SCHOOL OF MATHEMATICAL SCIENCES

SCHOOL OF MATHEMATICAL SCIENCES

Introduction

The School of Mathematical Sciences started with the establishment of the Department of Mathematics in 1970, which was also the establishment year of UKM. In 1978, the Unit of Statistics and Computer Science was established in the Department of Mathematics. In 1982, the Department of Mathematics was upgraded to a faculty, known as the Centre for Quantitative Studies and it was expanded to include the Department of Mathematics, Statistics and Computer Science. Later in 1991, the center was renamed as the Faculty of Mathematical and Computer Sciences. In 1994, this faculty separated into two faculties, namely the Faculty of Mathematical Sciences and the Faculty of Information Science and Technology. In 1996, the Faculty of Mathematical Sciences established the Centre for Quality and Productivity Improvement, in order to promote mathematical sciences to the general public. On 19th. July 1999, the faculty became the School of Mathematical Sciences within the Faculty of Science and Technology. The establishment of the School of Mathematical Sciences integrates knowledge in various major fields of mathematical sciences such as Mathematics, Statistics, Actuarial Science and Quality & Productivity Improvement.

Research Areas and Degrees Offered

The School of Mathematical Sciences conducts research in various fields of study such as Algebra, Complex Analysis, Group Theory, Fuzzy Mathematics, Fluid Mechanics, Dynamical Systems, Numerical Methods, Computational Mathematics, Mathematical Modeling, Biomechanics, Optimization, Ethno mathematics, History and Philosophy of Mathematical Sciences, Management Mathematics, Financial Mathematics, Actuarial Modeling, Multilevel Modeling, Statistical Modeling, Medical Statistics, Social Statistics, Traffic Studies, Time-Series Modeling and Forecasting, Stochastic Process, Sampling Techniques, Image Processing, Total Quality Management, Process Control and Quality Improvement as well as Productivity Measurement.

At postgraduate level, the School of Mathematical Sciences is offering the following programmes:

a) Doctor of Philosophy

- Mathematics
- Statistics
- Quality and Productivity Improvement

b) Master of Science

Thesis

- Mathematics
- Statistics

Course Work

- Mathematics
- Statistics
- Quality and Productivity Improvement

Preliminary Course Work

- Statistics

Entry Requirements

Candidate applying for these program in the School of Mathematical Sciences must possess:

Doctor of Philosophy

a) Master of Science degree in the field of mathematical sciences from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Other equivalent qualifications to Master of Science Degree or other qualifications such as experience approved by the Senate; or
c) Master of Science students in Universiti Kebangsaan Malaysia with excellent performance applying for conversion to Doctor of Philosophy program and supported by the Postgraduate Committee and approved by the faculty; or
d) Bachelor of Science degree or other equivalent qualifications to a Bachelors Degree with a good Cumulative Grade Point Average (CGPA) of at least 3.67 from Universiti Kebangsaan Malaysia or other universities approved by the Senate.

Master of Science

a) Bachelor of Science degree with a good CGPA in the field of mathematical sciences from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Bachelors Degree with a good CGPA in the fields of science, technology and medical or Bachelors Degree in the fields of social sciences from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
c) Bachelors Degree in the fields of science, technology and medical or Bachelors Degree in the field of social sciences from Universiti Kebangsaan Malaysia or other universities approved by the Senate with related and suitable working experience.

Program of Study

Doctor of Philosophy

All candidates of this program are required to register course STPD6014 Research Methodology and register for the thesis for each semester until completion of the academic program. Students are required to schedule meetings with their supervisor or postgraduate committee for no less than 40 hours per semester for full time students and 20 hours per semester for part-time students.

Master of Science

Thesis

Candidates taking the MSc program by thesis are required to take 12 credit hours of courses which comprise STPD6014 Research Methodology and two course that is related to the field of research to be studied to complete for Master of Science program.

Course Work

Candidates taking the MSc program by course work are required to take and pass at least 32 credit hours of courses (core and elective courses) and to complete 8 credit hours Research Project.

Preliminary Course Work

Candidates accepted to the MSc (Statistics) program by course work but do not have good foundation of statistics must take preliminary course work. They are required to take three courses totaling of 12 units. The candidates are required to get grade B for all these courses in order for them to continue doing MSc (Statistics).

DOCTOR OF PHILOSOPHY (MATHEMATICS)

PROGRAM EDUCATIONAL OBJECTIVE (PEO)

PEO1: To produce outstanding moral and character, ethical and competitive students.
PEO2: To equip students with the ability to translate and synthesize their understanding towards nature, human and development.
PEO3: To equip students with the awareness towards environment and uphold the established development.
PEO4: To equip students with the ability to utilize the mathematical problem solving methods such as analysis, modeling, programming and mathematical software applications in addressing the development issues and current changes.
PEO5: To equip students with the scientific approaches in generating and sharing knowledge which is inter- and intra- discipline.
PEO6: To equip students with the high creativity and innovative ability and able to contribute ideas towards the policy establishment process, decision making and development implementation.

PROGRAM LEARNING OUTCOME (PLO)

PLO1: Able to apply the mathematical sciences knowledge.
PLO2: Able to design the methodology suitable to the problem encountered.
PLO3: Able to analyse and interpret outputs and generate new ideas based on the outputs.
PLO4: Able to gather, utilize and generate informations.
PLO5: Able to have strength to manage emotions.
PLO6: Able to honour noble character and aesthetical values towards the Creator, customers and societies.
PLO7: Able to lead, work in team and give priority to the success of team.
PLO8: Able to communicate effectively through speaking and writing both in Bahasa Melayu and English.
PLO9: Able to understand mathematical sciences solution in every dimension of life.
PLO10: Ability to recognize the needs of life long learning and practise in the whole life.
PLO11: Able to possess the entrepreneur character.

DOCTOR OF PHILOSOPHY (STATISTICS)

PROGRAM EDUCATIONAL OBJECTIVE (PEO)

PEO1: Produce highly skilled, ethical and competitive student.
PEO2: Equip students with the ability to translate and synthesize their understanding towards nature, human and development.
PEO3: Equip students with the awareness towards environment and uphold the established development.
PEO4: Equip students with the ability to utilize the mathematical problem solving method such as analysis, modelling, programming and mathematic software application in addressing the development issues and current changes.
PEO5: Equip students with the scientific approaches in generating and sharing knowledge which is inter- and intra- discipline in nature; and

PEO6: Equip students with the high creativity and innovative ability and able to contribute ideas toward the policy establishment process, decision making and development implementation.

PROGRAM LEARNING OUTCOME (PLO)

PLO1: Able to apply the statistics knowledge.
PLO2: Ability to design the methodology suitable to the problem encountered.
PLO3: Ability to analyse and interpret outputs and generate new ideas based on the outputs.
PLO4: Able to gather, utilize and generate information.
PLO5: Strength to manage emotion.
PLO6: Honour noble character and aesthetical values towards the Creator, customers and society.
PLO7: Able to lead, work in a team and give priority to the success of a team.
PLO8: Able to communicate effectively through speaking and writing both in Bahasa Malaysia and English.
PLO9: Ability to understand statistics solution in every dimension of life.
PLO10: Ability to recognize the needs for continuous learning and practice it in the whole life.
PLO11: Possess the entrepreneur characteristics.

DOCTOR OF PHILOSOPHY (PRODUCTIVITY AND QUALITY IMPROVEMENT)

PROGRAM EDUCATIONAL OBJECTIVE (PEO)

PEO1: Produce highly skilled, ethical and competitive student.
PEO2: Equip students with the ability to translate and synthesize their understanding towards nature, human and development.
PEO3: Equip students with the awareness towards environment and uphold the established development;
PEO4: Equip students with the ability to utilize the mathematical problem solving method such as analysis, modelling, programming and mathematic software application in addressing the development issues and current changes;
PEO5: Students with the scientific approaches in generating and sharing knowledge which is inter- and intra- discipline in nature; and
PEO6: Equip students with the high creativity and innovative ability and able to contribute ideas toward the policy establishment process, decision making and development implementation.

