OPER 441: Modeling and Simulation **Credit hours: 4 (3+1)**

Random number generators. Monte Carlo techniques. Simulation design. Input modeling. Model validation. Analysis of simulation output. Evaluation of alternatives. Applications to various operations research models using simulation languages such as SLAM, GPSS and Arena.

Prerequisite: STAT 215 and CSC 202

Co-requisite : None

OPER 472: Stochastic Processes and Queuing Models **Credit hours: 4 (3+1)**

Definition of stochastic processes. Finite Markov chains. One step and multi-steps transition probability matrices. Chapman-Kolmogorof equation. State classification. Long run distribution of Markov chains. Continuous-time Markov processes (Birth-and-death processes, Poisson process). Queuing theory and models: Cumulative diagrams of queues. Performance measures. Basic Markovian queuing models (single server queue, multi-server queue, finite capacity queues). Some Non-Markovian queues. Some Non-Markovian queues with bulk arrival and service

Prerequisite: OPER 213 and STAT 215

Co-requisite : None

OPER 497: Graduation Project (1) **Credit hours: 1 (1+0)**

Recognition of the problem, chosen from real- world problems, under study. Gathering references and collecting data needed to investigate the problem under the supervision of a faculty member.

Prerequisite: OPER 351

Co-requisite : OPER 435, OPER 441, and OPER 472

OPER 498: Graduation Project (2) **Credit hours: 2 (2+0)**

Under the supervision of a faculty member, the student studies and models a solution to the problem previously investigated in OPER 497, and presents a report of his work.

Prerequisite: OPER 497
Co-requisite : None

STAT 100: Introduction to Statistics **Credit hours: 3 (2+1)**

escriptive statistics - Measures of central tendency - Measures of dispersion - Basic probability concepts - Conditional probability, Expectation - Variance - Bayes law- Random variables - Probability distribution - Binomial distribution - Poisson distribution - Hypergeometric distribution - Normal distribution – Applications by Excel.
Prerequisite: MATH 150
Co-requisite : None

STAT 105: Statistical Methods **Credit hours: 4 (3+1)**

Some Statistical distributions - Sampling distributions - Central limit theorem - Chebychev's inequality - Interval estimation - Testing hypotheses (two populations case) - Introduction to experimental designs (CRD and RBD)- Analysis of variance (one and two ways) - Regression (simple) - Correlation (Pearson and Spearman) - Chi square tests and application - Some nonparametric tests.
Prerequisite: STAT 100
Co-requisite : None

STAT 215: Probability (1) **Credit hours: 4 (3+1)**

Random variables and probability distributions (Discrete and continuous) - Famous discrete and continuous probability distributions – Random vectors - Expectation and variation - Discrete bivariate probability distributions - Marginal and conditional probability distributions - Independence, correlation and covariance - Moments and moment generating function - Distributions of Function of one and two random variable
Prerequisite: STAT 100 and MATH 111
Co-requisite : None

STAT 223: Theory of Statistics (1) **Credit hours: 3 (2+1)**

Sampling distributions - Central limit theorem - Point Estimation - Properties of estimator: unbiasedness, mean square error - consistency - sufficiency, minimal sufficiency - Exponential family - Uniformly Minimum Variance Unbiased Estimator - Cramer-Rao inequality - Fisher's information - Rao-Blackwell theorem - sufficiency and completeness - Lehmann-Sheffe theorem - Methods of Estimation: Method of Moments - Maximum Likelihood estimators and their properties including asymptotic properties - The Baysian Approach: Use of a prior density - Bayes estimators - Bayes estimators with mean square error loss function - invariant methods: Location invariant and scale invariant classes of estimators - Interval estimation (one population case): Confidence interval estimators, Pivotal methods - Bayesian credible intervals.
Prerequisite: STAT 215
Co-requisite : None

STAT 328: Statistical Packages **Credit hours: 3 (2+1)**

Using program code in a statistical software package (Excel – Minitab – SAS – SPSS - R - Maple - Matlab) to write a program for data and statistical analysis. Topics include creating and managing data files, graphical presentation - and Monte Carlo simulations.

Prerequisite: STAT 105
Co-requisite : None

STAT 332: Regression Analysis **Credit hours: 3 (2+1)**

Simple linear regression model - Multiple linear regression - Analysis of residuals and predictions. - Stepwise regression - Some nonlinear regression models and data transformations - Student will use statistical computer packages such as SAS, SPSS, Minitab, etc.
Prerequisite: STAT 328 and MATH 244
Co-requisite : None

STAT 436: Time Series and Forecasting **Credit hours: 3 (2+1)**

Data sources: Historical data- the Web. Checking time series components: trend – seasonality - cyclical. Transformation: Differences method - Seasonal adjustment. Forecasting: How to forecast future - adequacy of a forecast - regression forecasting against time series forecasting - some adequacy measures (MAD, MSE, MAPE). Decomposition and smoothing of times series: moving averages - exponential smoothing. Box-Jenkins models ARIMA(p,d,q): Autocorrelation and partial autocorrelation functions - identification of appropriate model - dealing with seasonal time series - fitting models to real and simulated data sets. Diagnostic checks on the residuals. Case studies: training on how to analyze real life data sets using the statistical package MINITAB - write reports
Prerequisite: STAT 332
Co-requisite : None

MATH 140: Introduction to Mathematics **Credit hours: 2 (2+0)**

Linear equations and applications, linear inequalities, absolute value in equations and inequalities, complex numbers, quadratic equations and applications, functions, odd and even functions, operations on functions, inverse functions, exponential and logarithmic functions, trigonometric functions, conic sections, systems of equations and inequalities, matrices, matrix operations.
Prerequisite: None
Co-requisite : None

MATH 150: Differential Calculus **Credit hours: 3 (3+0)**

The concept of limit, computation of limits, continuity and its consequences, limits involving infinity, formal definition of limit, the concept of derivative, computation of derivatives (power rule, higher order derivatives, acceleration), the product and quotient rules, the chain rule, derivatives of exponential and logarithmic functions, implicit differentiation and inverse trigonometric functions, the mean value theorem, indeterminate forms and L'Hopital's rule, maximum and minimum values, increasing and decreasing functions, concavity and the second derivative test, optimization, related rates.
Prerequisite: MATH 140
Co-requisite : None

MATH 111: Integral Calculus **Credit hours: 4 (3+1)**

Definition of Definite Integral and its Properties, The Anti-derivative, Indefinite Integral and the Fundamental Theorem of Calculus. Change of Variables. Integrals of natural and general

exponential functions. Integrals of natural and general Logarithmic functions. Derivatives and Integrals of Hyperbolic and Inverse-Hyperbolic functions. Techniques of Integration: by parts, Trigonometric substitutions, Completing the square, Integrals of rational functions, Miscellaneous Substitutions. Indeterminate forms, Improper Integrals. Applications of Integration: Area, Solids of Revolutions, Arc length and Surface of Revolution, Linear Motion, Work, Momentum and Center of Mass. Numerical Integration. Polar coordinates, relation between polar and Cartesian coordinates, Graphs of polar curves, Area in polar coordinates. Parametric Equations.

Prerequisite: MATH 150

Co-requisite : None

MATH 207: Advanced Differential and Integral Calculus **Credit hours: 3 (2+1)**

Cartesian coordinates, functions of two or several variables, limits and continuity, partial derivatives, chain rule, maxima and minima for functions of two and several variables, Lagrange multipliers, double integrals and their applications, triple integrals and their applications, sequences, infinite series, geometric series, convergence tests, alternative series, absolute convergence, conditional convergence, functions representation by power series, Taylor' series, Maclaurin' series, Binomial series, first order differential equation

Prerequisite: MATH 111

Co-requisite : None

MATH 244: Linear Algebra **Credit hours: 3 (3+0)**

Matrices and their operations, types of matrices. Elementary transformations. Determinants, elementary properties. Inverse of a matrix. Linear systems of equations. Vector spaces, linear independence, finite dimensional spaces, linear subspaces. Inner product spaces. Linear transformations, kernel and image of a liner transformation. Eigen values and Eigen vectors of a matrix and of a linear operator.