PROGRAM LEARNING OUTCOME (PLO)

PLO1: Able to apply the quality and productivity knowledge.
PLO2: Ability to design the methodology suitable to the problem encountered.
PLO3: Ability to analyse and interpret outputs and generate new ideas based on the outputs.
PLO4: Able to gather, utilize and generate information.
PLO5: Strength to manage emotion.
PLO6: Honour noble character and aesthetical values towards the Creator, customers and society.
PLO7: Able to lead, work in a team and give priority to the success of a team.

PLO8: Able to communicate effectively through speaking and writing both in Bahasa Malaysia and English.
PLO9: Ability to understand statistics solution in every dimension of life.
PLO10: Ability to recognize the needs for continuous learning and practice it in the whole life.
PLO11: Possess the entrepreneur characteristics.

MASTER OF SCIENCE (MATHEMATICS)

Introduction

This program is divided into three modules as follows:

- Pure Mathematics
- Applied Mathematics
- Management and Financial Mathematics

Entry Requirements

Candidates who wish to apply must have the following qualifications:

- Bachelor Degree in mathematics with a good CGPA and sufficient pure mathematics component from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
- Bachelor Degree in mathematics with a good CGPA and sufficient classical applied mathematics component from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
- Bachelor Degree in mathematical sciences (including management science, statistics, statistical economy, information science and technology) with a good CGPA from Universiti Kebangsaan Malaysia or other universities approved by the Senate.

PROGRAM EDUCATIONAL OBJECTIVE (PEO)

PEO1: To produce outstanding moral and character.
PEO2: To equip students with the ability to translate and synthesize their understanding towards nature, human and development.
PEO3: To equip students with the awareness towards environment and uphold the established development.
PEO4: To equip students with the ability to utilize the mathematical problem solving methods such as analysis, modeling, programming and mathematical software applications in addressing the development issues and current changes.
PEO5: To equip students with the scientific approaches in generating and sharing knowledge which is inter and intra discipline.
PEO6: To equip students with the high creativity and innovative ability and able to contribute ideas towards the policy establishment process, decision making and development implementation.

PROGRAM LEARNING OUTCOME (PLO)

PLO1: Able to apply the mathematical sciences knowledge.
PLO2: Able to design the methodology suitable to the problem encountered.
PLO3: Able to analyse and interpret outputs and generate new ideas based on the outputs.
PLO4: Able to gather, utilize and generate informations.
PLO5: Able to have strength to manage emotions.
PLO6: Able to honour noble character and aesthetical values towards the Creator, customers and societies.

PLO7: Able to lead, work in team and give priority to the success of team.
PLO8: Able to communicate effectively through speaking and writing both in Bahasa Melayu and English.
PLO9: Able to understand mathematical sciences solution in every dimension of life.
PLO10: Ability to recognize the needs of life long learning and practise in the whole life.
PLO11: Able to possess the entrepreneur character.

Program Structure

Candidates pursuing the program by course work must register and pass at least 32 credit hours (core and elective courses) and complete a research project of 8 credit hours.

Candidates taking the MSc program by thesis are required to take 12 credit hours of courses which comprise STPD6014 Research Methodology and two courses that related to the field of research to be studied to complete for Master of Science program.

STPD6014 Research Methodology
and 8 credit hours of courses that is related to the field of thesis research
and approved by supervisor.

Pure Mathematics Module

SEMESTER	CORE COURSES	ELECTIVE COURSES	TOTAL
I	STPD6014 Research Methodology STQM6114 Topology STQM6124 Algebra STQM6134 Functional Analysis	Choose three: STQM6024 Biomechanics STQM6034 Decision and Game Analysis STQM6044 Cryptology STQM6054 Linear Programming STQM6064 Mathematical Modeling and Methods STQM6074 Numerical Analysis STQM6214 Fuzzy Mathematics STQM6234 Argotic Theory STQM6254 Combinatorial Group Theory STQM6274 Measure Theory and Integration STQM6294 History and Philosophy of Mathematics STQM6324 Numerical Methods for Heat Transfer and Fluid Flow STQM6414 Dynamical System STQM6524 Linear Modeling of Non-Deterministic Dynamical System STQM6534 Fluid Mechanics STQM6624 Simulation	
II	STQM6224 Complex Analysis STQM6988 Research Project		

TOTAL	**28**	**12**	**40**

Applied Mathematics Module

SEMESTER	CORE COURSES	ELECTIVE COURSES	TOTAL
I	STPD6014 Research Methodology STQM6414 Dynamical System STQM6074 Numerical Analysis STQM6534 Fluid Mechanics	Choose three: STQM6024 Biomechanics STQM6034 Decision and Game Analysis STQM6044 Cryptology STQM6084 Linear Programming STQM6114 Topology STQM6124 Algebra STQM6134 Functional Analysis STQM6214 Fuzzy Mathematics STQM6224 Complex Analysis STQM6234 Ergodic Theory STQM6254 Combinatorial Group Theory STQM6274 Measure Theory and Integration STQM6294 History and Philosophy of Mathematics STQM6324 Numerical Methods for Heat Transfer and Fluid Flow STQM6524 Linear Modeling of Non-Deterministic Dynamical System STQM6624 Simulation	
II	STQM6064 Mathematical Modeling and Methods STQM6988 Research Project		
TOTAL	**28**	**12**	**40**

Management and Financial Mathematics Module

SEMESTER	CORE COURSES	ELECTIVE COURSES	TOTAL
I	STQA6024 Security Derivatives and Risk Management STQM6654 Mathematical Economics and Finance in Business STQS6444 Time Series Modeling and Forecasting STPD6014 Research Methodology	Choose three: STQM6084 Linear Programming STQA6934 Risk Management and Insurance STQM6034 Decision and Game Analysis STQM6044 Cryptology STQM6214 Fuzzy Mathematics STQM6224 Complex Analysis STQS6244 Stochastic Processes STQM6294 History and Philosophy of Mathematics STQM6324 Numerical Methods for Heat Transfer and Fluid Flow STQM6414 Dynamical System STQM6524 Linear Modeling of Non-Deterministic Dynamical System STQM6624 Simulation STQS6274 Statistical Computing	
II	STQA6014 Investment Analysis and Portfolio Management STQM6988 Research Project		
TOTAL	**28**	**12**	**40**

Courses Offered

STQA6014 Investment Analysis and Portfolio Management
STQA6024 Security Derivatives and Risk Management
STQA6034 Issues in Risk Management and Insurance
STQM6024 Biomechanics
STQM6034 Decision and Game Analysis
STQM6044 Cryptology
STQM6064 Mathematical Modeling and Methods
STQM6074 Numerical Analysis
STQM6084 Linear Programming

STQM6114	Topology
STQM6124	Algebra
STQM6134	Functional Analysis
STQM6214	Fuzzy Mathematics
STQM6224	Complex Analysis
STQM6234	Ergodic Theory
STQM6254	Combinatorial Group Theory
STQM6274	Measure Theory and Integration
STQM6294	History and Philosophy of Mathematics
STQM6324	Numerical Methods for Heat Transfer and Fluid Flow
STQM6414	Dynamical System
STQM6524	Linear Modeling of Non-Deterministic Dynamical System
STQM6534	Fluid Mechanics
STQM6624	Simulation
STQM6654	Mathematical Economics and Finance in Business
STQM6988	Research Project
STQS6244	Stochastic Process
STQS6274	Statistical Computing
STQS6444	Time Series Modeling and Forecasting
STPD6014	Research Methodology

Course Contents

STQA6014 Investment Analysis and Portfolio Management

The course aims to introduce the use of various investment instruments and its role in risk management. The concept of risks and returns are covered comprehensively. Efficient diversification is introduced with the emphasis on the construction of efficient portfolio. The different kinds of investment instruments are also introduced. Share valuation methods and portfolio theories such as the Markowitz theory, the One-Factor model, the Capital Asset Pricing Model are studied. The fundamental and technical analyses are also discussed. The behavioral finance theory such as the Efficient Market Hypothesis is also included. At the end of the semester, students are expected to present, discussed and submit a project.

References

Bodie, Z., Kane, A. & Marcus, A. 2011.*Investments & Portfolio Management.* 9th ed. New York: Mc-Graw Hill.

Elton, E.J, Gruber, M.J, Brown, S.J. &Goetzmann, W.N. 2007.*Modern Portfolio Theory and Ivestment Analysis*.7th. Ed. New Jersey: John Wiley.

Reilly, F.K. & Brown K.C. 2000. *Investment Analysis and Portfolio Management.*6th Ed. New York : South-Western Thomson.

John L., Donald L., Jerald E. & Dennis W. 2007. *Managing Investment Portfolios: A Dynamic Process.*London: John Wiley.

STQA6024 Security Derivatives and Risk Management

This course is an introduction to the management of risk which is fast developing in academia as well as in industrial finance. It will focus on risk management using market securities. Basic concepts and methods of risk management using market securities will be covered such as options, future securities and exchangeable securities. Evaluation of various security derivatives will be included. At the end of the course it is hoped the student will be able to study the application of derivatives in the management of various risks such as market risk, financial risk, rate of interest risk and credit risk.

References

Chance, D. M. 2004. *An Introduction to Derivatives & Risk Management.* 6th. Ed. Mason, OH: Thomson South-Western.

Chorafas, D. 2008. *Instruments: Bonds, Swaps, Options, and Hedging.* London: McGraw-Hill

Capinski M. & Zastawniak T. 2000. *Mathematics for Finance: An Introduction to Financial Engineering.* New York: Springer.

Cuthbertson K. & Nitzsche. 2002. *Financial Engineering: Derivatives and Risk Mangement*. New York: John Wiley.

Wilmott, Howison S. & Dewynne J. 1995. *The Mathematics of Financial Derivatives.* Cambridge: Cambridge University Press.

STQA6034 Issue in Risk Management and Insurance

This course aims to discuss the concept of risk, the principle of risk management and the application of risk management in insurance. The students will be exposed to several actuarial approaches used in non-life insurance businesses. At the end of this course, the students are expected to understand the concepts of risk and risk management, classify risk into several categories, understand the principles of insurance and their relationship with risk management, understand the structure of insurance market in Malaysia, learn the operation of non-life insurance business, study and analyze the factors that affect premium and analyze insurance claims.

References

Denuit, M., Marechal, X., Pitrebois, S. & Walhin, J.F. 2007. *Actuarial Modeling of Claim Counts.* London: John Wiley & Sons.

Klugman, S.A., Panjer, H.H. & Willmot, G.E. 2004. *Loss Models, From Data to Decisions.* 2nd. Ed. New Jersey: John Wiley & Sons.

Lee, H.L. 1997. *The Insurance Industry in Malaysia: A Study in Financial Development and Regulation.* Kuala Lumpur: Oxford University Press.

Redja, G.E. 2003. *Principles of Risk Management and Insurance.* 8th. Ed. New York: Addison-Wesley.

Trieschmann, J.S., Gustavson, S.G. & Hoyt, R.R. 2001. *Risk Management and Insurance.* 11th. Ed. Ohio: South Western College Publishing.

STQM6024 Biomechanics

The course begins with the general equations of three-dimensional motion. The variables in these equations are explained and a summary on how these variables can be determined experimentally or theoretically is presented. The course will discuss selected methods for quantifying biomechanical data experimentally, which includes discussion on force measurements, accelerometry, measurement of motion with optical methods, electromyography, and strain measurement. The goal is to explain the principles involved in the experimental techniques, and to compare the different techniques. Next the course will discuss the place of mathematical modeling in biomechanics. The concept of force system analysis is discussed. The course will look into various mathematical models that were determinate. The indeterminate systems are also discussed as well, including solving it using optimization theory. Lastly the course discusses simulation as a tool of biomechanical research.

References

Allard, P. Stokes, I. A. F. &Blanchi, J. 1995. *Three-Dimensional Analysis of Human Movement.* Human Kinetics: Champaign, IL.

Chaffin, D. B., Andersson, G. B. J. & Martin, B. J. 2006.*Occupational Biomechanics.*4th. ed. New York: John Wiley & Sons.

Humphrey, J. &DeLange, S. 2004. *An Introduction to Biomechanics: Solids and Fluids, Analysis and Design.* Berlin: Springer-Verlag.

Nigg, B. M. & Herzog, W. 2007.*Biomechanics of TheMusculo-Skeletal System*.3rd.ed. London: John Wiley & Sons.
Winter, D. A. 2005. .B*iomechanics and Motor Control of Human Movement.* 3rd. ed. London: John Wiley & Sons.
Yamaguchi, G.T. 2006. *Dynamic Modelling of Musculoskeletal Motion. A Vectorized Approach for Biomechanical Analysis in Three Dimensions.* New York: Springer.

STQM6034 Decision and Game Analysis

This course aims at showing students that decision problems with limited number of alternatives can be solved by using decision analysis techniques. Instruments that are used to solve these problems depend on the type of problems. Analytic Hierarchy Process, ELECTRE and TOPSIS methods are used to solve problems with certainty. Decision tree is the best instrument to obtain solution for problems which involve probability. For decision problems with uncertainty, criteria that reflect decision maker's attitude towards risks are used, while game theory is used to obtain the best decision for two competitors with contradicting goals, under each competitor's worst condition.

References

Binmore, K. 2007. *Playing for Real: A Text on Game Theory*. New York: Oxford University Press.
Clemen, R.J. & Reilly, T. 2005. *Making Hard Decisions: An Introduction to Decision Analysis*. Pacific Grove: Duxbury.
Meyerson, R. 1991. *Game Theory: Analysis of Conflict*. Cambridge: Harvard University Press.
Winston, W.L. 2004. *Operations Research: Applications and Algorithms*. 4th Ed. Belmont: Brooks/Cole-Thomson Learning.
Zeleny, M. 1982. *Multiple Criteria Decision Making*. New York: McGraw Hill.

STQM6044 Cryptology

Cryptology is the science of secure communication which embraces both cryptography and cryptanalysis. The symmetric and asymmetric systems of writing secret codes (cryptography) will be introduced and the development of cryptosystem, digital signature and other cryptographic techniques such as threshold cryptography, secret sharing, identification and authentication scheme and key agreement protocol will be thoroughly explained and discussed. The techniques of breaking codes (cryptanalysis) will also be investigated throughout the course.

References

Jeffrey Hpffstein, Jill Pipher & Joseph H. Silverman. 2010. *An Introduction to Mathematical Cryptography.* Springer.
Christof Paar & Jan Pelzl. 2010. *Understanding Cryptography.* Springer.
Willian Stallings. 2011. *Cryptography and Network Security.* Pearson.
Jonathan Katz, Yehuda Lindell. 2008. *Introduction to Modern Cryptography.* Chapman & Hall/CRC.
Douglas Robert Stinson. 2006. *Cryptography: Theory and Practice.* Chapman & Hall/CRC.

STQM6064 Mathematical Modelling and Methods

Mathematical modelling is a process of developing mathematical presentation of a phenomenon for obtaining better understanding of it. This course aims to train students in developing, analyzing and solving mathematical models for certain complex problems (in particular a deterministic model in physical sciences). The basic concepts of mathematical modelling will be explained. Scaling analysis, approximations and dimensional analysis procedures will be discussed first. Both linear and non-linear models will be considered.

Analytical solution methods discussed in this course include the perturbation expansion method, calculus of variation and Fourier series.Utilization of computer algebra system/package such as Maple and Mathematica will be stressed.

References

Bender, C.M. & Orszag, S.A. 1999. *Advanced Mathematical Methods for Scientists and Engineers: Asymptotic Methods and Perturbation Theory.* New York: Springer-Verlag.

Bender, E. 2003. *An Introduction to Mathematical Modelling.* New York: Dover.

Debnath, L. 2005. *Nonlinear Partial Differential Equations for Scientists and Engineers*. Boston: Birkhauser.

Gregory, R.D. 2006. *Classical Mechanics*. Cambridge: CUP.

Riley, K.F., Hobson, M.P. & Bence, S.J. 2007. *Mathematical Methods for Physics and Engineering: A Comprehensive Guide.* Cambridge: CUP.

STQM6074 Numerical Analysis

This course covers numerical methods for solving ordinary/ partial differential equations (ODEs/PDEs). The problems considered include initial value problems and boundary value problems for ODEs. Numerical methods discussed include one-step and multi-step methods with fixed or variable step size for stiff and non-stiff as well as chaotic equations/system of equations. Further, the topics covered include stability and error analysis; introduction to numerical method for PDEs such as finite difference methods; analysis of hyperbolic and elliptic equations; convergence, consistency, order and stability methods. Applications to certain problems in engineering/science.