Prerequisite: MATH 111

Co-requisite : None

CSC 201: Computer Programming **Credit hours: 4 (3+1)**

Introduction to computer programming, algorithms, variables and data types, concepts of object oriented programming, classes, objects and methods, basic control structures (sequence, if /else, looping), arrays , strings, file processing, interfaces, inheritance and polymorphism, GUI (graphical user interface).

Prerequisite: None

Co-requisite : None

CSC 202: Computer Programming Using MATLAB **Credit hours: 3 (2+1)**

Interacting with MATLAB, program design and algorithm development, M-files, designing GUI (graphical user interface), calculus with MATLAB, vectors and matrices, strings, functions, 2-D and 3-D graphics, MATLAB programming, data analysis operations, errors, applications: (randomness, simulation, Markov process, linear equations, some numerical methods), integrating MATLAB based algorithms with external applications and languages, such as C, C++, Fortran, Java, COM, and Microsoft Excel

Prerequisite: CSC 201

Co-requisite : None

Elective Courses:

OPER 313: Integer Programming **Credit hours: 3 (2+1)**

Introduction to integer programming. Examples of integer programming problems . Some applications of integer programming . Optimality of integer programming . Branch and bound methods. Implicit enumeration methods . Cutting plane method.

Prerequisite: OPER 213
Co-requisite : None

OPER 453: Sequencing and scheduling **Credit hours: 3 (2+1)**

Introduction to sequencing and scheduling: concepts and examples. Optimality in sequencing and scheduling. Basic results of single machine sequencing and scheduling. Algorithms for general Job-Shop and Flow-Shop problems. Dynamic programming models for sequenced decisions using the principle of optimality. Use of dynamic programming in solving sequencing and scheduling problems.

Prerequisite: OPER 213
Co-requisite : None

OPER 490: Special Applications in Operations Research **Credit hours: 3 (2+1)**

Topics in Supply Chain Management. Traveling Salesman Problem. Vehicle Routing Problem. Facility Location Problem. Multi-objective Programming. Goal Programming

Prerequisite: OPER 331 and OPER 351
Co-requisite : None

OPER 492: Pricing and Revenue Management **Credit hours: 3 (2+1)**

Pricing and revenue management concepts. Basic price optimization. Price differentiation. Pricing with constrained supply. Revenue management. Capacity allocation. Network management. Overbooking. Markdown management. Customized pricing.

Prerequisite: OPER 331 and STAT 215
Co-requisite : None

STAT 315: Probability (2) **Credit hours: 3 (2+1)**

Sequence of Events – Continuous random vector - Joint probability distribution - marginal and conditional probability functions - Conditional expectation and variation - Joint probability distributions of functions of random variables- Joint moment generating functions - Order statistics- Probability inequalities- Sequences of random variables and modes of convergences - Central limit theorem and proof - normal approximation

Prerequisite: STAT 215 and MATH 207
Co-requisite : None

STAT 325: Decision Theory **Credit hours: 3 (3+0)**

The elements of making decision problem without data: Utility, Actions Space, State of nature space- Pure actions - MinMax and Bayes actions - MinMax mixed actions - Using data for making decisions (Decision Rule)- MinMax pure and mixed decision rules- Bayes decision rule - Estimation as a decision problem: for instance Bayes Estimate - Testing hypothesis as a decision problem: for instance - Most powerful - MinMax and Bayes tests - Comparing between tests.

Prerequisite: STAT 223
Co-requisite : None

STAT 326: Theory of Statistics (2) **Credit hours: 3 (2+1)**

Interval estimation (two population cases): Confidence interval estimators, Pivotal methods - Hypotheses Testing: Type I and Type II error, power of the tests - Most powerful test, Neymann-pearson lemma, asymptotic tests - unbiased test - uniformly most powerful test. Monotone tests – Neymann Pearson theorem - power curves - Likelihood ratio tests - asymptotic distribution of likelihood ratio statistics - The Sequential Probability Ratio Test - Goodness of-fit Tests - Bayesian testing hypotheses

Prerequisite: STAT 223 and MATH 207

Co-requisite : None

STAT 333: Nonparametric Statistics Methods **Credit hours: 3 (2+1)**

Concept of nonparametric statistics -Statistical tests based on the binomial distribution (binomial test and estimation of ratio - quantile test - tolerance limits) - Contingency tables in (median tests - measures of dependence - chi-square tests - Cochran test for related observations) - Some nonparametric tests that depend on ranks (two independent samples -several independent samples -test for equal variances - measures of rank correlations-nonparametric regression methods - several related samples - tests of randomization) -Tests of the Kolmogorov-Smirnov type (the Kolmogorov goodness of fit tests - goodness of fit tests for families of distributions).