References

Iserles, A. 1997. *A First Course in the Numerical Analysis of Differential Equations.* Cambridge: CUP.

Butcher, J.C. 2003. *The Numerical Analysis of Ordinary Differential Equations: Runge-Kutta and General Linear Methods.* New York: John Wiley.

Knabner, P. & Angerman, L. 2002. *Numerical Methods for Elliptic and Parabolic Partial Differential Equations: An Applications-Oriented Introduction*. New York: Springer.

Larsson, S. & Thomee, V. 2005. *Partial Differential Equations with Numerical Methods.* New York: Springer.

Press, W.H., Teukolsky, S.A., Vetterling, W.T. & Flannery, B.P. 2007. *Numerical Recipes.* 3rd. Ed. The Art of Scientific Computing. Cambridge: CUP.

STQM6084 Linear Programming

The aim of this course is to introduce to the students the application of mathematical modeling methods for managerial decision makings. Several deterministic models will be discussed with a focus on how to model problems and derive solutions using LINGO computer software. Assignments in the form of case studies require students to use LINGO to obtain the solutions and write short reports. Among the topics discussed include linear programming, integer programming and goal programming problems, while emphasizing on the use of these methods in solving real world problems such as problems in network analysis, transportation and assignment problems, travelling salesman problems and efficiency analysis.

References

Ignizio, J.P. 1982. *Linear Programming in Single and Multiple Objective Systems.* New Jersey: Prentice Hall.

Schniederjans, M. 1995. *Goal Programming: Methodology and Applications.* Boston: Kluwer Academic Publishers.

Taha, H.A. 2007. *Operations Research: An Introduction.* 8th. Ed. New Jersey: Prentice Hall.

Tamiz, M. 1996. *Multi-Objective Programming and Goal Programming: Theories and Applications.* Berlin: Springer Verlag.

Winston, W.L. 2004. *Operations Research: Applications and Algorithms.* 4th. Ed. Belmont, CA: Brooks/Cole.

STQM6114 Topology

Topological spaces show up naturally in almost every branch of mathematics. This has made topology one of the great unifying ideas of mathematics. This course concerns with properties that are preserved under continuous deformations of objects that emerges through the development of concepts from geometry and set theory. The most basic and traditional division of topology namely point set topology will be considered.

References

Bredon, G.E. 1995. *Topology and Geometry.*3rd. Ed. New York: Springer Verlag.
Janich, K. 1995. *Topology*. LMS Students Text 14. Cambridge: CUP.
Munkres, J.R. 1999. *Topology*. London: Prentice-Hall.
Roseman, D. 1999. *Elementary Topology.* London: Prentice-Hall.
Schwarz, A.S. 1994. *Topology for Physicists.* Berlin: Springer Verlag.

STQM6124 Algebra

The course begins by recapitulating groups, rings and some related concepts. Group series. Polynomial rings, Evaluation homomorphism, Division algorithm. Irreducible polynomials. Field extensions: Kronecker Theorem, algebraic and transcendental elements, simple extensions, Vector concept in polynomial rings, Algebraic extensions, impossibilities in geometric constructions. Automorphism field, Isomorphism extension theorem, Spilt field, Separable extension. Totally inseparable extension. Galois Theory.

References

Fraleigh, J.B. 1988. *Kursus Pertama Aljabar Niskala.* Terj. Abu Osman Md Tap & Abdul Razak Salleh. Kuala Lumpur: Dewan Bahasa dan Pustaka.

Jones, A,. Morris, S.A. & Pearson, K.R. 1991. *Abstract Algebra And Famous Impossibilities.* New York: Springer-Verlag.

Lang, S. 1993. *Algebra*. 3rd. Edition. Reading, Mass.: Addison-Wesley

MacLane, S. & Birkoff, G. 1993. *Algebra*. 3rd. Edition. London: Collier-Macmillan.

Trignol, J-P. 2001. *Galois' Theory of Algebraic Equations.* Singapore: World Scientific.

STQM6134 Functional Analysis

This course aims at showing the relation between two important structures in mathematics, that is algebraic structure and topological structure. Combining these two structures into one mathematical system known as Banach algebra. This course begins with the introduction of Hilbert space and its properties. Next orthogonality, Banach space and its properties are discussed. Also discussed are linear operators on normed space, Hilbert spaces with the Hahn-Banach theorem, Banach algebra and spectral theory. Finally the notion of C*-algebras shall be introduced briefly.

References

Conway, J.B. 1985. *A Course in Functional Analysis*. New York: Springer Verlag.

Kutateladze, S.S. 1996. *Fundamentals of Functional Analysis.* Dordrecht: Kluwer Academic Publishers.

Lang, S. 1993. *Real and Functional Analysis.* New York: Springer Verlag.

Larcombe, G. & Levy, S. 1999. *Elements of Functional Analysis.* New York: Springer Verlag.
Yoshida, K. 1995. *Functional Analysis*. Berlin: Springer Verlag.

STQM6214 Fuzzy Mathematics

This course introduces fuzzy set as a generalization of classical set. Basic operations on fuzzy sets: fuzzy complement, fuzzy union and fuzzy intersection. *s*-norm and *t*-norm. averaging operators. Fuzzy relations. Projection and cylindric extension. Composition of fuzzy relations. Linguistic variables. Fuzzy IF-THEN rule. Interpretation of fuzzy IF-THEN rule. Fuzzy logic and approximate reasoning. Fuzzy rule base and fuzzy inference engine. Fuzzy systems and fuzzy theory.

References

Czogala, E. & Leski, J. 2000. *Fuzzy and Neuro-Fuzzy Intelligent Systems.* New York: Physica Verlag.
Li-Xin Wang. 1997. *A Course in Fuzzy Systems and Control*. London: Prentice-Hall.
Yager, R. 1994. *Essentials of Fuzzy Modeling and Control.* New York: John Wiley.
Zimmermann, H-J. 1996. *Fuzzy Set Theory and its Applications*. 2nd. Edition. New York: Springer-Verlag.

STQM6224 Complex Analysis

This course gives a view of analyticity of functions, the proof of Cauchy's theorem (in triangle, convex domain or in a disc), Goursat's theorem with various versions, homotopy path, singularities, maximum/minimum modulus theorem various versions, Rouche's theorem and Phragmen-Lindelof's theorem. Schwarz lemma and Riemann mapping theorem. This course also introduces a theorem in the space of analytic functions and shows the application of Runge's theorem to prove Cauchy's theorem and Mittag-Leffler's theorem. Harmonic functions including solutions to Dirichlet's problem and the application of Green's theorem to the onto functions are also introduced. This course also concentrate on application of Weierstrass factorization, gamma and zeta functions. Picard's theorem also will be introduced in the sense of singularities.

References

Ahlfors, L.V. 1990. *Complex Analysis: An Introduction to the Theory of Analytic Functions of One Complex Variable.* London: McGraw-Hill.
Bac, J. & Newman, D.J. 1997. *Complex Analysis.* New York: Springer Verlag.
Conway, J.B. 1995. *Functions of One Complex Variable II*. 2nd. Ed. New York: Springer Verlag.
Greene, R.E. & Krantz, S.G. 1997. *Function Theory of One Complex Variable.* New York: John Wiley.
Lang, S. 1993. *Complex Analysis.* 3rd. Ed. New York: Springer Verlag.

STQM6234 Ergodic Theory

Ergodic theory is a quantitative study of the long term behavior of a system. The collection of all states of a system constitute a space X and the evolution of the system is represented by a transformation whereby if x represents the state of the system at one particular time, then *T(x)* represents the state of the system after one unit of time. A study will be conducted on *X* which is a measure space (and T measure-preserving) and topological space (with T continuous). The main objective is to understand as T^n increases.

References

Cornfeld, I., Fomin, F. & Sinai, Y. 1991. *Ergodic Theory*. New York: Springer Verlag.

Katok, A. & Hasselblatt, B. 1995. *Introduction to the Modern Theory of Dynamical Systems.* Cambridge, Mass.: Cambridge University Press.
Lind, D. & Marcus, B. 1999. *Introduction to Symbolic Dynamics.* London: Cambridge University Press.
Rudolph, D. 1999. *Fundamentals of Measurable Dynamics.* Oxford: Clarendon Press.
Walters, P. 1982. *An Introduction to Ergodic Theory.* New York: Springer Verlag.

STQM6254 Combinatorial Group Theory

The course aims to display geometrical techniques and ideas to study free groups and group presentations, basic to the combinatorial group theory. Variety of equivalent classes will be discussed and related groups will be constructed using various geometrical techniques. Geometrical techniques discussed include graph, group of graph, complexes, picture and diagram. Then several selected and latest articles will be discussed.

References

Baumblag, G. 1993. *Topics in Combinatorial Group Theory. Lectures in Mathematics.* Zurich: Birkhauser.
Cohen. D.E. 1989. *Combinatorial Group Theory: A Topological Approach. LMS Students Text 14.* Cambridge: CUP.
Collins, D.J. 1998. *Combinatorial Group Theory and Applications to Geometry.* New York: Springer Verlag.
Fine, B. & Rosenberger, G. 1999. *Algebraic Generalizations of Discrete Groups: a Path to Combinatorial Group Theory Through One-relator Products.* London: Marcel Dekker.
Johnson, D.L. 1990. *Presentation of Groups. LMS Students Text 15.* Cambridge: CUP.

STQM6274 Measure Theory and Integration

Firstly the idea of σ--algebra is introduced. Next a measure is defined as a real valued function with domain σ-algebra. Next outer measures is discussed (including metric outer measures) and with it is defined measurable sets, abstract measure spaces, measurable functions and convergence measurable functions. Using these concepts, properties of integrable functions, convergence theorems, spaces and important inequalities are discussed. Examples of definite integrals like Riemann integral, Lebesgue integrals and Lebesgue-Stieltjes integrals will be briefly discussed. Finally the concept of measures is extended to sign measures, complex valued measures and integration on product spaces.

References

Bartle, R. G. 1995. *The Elements of Integration and Lebesgue Theory.* New York. John-Wiley.
Burk, F. 1997. *Lebesgue Measure and Integration: An Introduction.* New York. John-Wiley.
Cohn, D. L. 1980. *Measure Theory.* Boston. Birkhauser.
Konig, H. 1997. *Measure and Integration: An Advanced Course in Basic Procedure and Applications.* New York. Springer-Verlag.
Munroe, M. E. 1971. *Measure and Integration.* 2nd. Ed. Reading, Mass. Addison-Wesley.
Strook, D. W. 1998. *A Concise Introduction to the Theory of Integration.* New York. Sringer-Verlag.
Weir, A. J. 1999. *Lebesgue Integration and Measure.* Cambridge: Cambridge University Press.

STQM6294 History and Philosophy of Mathematics

This course will deepen the history and philosophy of mathematics in various aspects. Topics to be discussed include mathematical reality from metaphysical, epistemological, logical and axiological aspect will be examined together with the relationship between mathematics and

belief systems. History and philosophy of the Islamization of knowledge and the indigenization of knowledge will also be discussed.

References

Abdul Latif Samian. 1997. *Falsafah Matematik.* Kuala Lumpur: Dewan Bahasa dan Pustaka.
Ascher, M. 1991. *Ethnomathematics.* Pacific Grove, Ca.: Brooks-Cole.
Lakatos, I. 2001. *Pemalsuan dan Tatakaedah Aturcara Penyelidikan Sains.* Terj. Shaharir Mohamad Zain. Bangi: Penerbit Universiti Kebangsaan Malaysia.
Putnam, H. 1990. *Realism with a Human Face.* London: Harvard Univ. Press.
Shaharir Mohamad Zain. 2000. *Pengenalan Sejarah dan Falsafah Sains.* Bangi: Penerbit Universiti Kebangsaan Malaysia.

STQM6324 Numerical Methods for Heat Transfer and Fluid Flow

This course will present heat transfer and fluid flow models and their numerical solutions. The course begins with heat transfer and fluid flow model formulations. Steady and unsteady heat conduction up to three dimensions will be discussed. Next, the course discusses Crank-Nicholson method, steady and unsteady convection and diffusion up to three dimensions, and their numerical solution schemes include hybrid and power laws. Flow regimes and numerical solution methods will also be presented.

References

Chen, C.J., Bernatz, R., Carlson, K.D. & Lin, W. 2000. *The Finite Analytic Method in Flows and Heat Transfer*. New York: Hemisphere Publ.
Holman, J.P. 1996. *Heat Transfer.* New York: McGraw-Hill.
Incropera, F.P. & Dewitt, D.P. 2001. *Fundamentals of Heat and MassTransfer*. 5th. Ed. London: John Wiley.
Tannehill, J.C., Anderson, D.A. & Pletcher, R.H. 1997. *Computational Fluid Mechanics and Heat Transfer*. 2nd. Ed. Philadelphia: Taylor & Francis.
Temam, R. 1984. *Navier-Stokes Equations. Theory and Numerical Analysis.* 2nd. Ed. Amsterdam: North-Holland.

STQM6414 Dynamical Systems

The course deals with numerical methods for heat transfer and fluid flow models. The course begins with the basics for numerical solutions of ODEs and PDEs. The stability analysis of numerical methods is given. Formulation of the fluid flow and heat transfer problems are discussed. Steady and unsteady heat conduction problems up to three dimensions are considered. Some numerical methods like the particular Crank-Nicholson scheme are discussed.

References

Anderson, J. D. Jr. 1995. *Computational Fluid Dynamics: The Basics with Applications.* McGraw-Hill: New York.
Incropera, F.P. 2006. *Fundamentals of Heat and Mass Transfer*. 6th. Ed. London: Wiley.
Puckett, E.G. 2009. *Finite Difference Methods for Computational Fluid Dynamics.* CUP: Cambridge.
Tannehill, J. C., Anderson, A. A. & Pletcher, R. H. 1997. *Computational Fluid Mechanics and Heat Transfer*. Taylor & Francis: Philadelphia.
Tu, J., Yeoh, G.H. & Liu, C. 2007. *Computational Fluid Dynamics: A Practical Approach.* Butterworth: Heinemann.

STQM6524 Non-Deterministic Linear Dynamical Systems Modeling

This course is designed to exhibit the capability to model the dynamical system with non-deterministic condition as a stochastic process which fulfills the linear stochastic differential

equations. It, furthermore can lead to the stochastic integral. This includes various Newtonian dynamical systems with noise, planning of monitoring system, management and screening of information. From this model, the definition of the concept of stochastic process is exhibited and in addition the analytical and numerical Ito's Stochastic Calculus is constructed to solve the mentioned model. The relationship between the stochastic differential equations and the diffusion process is discusses to the research boundary.

References

Friedman, A. 2006. *Stochastic Differential Equations and Applications*. Dover Publication.
Mikosch, T. 1998. *Elementary Stochastic Calculus with Finance in View.* World Scientific.
Oksendal, B. 2003. *Stochastic Differential Equations: An Introduction with Applications.* Springer.
Ross, S.M. 1996. *Stochastic Processes.* John Wiley.

STQM6534 Fluid Mechanics

The aim of this course is to show how the ideal and viscous fluids can be modelled mathematically, and further, to investigate the behaviour of the fluids analytically and numerically, especially towards the Navier-Stokes equation. This course starts with general introduction to fluid and the principle of fluid static and kinematic. Discussion on ideal fluid includes continuity, Euler and Bernoulli equations. Potential flow and incompressible flow will also be discussed. Most parts of this course discuss viscous fluid, which leads to Navier-Stokes equation, its derivations and exact solutions, as well as steady and unsteady flows. Basic flows, Stokes flow, laminar and turbulent flows, dimensional analysis, similarity method as well as Reynolds number and its importance will also be discussed. In addition, boundary layer theory and fluid instabilities will also be discussed in detail.

References

Acheson, D.J. 1990. *Elementary Fluid Dynamics (Oxford Applied Mathematics and Computing Science Series).* Oxford: Oxford University Press.
Batchelor, G.K. 2000. *An Introduction to Fluid Dynamics.*3rd. ed.Cambridge: Cambridge University Press
Chorin, A.J. & Marsden, J.E. 2000. *A Mathematical Introduction to Fluid Mechanics.*3rd.ed. New York: Springer Verlag.
Galdi, G.P., Heywood, J.G. &Rannacher, R. 2000. *Fundamental Directions in Mathematical Fluid Mechanics.* Berlin: Birkhauser.
White, F. M. 2005. *Viscous Fluid Flow.*3rd.ed. New York: McGraw-Hill.