Prerequisite: STAT 105

Co-requisite : None

STAT 331: Sampling Techniques **Credit hours: 3 (2+1)**

Definition of Population and sample - Types of surveys - sampling methods - Parameters estimation- Estimation of (population mean - Estimation of population ratios - Population total). Confidence intervals for population parameters - Selecting the sample size for estimating population mean and total number.

Prerequisite: STAT 223

Co-requisite : None

STAT 362: Theory of reliability **Credit hours: 3 (3+0)**

Concept of reliability - structural properties of Coherent systems - Reliability of coherent systems, Joint Structural and Reliability importance - Some parametric lifetime models (continuous and discrete) - Classes of lifetime distributions (notions of aging) - Reliability operation, Specialized models (competing risks, accelerated models, ..) - Life data analysis.

Prerequisite: STAT 223

Co-requisite : None

STAT 401: Econometrics **Credit hours: 3 (3+0)**

Simple and Multiple regression models - Non-Linear regression models - Dummy Variables - Multicollinearity Problem-Identification Errors - Generalized Least Square Method – Heteroscedasticity Problem - Autocorrelation Problem - Time series models- Simultaneous Equations-Errors in variables

Prerequisite: STAT 332

Co-requisite : None

STAT 431: Insurance Methods **Credit hours: 3(2+1)**

Survival Distributions: Future lifetime, life tables; fundamental theorems for calculating moments of actuarial functions - Other actuarial functions; 3 assumptions for fractional ages; analytical laws of mortality - Net Single Premiums for Life Insurance Contracts: Definition using a stochastic approach - distribution of the actuarial - present value function for different insurance contracts - Life Annuities: Actuarial accumulation function; aggregate payment and current payment techniques - life annuities with monthly payments - complete annuities (immediate), apportionable annuities (due) - recursive equations - Net Annual Premiums: Actuarial equivalence principle; basic contracts; monthly premiums; life insurance with accumulation type benefits - Reserves: Definition of prospective loss - basic contracts - monthly premiums reserves: recursive equations for discrete reserves, reserves at fractional durations, allocation of the loss to the policy years

Prerequisite: STAT 326

Co-requisite : None

STAT 434: Linear Models **Credit hours: 3 (3+0)**

Review of necessary concepts of matrix algebra - Normal distribution with n-variables - Quadratic forms and their distributions - The general linear model of full rank - Estimation and hypothesis testing in the full rank model-Estimation and hypothesis testing in the less than full rank model - Computational methods - Applications in regressions, experimental design and ANOVA using statistical packages

Prerequisite: STAT 332 and MATH 244

Co-requisite : None

STAT 437: Design and Analysis of Experiments **Credit hours: 3 (2+1)**

Introduction: Review of statistical inference. Main principals of experimental design: Replication – Randomness – Blocks – Simple comparisons experiments: t-test and alike tests. Single Factor Experiments: Completely randomized desing – Model adequacy checking – Contrasts and orthogonal contrasts – Comparing pairs of treatment means. Block designs: Randomized complete block design – Latin square design – Graeco-Latin square design. Factorial designs : Two-Factor factorial design – Three-Factor factorial design – General factorial designs. Designs with two-level factors: Two factors with two levels designs – Three factors with two levels designs – General two-level factors designs. Confounding. Fractional factorial designs.