STQM6624 Simulation

This course introduces to the students the concept and applications of simulation systems. The aim is to enable the students to model, simulate and analyse simple but representative system quite soon throughout the course, and to encourage them to further explore the results experimentally. Static, discrete and dynamic system simulation models will be explained. The topics include simulation concept, modelling, simulation and analyses of various systems especially those that use Excel, @Risk and Arena. The scientific aspect in the management of simulation system projects is also covered.

References

Banks, J., Carson II, J.S., Nelson, B.L. & Nicol, D.M. 2005. *Discrete-event System Simulation.* 4th. Ed. New Jersey: Prentice Hall.

Chung, C.A. 2004. *Simulation Modeling Handbook: A Practical Approach.* Boca Raton: CRC Press.
Kelton,W.D., Sodowski, R.P. & Swets N.B. 2010. Simulation with Arena. 5th Ed. Boston:Mc-Graw Hill.
Law, A.M. & Kelton, W.D. 2000. *Simulation Modeling and Analysis.* Boston: McGraw Hill.
Seila, A.F., Ceric, V.R & Tadikamalla, P. 2004. *Applied Simulation Modeling.* Belmont: Brooks/Cole.

STQM6654 Mathematics of Economy and Finance in Business

Mathematics of Economy and Finance is a building block to learners in the field of finance. It exposes the student to fundamental concepts of financial mathematics, and how those concepts are applied in calculating present and accumulated values for various streams of cash flows as a basis for future use in: reserving, valuation, pricing, asset/liability management, investment income, capital budgeting and valuing contingent cash flows. The candidate will also be given an introduction to financial instruments, including derivatives. A basic knowledge of calculus and an introductory knowledge of probability is assumed.

References

Zaidi Isa & Noriza Majid. 2011. Matematik Kewangan: Aplikasi Terhadap Kewangan Islan Dan Konvensional. Penerbit UKM, Bangi.
Kellison, S.G. 2009. *Theory of Interest.*3rd ed. Homewood: Irwin.
Broverman, S.A. 2010. *Mathematics of Investment and Credit.* 5th ed. ACTEX Publications, Inc.
Daniel, J.W., &Vaaler, L.J.F. 2009. *Mathematical Interest Theory.* 2nd ed.The Mathematical Association of America.
McDonald, R.L. 2006. *Derivatives Markets.* 2nd ed. Addison Wesley.
Ruckman, C.; and Francis, J. 2005. *Financial Mathematics: A Practical Guide for Actuaries and other Business Professionals.* 2nd ed. BPP Professional Education.

STQM6988 Research Project

Research project is a compulsory course, which is either a practical training, an industrial training, a literature review or a research. Every student does this project under the supervision of a supervisor. Each student must choose a suitable topic within his/her programme module and it must be approved by the supervisor. The student must complete a report, which is either a critical review to the selected topic, a new theory or a new model in its own way.

STQS6244 Stochastic Process

The aim of this course is to introduce the students to the theory of stochastic process. Among the topics to be discussed include discrete and continous time Markov chain. This include subtopics regarding the Chapman-Kolmogorov equation, Birth and Death process, limiting probabilities and some important properties of Markov process. Other topics to be discussed include the Poisson process and the Renewal process which include the subtopics of Homogeneous and Nonhomogeneous Poisson process, compound Poisson Process, decomposition of Poisson Process, Renewal equation, mean-value function, limit theorem and etc. The students will also be expose with the topics of Reliability theory, Brownian motion and the application of Markov Chain Monte Carlo method.

References

Ross, S.M. 2007. *Introduction to Probability Models. 9th edition.* Burlinton: Elsevier.

Kao, E.P.C. 1997. *An Introduction to Stochastic Processes.* California: Wadsworth Publishing Company.

Beichelt, F. E. & Fatti L.P. 2002. *Stochastic Process and Their Application.* London: Taylor & Francis.

Papoulis, A. & Pillai, S.U. 2002. *Probability, Random Variables and Stochastic Processes.* 4th Edition. New York: McGraw-Hill.

STQS6274 Statistical Computing

Students will be equipped with sufficient computing knowledge that useful for data analysis and statistical inferences. For these objectives they are given programming skills using S-plus and R. Utilizing the skills the students will be trained to write function for obtaining various statistical summaries, empirical distribution, nonparametric measures using quantiles and the quantile based distribution summaries. In addition the students will also be exposed to various methods for simulating random data. S-plus and R computing for classical and Bayesian statistical inference will be discussed. All the discussions are data and practical problems based. Re-sampling techniques for statistical inference - bootstrap and jackknife, order statistics will be explored together with testing hypothesis using permutation and Monte Carlo methods. Spatial data analysis.

References

Congdon, P. 2006. *Bayesian Statistical Modelling.* 2nd. Ed. USA: John Wiley.

Higgin, J.J. 2004. *An Introduction to Modern Nonparametric Statistics*. USA: Brook/Cole-Thomson Learning.

Lunneborg, C.E. 2000. *Data Analysis by Resampling: Concepts and Application*. USA: Duxbury Thomson Learning.

Venables W.N. & Ripley B.D. 2002. *Mordern Applied Statistics with S.* 4th. Ed. New York: Springer Verlag.

Tanner, M.A. 1993. *Tools for Statistical Inference, Method for the Exploration of Posterior Distribution and Likelihood Functions*. 2nd. Ed. New York: Springer Verlag.

STQS6444 Time Series Modeling and Forecasting

The objectives of this course are estimating simple regression models, explaining the techniques for modeling trend and volatility in time series data, explaining the cointegrating relation between two or more time series, and at the same time highlighting several major issues in time series analysis that are related to stationarity, trend, volatility, and cointegration. In particular, for modeling trend and volatility, the focus will be on the ARCH-GARCH models. As for cointegration, the error-correction mechanism and the Johansen approach will be discussed. At the end of the semester, the students will be required to write one short report on the application of statistical testing methods and model analyses that are covered during the semester.

References

Enders, W. 2004. *Applied Econometric Time Series.* 2nd. Ed. Hoboken, NJ: John Wiley & Sons.

Greene, W.H. 2007. *Econometric Analysis.* 4th. Ed. Upper Saddle River, NJ: Prentice Hall.

Hamilton, J.D. 1994. *Time Series Analysis.* Princeton: Princeton University Press.

Tsay, R.S. 2005. A*nalysis of Financial Time Series.* Hoboken, NJ: John Wiley & Sons.

Vogelvang, B. 2005. *Econometrics Theory and Applications with Eviews.* Harlow: Pearson Education.

MASTER OF SCIENCE (STATISTICS)

Introduction

Statistics is an area of study that deals with the collection, classification, analysis and interpretation of data to explain reality based on the scientific method. The Master of Science Programme (Statistics) offers several courses in statistics, suitable for candidates who want to further their education in this area. The programme emphasizes on the theory and application of statistics so that candidates would master the statistical knowledge and able to apply it.

Entry Requirements

The candidate applying for the Master of Science (Statistics) programme must possess:

a) Bachelor of Science degree with a good CGPA in the field of statistics from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Bachelor of Science degree with a good CGPA in the related field from Universiti Kebangsaan Malaysia or other universities approved by the Senate.

PROGRAM EDUCATIONAL OBJECTIVE (PEO)

PEO1: Produce highly skilled, ethical and competitive student.
PEO2: Equip students with the ability to translate and synthesize their understanding towards nature, human and development.
PEO3: Equip students with the awareness towards environment and uphold the established development.
PEO4: Equip students with the ability to utilize the statistical problem solving method such as analysis, modelling, programming and application of statistical software in addressing the development issues and current changes.
PEO5: Equip students with the scientific approaches in generating and sharing knowledge involving is inter- and intra- discipline in nature; and
PEO6: Equip students with a high creative and innovative ability and able to contribute ideas toward the process of establishing policy, decision making and development implementation.

PROGRAM LEARNING OUTCOME (PLO)

PLO1: Able to apply the statistics knowledge.
PLO2: Able to design the methodology suitable to the problem encountered.

PLO3: Able to analyse and interpret outputs and generate new ideas based on the outputs.
PLO4: Able to gather, utilize and generate information.
PLO5: Able to manage emotion.
PLO6: Honour noble character and aesthetical values towards the Creator, customers and society.
PLO7: Able to lead, work in a team and give priority to the success of a team.
PLO8: Able to communicate effectively through speaking and writing both in Bahasa Malaysia and English.
PLO9: Able to understand mathematical science solution in every dimension of life.
PLO10: Able to recognize the needs for continuous learning and practice it throughout the whole life.
PLO11: Possess the entrepreneur characteristics.

Program Structure

Candidates who wish to do course work, must attend and pass at least 32 credit hours of courses (compulsory and elective courses) and complete a Research Project of 8 credit hours. Candidates who do not have a good foundation of statistics must take a few preliminary courses as listed below and must pass with an average grade of B before pursuing the masters program. These courses are:

Code	**Name of courses**	**Units**
STQS6004	Calculus and Matrix Algebra for Statistics	4
STQS6014	Mathematical Statistics	4
STQS6024	Modeling and Data Analysis	4
TOTAL		**12**

SEMESTER	**CORE COURSES**	**ELECTIVE COURSES**	**TOTAL**
I	STPD6014 Research Methodology STQS6034 Statistical Inference STQS6274 Statistical Computing STQS6584 Statistical Modeling	Choose two: STQS6064 Medical Statistics STQS6094 Sampling Techniques STQS6244 Stochastic Process STQS6284 Multivariate Analysis STQS6424 Nonparametric Methods STQS6444 Time Series Modeling and Forecasting	
II	STQS6234 Bayesian Inference STQS6254 Design and Analysis of Experiments STQS6988 Research Project		
TOTAL	**32**	**8**	**40**

Candidates who wish to choose the program by thesis must take 12 credit hours of courses and write up a thesis. The 12 credit hours that are required include:

STPD6014 Research Methodology
Two course valued 8 credit hours related to the research field.

List of courses Offered

STPD6014 Research Methodology
STQS6004 Calculus and Matrix Algebra for Statistics
STQS6014 Mathematical Statistics
STQS6024 Modeling and Data Analysis
STQS6034 Statistical Inference
STQS6064 Medical Statistics
STQS6094 Sampling Techniques
STQS6234 Bayesian Inference
STQS6244 Stochastic Process
STQS6254 Design and Analysis of Experiments
STQS6274 Statistical Computing
STQS6284 Multivariate Analysis
STQS6424 Nonparametric Methods
STQS6444 Time Series Modeling and Forecasting
STQS6584 Statistical Modeling
STQS6988 Research Project

Course Contents

STQS6004 Calculus and Matrix Algebra for Statistics

The aim of this course is to introduce students to the use of calculus and matrix algebra in the field of statistics. The concept of limit is given intuitively. The concept of differentiation, rate of change and problem of extremum are discussed. Integration as anti derivative and several integration techniques are discussed. Various basic concepts about matrices are given: inverse, transpose, determinant, trace, quadratic form and orthogonal. Various basic concepts about vectors are discussed: vector, linearly dependent and not linearly dependent, eigen values and eigen vectors. Introduction is given on generalized inverse and partitioning of matrix. Several examples for linear model are given.

References

Basilevsky, A. 2005. *Applied Matrix Algebra in the Statistical Sciences.* Amsterdam: Elsevier.

Freund, J.E. 2004. *Mathematical Statistics with Applications.* New Jersey: Pearson Prentice-Hall.

Graybill, F.A. 2001. *Matrices with Applications in Statistics.* 2nd. Ed. Belmont: Wadsworth Group.

Hoffman, L.D., Bradley, G.L. & Rosen, K.H. 2005. *Applied Calculus.* 8th. Ed. New York: McGraw-Hill.

Kolman, B. 1997. *Introductory Linear Algebra with Applications.* New York: Macmillan.

STQS6014 Mathematical Statistics

The aim of this course is to introduce students to the concept of statistical thinking and tools. The concept of random variables and several distribution functions. Distributions function of random variables and the techniques to identify the particular distribution: distribution function technique, transformation technique and moment generating function technique. Bivariate and multivariate distribution are discussed in the aspects of joint densities, joint distribution function, marginal distribution, conditional distribution, independence between random variables, conditional expectation and correlation coefficient. Chebyshev theorem and bivariate normal. Order statistics and sampling distribution. Several distributions related to normal distribution such as t distribution, Chi-square and F. Law of large numbers and central limit theorem. Methods of point estimation, maximum likelihood technique and

method of moment. Point estimation and interval estimation involves estimation of one population parameter and two population parameters. Hypothesis testing covers one and two populations.

References

Freund, J.E. 2004. *Mathematical Statistics with Applications.* 7th ed. New Jersey: Prentice-Hall.

Hogg, R.V. & Tanis, E.A. 2010.*Probability and Statistical Inference.* 8th ed. New Jersey: Prentice Hall.

Wackerly, D. D., Mendenhall, W. &Scheaffer, R.L. 2008.Mathematical Statistics with Applications.7th ed. Belmont: Duxbury Press.

Rice, J.A. 2007. *Mathematical Statistics and Data Analysis.* Belmont: Thomson Brooks/Cole.

Upton, G. & Cook, I. 1997. *Understanding Statistics*. Oxford: Oxford University Press.

STQS6024 Modeling and Data Analysis

The aim of this course is to introduce students to the practical use of statistical software in doing statistical tests. The topics covered are test of hypothesis, error measurement, power of the test, test to compare means such as t test, analysis of variance (ANOVA), analysis of covariance (ANCOVA); goodness of fit test for distributions; test for linear relationship which covers correlation, simple regression and multiple regression as well as introduction to the analysis of residuals. Several related topics on nonparametric statistics will also be discussed.

References

Agresti, A. & Franklin, C.A. 2006. *Statistics: The Arts and Science of Learning from Data*. 2nd. Ed. New Jersey: Prentice-Hall.

Draper, N.R. & Smith, H. 1998.*Applied Regression Analysis*. 3rd ed. New York: John Wiley.

Mann, P.S. 2004.*Introductory Statistics*. 5th ed. New York: John Wiley.

Jacques J., Christos H.S. & Constantin Z. 2010. *Advances in Stochastic Modelling and Data Analysis.* The Netherlands: Kluwer Academic.

Charles M.J., Gary H.M.&Carey S.R. 2008. *Data Analysis: A Model Comparison Approach*, 2nd ed. New York: Routledge.

Andrew G. & Jennifer H. 2006. *Data Analysis Using Regression and Multilevel/Hierarchical Models.* 1st ed. New York: Cambridge.

Salvarote I., Roberto R. & Maurizio V. 2011. New Perspectives in Statistical Modeling and Data Analysis. 1st ed. New York: Springer.

Mendenhall, W. &Sincich, T. 2011.*Second Course in Statistics: A Regression Analysis*. 7th ed.New Jersey: Prentice Hall.

Montgomery, D. C. &Runger, G. C. 2011.*Applied Statistics and Probability for Engineers.* 5th ed. New York: John Wiley.

STQS6034 Statistical Inference

The aim of this course is to enhance understanding of students in the theory of statistics, point estimations and the properties of the estimators. The properties discussed include efficiency, unbiasedness, minimum variance unbiased estimator, sufficiency and completeness. Rao-Cramer Inequality and Rao-Blackwell Theorem are discussed. The estimation methods studied include maximum likelihood, method of moment and least square. Asymptotic evaluations of the estimators are also covered. Various topics under hypothesis testing such as best critical region and likelihood ratio are also discussed.

References

Berry, D.A. & Lindgren, B.W. 1996. *Statistics: Theory and Methods*. 2nd. Ed. Boston: Duxbury Press.

Casella, G & Berger, R.L. 2002 *Statistical Inference.*2nd. Ed. Pacific Grove: Duxbury Press.

Garthwaite, P.H., Jolliffe, I.T. & Jones, B. 1995. *Statistical Inference*. London: Prentice-Hall.
Gnedenko, B.V. 1999. *The Theory of Probability and the Elements of Statistics*. Oxford: Oxford University Press.
Hogg R.V. & Tanis, E.A. 2010.Probability and Statistical Inference. 8th ed. NJ: Prentice Hall.
Wackerly, D. D., Mendenhall, W. & Scheaffer, R.L. 2008.Mathematical Statistics with Applications.7th ed. Belmont: Duxbury Press.