Prerequisite: STAT 328

Co-requisite : None

STAT 441: QUALITY CONTROL **Credit hours: 3 (2+1)**

Historical background of Quality Control - What is Quality? - the formation of Quality Control, Quality Planning, Quality Improvement - Quality Assurance and Total Quality Management - Modeling Process Quality - Review of statistical distributions used in Quality Control - Statistical inference and test of hypotheses - Statistical Process Control (SPC) - Magnificent Seven - Introduction of Control Charts - Statistical process in Quality Improvement - Pareto Chart - Cause and Effect Diagram - Scatter Diagram - Types of control charts - Control Charts for Variables - Process Capability Ratios - Process Capability Cpk - Control Charts for Attribute data - Acceptance Sampling - Operating Characteristic Curve.

Prerequisite: STAT 223

Co-requisite : None

Program of M.Sc. in Statistics and Operations Research:

Aims of the programs

1- Offering A high training in statistics and operations research for distinguish students holding the bachelor degree is statistics, operations research, mathematics or any other related fields.
2- Provide the society with statisticians and operations research people they have a very good motivations in dealing with statistical analysis, computing, statistical software packages; working with large data sets; exploratory data analysis; graphical methods; statistical consulting practice.
3- Provide a strong background for students wish to continue for Ph. D. in Statistics and in Operations Research.

Majors and Fields

1- Statistics
2- Operations Research
3- Biostatistics

Admissions

See the admission requirements in the Academic Calendar of the Graduate Studies.

Requirements

For M. Sc. in Statistics

1- The student must successfully complete 24 credit hours of courses included in M.Sc. Academic Calendar (in accordance with the bylaws of graduate studies). These courses divided to 15 compulsory credit hours and 9 optional credit hours that he/she can select.
2- A Thesis satisfies some regulations, guidelines and specifications of the Graduate College should be submitted.

For M. Sc. in Operations Research

1- The student must successfully complete 24 credit hours of courses included in M.Sc. Academic Calendar (in accordance with the bylaws of graduate studies). These courses divided to 15 compulsory credit hours and 9 optional credit hours that he/she can select.
2- A Thesis satisfies some regulations, guidelines and specifications of the Graduate College should be submitted.

M. Sc. Program in Statistics

The plan of study for the Department of Statistics and Operations Research
Specialization: Statistics
Degree: Masters degree of Science

Compulsory courses		
Course Code	**Name of course**	**Unit**
STAT 520	Theory of statistics I	3
STAT 531	Analysis of variance	3
STAT 533	Regression analysis	3
STAT 559	Theory of statistics II	3
STAT 570	Stochastic processes I	3

Optional courses		
Course Code	**Name of course**	**Unit**
STAT 523	Special topics in Statistics	3
STAT 532	Analysis of biomedical categorical data	3
STAT 534	Design of experiments	3
STAT 536	Nonparametric statistics	3
STAT 556	Linear models	3
STAT 557	Order Statistics	3
STAT 558	Time Series Analysis	3
STAT 574	Survival analysis	3
STAT 576	Sample survey	3
STAT 578	Applied multivariate Analysis	3
OPER 563	Theory of reliability and life testing	3

Statistics Course Description

STAT 520: Theory of Statistics (I) **Credit hours: 3**

Theory of probability. Probability spaces, continuous and discrete distributions, functions of random variables, multivariate distributions, expectation, conditional expectation, characteristic functions, central limit theorem, useful convergence results, sampling distributions of order statistics, empirical distribution function.

STAT 523: Special Topics in Statistics **Credit hours: 3**

This course offers either some important topics which are not included in other enlisted courses or some special research topics of current research interest.

STAT 531: Analysis of Variance **Credit hours: 3**

Analysis of variance for one-way, two-way and higher-way classification models. Analysis of standard designs and factorial experiments. Multiple comparisons, orthogonal contrasts, and regression. Analysis using concomitant information. Some consideration of non-orthogonal data.

STAT 532: Analysis of Biomedical Categorical Data **Credit hours: 3**

Categorical response data. Methods for rats and proportions. Describing two-way contingency tables. Models for binary response variable. Loglinear models. Fitting loglinear and logit models. Building and applying loglinear models. Loglinear - logit models for ordinal variables. Multi-nominal response models. Models for matched pairs. Analysis of repeated categorical response data.

STAT 533: Regression Analysis **Credit hours: 3**

Multiple linear regression; Residual analysis; Polynomial regression; Indicator variables; Model building and variable selection; Non-linear and robust regression.

STAT 534: Design of Experiments **Credit hours: 3**

Basic concepts; Blocking as a method of improving precision; RCB designs; LS and GLS designs (construction); Factorial experiments; 2n factorial experiments; Confounding and fractional replications; 3n factorial experiments; BIB designs; Youden & Lattice designs; PBIB designs; Response surface designs.

STAT 536: Non-parametric Statistics **Credit hours: 3**

Classes of distribution-free statistics; linear rank statistics and their applications to location, scale, scale and location problems; one, tow- and multiple-sample problems; Non-parametric estimation; asymptotic distributions; Goodness of fit tests.

STAT 556: Linear Models **Credit hours: 3**

Generalized inverse of matrices; Distribution of quadratic forms; Non-full rank models; estimable functions; General linear hypothesis; One-way and two-way classifications (nested \& crossed); Some aspects of random effects and mixed-effects models.

STAT 557: Order Statistics **Credit hours: 3**

Basic theory of distributions of order statistics and their applications in quantile confidence intervals and in tolerance limits; Moments of order statistics; Application of order statistics in estimation and hypothesis testing.

STAT 558: Time Series Analysis **Credit hours: 3**

Time series as a stochastic process; Stationarity; orthogonal decomposition of time series (Wald's decomposition); ergodic theorems in time series (estimation of the series moments); auto-correlation and auto-covariance functions and their properties; Hilbert spaces [projection theorem, m. s. convergence, conditional expectation and best linear prediction in L2, (; P); Fourier series] stationary ARMA processes, spectral representation of stationary process.

STAT 559: Theory of Statistics (II) **Credit hours: 3**

Methods of point estimation, properties of estimators, confidence intervals. Hypothesis testing, uniformly most powerful tests, likelihood ratio tests, univariate normal inference. Some aspects of sequential testing, decision theory and analysis of categorical data.

STAT 574: Survival Analysis **Credit hours: 3**

Survival data and distributions. Survival data models. Inference in parametric models. The proportional hazards model Statistical computer packages for survival analysis. Likelihood construction. Inference based on ranks in the accelerated failure time model.

STAT 576: Sample Survey **Credit hours: 3**

Theory and application of commonly used sampling techniques. Simple and stratified random sampling; cluster, multistage and systematic sampling. Estimation of parameters: ratios, regression coefficients, and correlation linearization, jackknife and bootstrap. Selected topics: model-based estimation, regression analysis from complex survey data. Relevant computer packages.

STAT 578: Applied Multivariate Analysis **Credit hours: 3**

The multivariate normal distribution; estimation of the mean vector and the covariance matrix. The distribution of the sample covariance matrix and the sample generalized variance. Techniques for analyzing multivariate data. Emphasis on MANOVA and tests on the structure of the dispersion matrix. Topics will include discriminant, factor, profile, and cluster analysis. Data analysis will be done using relevant computer packages

OPER 563: Reliability and Life Testing **Credit hours: 3**

Structural properties of coherent systems. Reliability of coherent systems. Classes of life distributions based on ageing notions. Concepts of positive and negative dependence. Point and interval estimation procedure for life testing distributions. Testing reliability hypothesis.

M. Sc. Program in Operations Research

The plan of study for the Department of Statistics and Operations Research

Specialization: Operations Research

Degree: M. Sc. degree of Science

Compulsory courses		
Course Code	**Name of course**	**Unit**
STAT 520	Theory of statistics I	3
STAT 559	Theory of statistics II	3
OPER 530	Theory of nonlinear programming (I)	3
OPER 554	Network flows	3
OPER 574	Stochastic models in O. R. (I)	3

Optional courses		
Course Code	**Name of course**	**Unit**
OPER 534	Nonlinear programming methods (II)	3
OPER 537	Integer and combinatorial optimization	3
OPER 543	Simulation and modeling	3
OPER 553	Sequencing and scheduling	3
OPER 563	Theory of reliability and life testing	3
OPER 521	Advanced forecasting	3
OPER 579	Special topics in O. R.	3

Operations Research Course Description

STAT 520: Theory of Statistics (I) **Credit hours: 3**

Theory of probability. Probability spaces, continuous and discrete distributions, functions of random variables, multivariate distributions, expectation, conditional expectation, characteristic functions, central limit theorem, useful convergence results, sampling distributions of order statistics, empirical distribution function.

STAT 559: Theory of Statistics (II) **Credit hours: 3**

Methods of point estimation, properties of estimators, confidence intervals. Hypothesis testing, uniformly most powerful tests, likelihood ratio tests, univariate normal inference. Some aspects of sequential testing, decision theory and analysis of categorical data.

OPER 521: Advanced Forecasting Methods **Credit hours: 3**

ARIMA modeling and the Box-Jenkins methodology of forecasting. Non-seasonal and seasonal models. Transfer function analysis. Intervention analysis. State space forecasting. Adaptive filtering.

OPER 530: Nonlinear Programming (I) **Credit hours: 3**

Elements of convex analysis including convex sets and convex functions. Necessary and sufficient conditions for unconstrained and constrained optimization. Lagrangean duality theory.

OPER 534: Nonlinear Programming (II) **Credit hours: 3**

Theoretical and practical aspects of nonlinear optimization. Development and application f optimization techniques used for unconstrained and constrained problems. Sequential search procedure, gradient methods. Newton's methods and conjugate directions. Quadratic programming. Geometric programming. Penalty and Barrier methods. Projection methods.

OPER 537: Integer and Combinatorial Optimization **Credit hours: 3**

Study of techniques for solving discrete-valued and combinatorial optimization problems. Topics include enumeration and cutting plane methods. Application of these methods to integer and combinatorial models. Special treatment of Knapsack problems, routing and spanning tree problems, covering problems.

OPER 543: Simulation and Modeling **Credit hours: 3**

A comprehensive course in formulation, implementation and application of simulation models. Topics include data structures, simulation languages statistical analysis., Pseudo-random number generation and design of simulation experiments. (Students will apply simulation modeling methods to problems of their own design).

OR 553: Sequencing and Scheduling **Credit hours: 3**

Scheduling problems. Optimality of scheduling. Algorithms for flow. Shops and job-shops. Dynamic programming approach. Branch and bound method. Integer programming formulations.

Hard problems (The classes P and NP) NP completeness. Heuristic methods.

OPER 554: Network Flows	**Credit hours: 3**

Theory of flows in capacity constrained network, maximal flow. Feasibility criteria. Scheduling problems, matching and covering problems,. Minimum length and minimum cost sand associated combinatorial problems. Extension of max-flow. Min cut theorem to some Min-Max results in combinatorial optimization.

OPER 563: Reliability and Life Testing	**Credit hours: 3**

Structural properties of coherent systems. Reliability of coherent systems. Classes of life distributions based on ageing notions. Concepts of positive and negative dependence. Point and interval estimation procedure for life testing distributions. Testing reliability hypothesis.

OPER 574: Stochastic Model in OR (2)	**Credit hours: 3**

Design and decision problems under uncertainty. Markovian decision making. Reliability, maintenance and renewal theory of stochastic systems. Queuing, inventory production planning, computer network and information system.

OPER 579: Special Topics in O. R.	**Credit hours: 3**

Design and decision problems under uncertainty. Markovian decision making. Reliability, maintenance and renewal theory of stochastic systems. Queuing, inventory production planning, computer network and information system.

Program of Ph. D. in Statistics

Aims of the program

1- Provide the candidate with a broad knowledge of Statistics and mastery of a chosen area.
2- Equip the candidate with the ability for independent research in an active area of Statistics.
3- Meet the needs of higher educational institutions and research centers for highly qualified statisticians.
4- Satisfy locally the aspirations of a growing number of holders of M.Sc. degrees in Statistics for higher qualifications

Admission Requirements

An applicant for admission into a Ph.D. program must:
1- Hold M.Sc. degrees in Statistics from King Saudi University or its equivalent.
2- Pass a TOEFL examination with a score of at least 500.
3- Pass an interview held by a subcommittee of the department.

Degree Requirements

The Ph.D. program involves three stages: preparation for research (course requirement), certification that the preparation is adequate (comprehensive examination) and thesis research.

1- Course requirements

The student must successfully complete 18 credit hours of courses of which a maximum of 9 can be chosen from M.Sc. courses which he/she has not taken previously.

2- Comprehensive examination.

The student must pass a comprehensive examination to he held subject to the regulations and guidelines of the Graduate College and those of the college of Science.

3- The students must present a research thesis on a chosen topic in Statistics, reflecting creativity and originality.

Ph. D. Program in Statistics

The plan of study for the Department of Statistics and Operations Research

Specialization: Statistics

Degree: PH. D. degree of Science

Compulsory courses		
Course Code	**Name of course**	**Unit**
STAT 611	Probability theory I	3
STAT 621	Statistical Inference I	3
STAT 622	Statistical Inference II	3

Optional courses		
Course Code	**Name of course**	**Unit**
STAT 612	Probability theory II	3
STAT 613	Stochastic Process II	3
STAT 623	Survival analysis	3
STAT 624	Theory of nonparametric statistics	3
STAT 625	Advanced topics in experimental design	3
STAT 626	Theory of time series	3
STAT 627	Generalized linear models	3
STAT 628	Multivariate analysis	3
STAT 629	Special topics in statistics	3

Statistics Course Description

STAT 611 Probability theory I **Credit hours: 3**

Probability spaces in the framework of measure theory; Random variables as measurable function; Modes of convergence; Dominated convergence theorem: Distribution functions; Decomposition of a distribution function; Convergence of distribution functions; Weak compactness theorem and Helly-Bray lemma.

STAT 612 Probability theory II **Credit hours: 3**

Summability of independent random variable, laws of large numbers, convergence in distribution, characteristic functions, uniqueness and continuity theorems, the Lindeberg-Feller central limit theorem, degenerate convergence criterion

STAT 613 Stochastic Processes **Credit hours: 3**

Continuous time Markov processes. The Poisson and allied processes. The kolmogorow equations. Renewal theory.

STAT 621 Statistical inference I **Credit hours: 3**

Sufficiency, completeness likelihood, multiparameter estimation; linear estimation; maximum likelihood estimation; Bayesian estimation; large sample properties and procedures.

STAT 622 Statistical inference II **Credit hours: 3**

Testing statistical composite hypotheses; invariance principles, Bayesian statistics, large sample properties and procedures.

STAT 623 Survival analysis **Credit hours: 3**

Theory of analysis of randomly right censored failure time data: failure time models, inference in parametric models, the proportional hazards model, likelihood construction of failure time data, rank analysis in accelerated failure time models.

STAT 624 Theory of nonparametric statistics **Credit hours: 3**

Theoretical foundations of nonparametric statistics: theory of U-statistics, Noether's theorem and Pitman asymptotic relative efficiently, estimation and hypothesis testing with one and two sample location (scale) models, theory of linear rank statistics, applications to general linear models analyses.

STAT 625 Advanced topics in experimental design **Credit hours: 3**

The general pn factorial stem; split-plot experiments, blocking, fractional replication. Quasi factorial or lattice designs. Incomplete block designs - constructions and analysis. Response surface designs - objective, models and criteria. Continuous design theory; optimal design measure and some simple equivalence results. Multiresponse experiments. Designs for non-linear models.

STAT 626 Theory of time series **Credit hours: 3**

The Ito calculus and stochastic differential equations, stochastic integrals, ergodic theorems. Non-stationary time series and evolutionary spectra. Prediction, filtering and control of non-stationary processes. Nonlinear (bilinear, threshold, and exponential autoregressive) time series models. Special topics in recent time series research.

STAT 627 Generalized linear models **Credit hours: 3**

Theory of generalized linear models, quasi-likelihood models, higher order asymptotic, generalized estimating equa, GLIM computer package.

STAT 628 Multivariate analysis **Credit hours: 3**

Singular transformations and the generalized Jocobian. The multivariate normal distribution, Wishart distribution, and the U distribution. Distribution of the latent roots of one Wishart matrix in the metric of another. Noncentral counterparts of these distributions. Introduction of zonal polynomials.

STAT 629 Special topics in Statistics **Credit hours: 3**

This course offers either some important topics which are not included in other enlisted courses or some special research topics of current research interest.

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