STQS6064 Medical Statistics

Several important statistical concepts in medicine are discussed in detail. Basic analysis methods will be examined including the evaluation of the diagnostic tests. Topics that will be discussed are risk, relative risk, odds and odds ratio, prevalence and incidence, attributal risk, confounding and interaction, detection of and adjustment for confounding effects. Observational studies such as cohort studies, control-case will be covered; intervention methods; sample size determination. Other topics discussed are modelling in medicine, classical linear model, logistic model and survival model.

References

Armitage, P., Berry, G. & Mathews, J.N.S. 2001. *Statistical Methods in Medical Research.* 4th. Ed. Oxford: Blackwell.
Bland, M. 2000. *An Introduction to Medical Statistics*. 3rd. Ed. Oxford: Oxford University Press.
Collett, D. 2003. Modelling Survival Data in Medical Research. 2nd. Ed. London: Chapman and Hall.
Schlesselman, J.J. 1982. *Case Control Studies: Design Conduct and Analysis.* London: Oxford University Press.
Woordward, M. 2005. *Epidemiology: Study Design and Data Analysis*. 2nd. Ed. London: Chapman and Hall.

STQS6094 Sampling Techniques

This course introduces sampling designs and the related theories. The discussion will begin with various important statistics obtained from surveys and the necessary measures for initiating a survey. Simple random sampling will be discussed in detail, the theory, practical aspects, and mathematical derivations. Estimators and the properties will be studied mathematically and supported using computing techniques. Stratified sampling will be explored in details - include mathematical derivation, computing and the practical aspects. Simulation methods will be utilized for data generation and for investigating the properties of the estimators. Single and two stages cluster sampling will also be studied. Similar approaches as used for stratified sampling will be implemented in investigating the properties of estimators produced by cluster sampling. This course covers sampling design for wildlife population and spatial sampling.

References

Barnett, V. 2003. *Sample Survey: Principles and Methods.*3rd.ed. London: Hodder Arnold Publication.
Lohr S. L. 1999 *Sampling: Design and Analysis*. Duxbury Press. International Thomson Publishing.
Levy, P.S. &Lemeshow, S. 2008. *Sampling of Populations: Methods and Applications.* 4th. New York: Wiley.
Rao, P.S.R.S. 2000. *Sampling Methodologies with Applications*. Boca Raton, Florida: CRC Press LLC.

Thompson, S.K. 2002. *Sampling (Wiley Series in Probability and Statistics).* 2nd.ed. New York: John Wiley.

STQS6244 Stochastic Process

The aim of this course is to introduce the students to the theory of stochastic process. Among the topics to be discussed include discrete and continous time Markov chain. This include subtopics regarding the Chapman-Kolmogorov equation, Birth and Death process, limiting probabilities and some important properties of Markov process. Other topics to be discussed include the Poisson process and the Renewal process which include the subtopics of Homogeneous and Nonhomogeneous Poisson process, compound Poisson Process, decomposition of Poisson Process, Renewal equation, mean-value function, limit theorem and etc. The students will also be expose with the topics of Reliability theory, Brownian motion and the aplication of Markov Chain Monte Carlo method.

References

Ross, S.M. 2007. *Introduction to Probability Models. 9th edition*. Burlinton Elsevier.

Kao, E.P.C. 1997. *An Introduction to Stochastic Processes.* California: Wadsworth Publishing Company.

Beichelt, F.E. & Fatti, L.P. 2002. *Stochastic Process and Their Application.* London:Taylor & Francis.

Papoulis, A. & Pillai, S.U. 2002. *Probability, Random Variables and Stochastic Processes.* 4th Edition. New York: McGraw-Hill.

STQS6254 Design and Analysis of Experiments

The aim of this course is to explain the role of statistics in the scientific method which is a prerequisite to design an efficient experiment. This course will cover the basic principles of experimentation; randomization, and replication. RRL & one-way ANOVA; linear contrasts; underlying assumptions in ANOVA; analysis of residuals; additivity and interaction; transformation of data to satisfy ANOVA assumptions; block design; incomplete block design; properties of orthogonality and balance; rule of assignment of treatments in blocks; 2^n factorial designs; blocking and confounding in factorial experiments; fractional factorial designs; confounding systems and aliases; design resolutions. Other topics covered will be fractional factorial designs; response surface methodology; and covariance analysis.

References

Berger, P.D. & Maurer, R.E. 2002. *Experimental Design with Application in Management, Engineering, and the Sciences.* Duxbury: Thompson Learning.

Cox, D.R. & Reid, N. 2000. *The Theory of the Design of Experiments*. Boca Raton, Florida: CRC Pres LLC.

Hinkelmann, K. & Kempthorne, O. 2008. *Design and Analysis of Experiments, Vol. 1: Introduction to Experimental Design.* Hoboken, NJ: John Wiley & Sons.

Kuehl, R.O. 2000. *Design of Experiments: Statistical Principles of Research Design and Analysis.* 2nd. ed. Duxbury: Thompson Learning.

Montgomery, D.C. 2005. *Design and Analysis of Experiments*. 6th. ed. New York: John Wiley.

STQS6274 Statistical Computing

Students will be equipped with sufficient computing knowledge that useful for data analysis and statistical inferences. For these objectives they are given programming skills using R. Utilizing the skills the students will be trained to write function for obtaining various statistical summaries, empirical distribution, nonparametric measures using quantiles and the quantile based distribution summaries. In addition the students will also be exposed to various methods for simulating random data. R computing for classical and Bayesian

statistical inference will be discussed. All the discussions are data and practical problems based. Re-sampling techniques for statistical inference - bootstrap and jackknife, order statistics will be explored together with testing hypothesis using permutation and Monte Carlo methods.

References

Congdon, P. 2006. *Bayesian Statistical Modelling.* 2nd. Ed. USA: John Wiley.

Higgin, J.J. 2004. *An Introduction to Modern Nonparametric Statistics.* USA: Brook/Cole-Thomson Learning.

Lunneborg, C.E. 2000. *Data Analysis by Resampling: Concepts and Application*. USA: Duxbury Thomson Learning.

Venables W.N. & Ripley B.D. 2002. *Mordern Applied Statistics with S.* 4th. ed. New York: Springer Verlag.

Tanner, M.A. 1993. *Tools for Statistical Inference, Method for the Exploration of Posterior Distribution and Likelihood Functions.* 2nd. Ed. New York: Springer Verlag.

STQS6284 Multivariate Analysis

This course introduces the nature of multivariate as compare to univariate data. The practices of univariate data analysis are extended to multivariate data. Estimation theories and statistical inferences for multivariate distributions will be covered. Multivariate methods such as multivariate analysis of variance, principle component analysis, factor analysis, canonical correlation analysis, discriminants analysis and cluster analysis are explained. The mathematics, computing and data analysis will be integrated in the course.

References

Anderson, T.W. 2003. *An Introduction to Multivariate Statistical Analysis*. 3rd. Ed. New York : John Wiley & Sons.

Johnson, R.C. & Wichern, D.W. 2002. *Applied Multivariate Statistical Analysis*. 5th. Ed. New Jersey: Prentice Hall.

Lattin, J., Carroll, J.D. & Green, P.E. 2003. *Analyzing Multivariate Data*. Duxbury: Thomson Learning.

Mardia, K.V., Kent, J.T. & Bibby, J.M. 1979. *Multivariate Analysis*. New York: Academic Press.

Tacq, J. 1997. *Multivariate Analysis Techniques in Social Science Research*. New York: Sage Publ.

STQS6444 Time Series Modeling and Forecasting

The objectives of this course are estimating simple regression models, explaining the techniques for modeling trend and volatility in time series data, explaining the cointegrating relation between two or more time series, and at the same time highlighting several major issues in time series analysis that are related to stationarity, trend, volatility, and cointegration. In particular, for modeling trend and volatility, the focus will be on the ARCH-GARCH models. As for cointegration, the error-correction mechanism and the Johansen approach will be discussed. At the end of the semester, the students will be required to write one short report on the application of statistical testing methods and model analyses that are covered during the semester.

References

Enders, W. 2004. *Applied Econometric Time Series*. 2nd.ed. Hoboken, NJ: John Wiley & Sons.

Greene, W.H. 2007. *Econometric Analysis.* 4th.ed. Upper Saddle River, NJ: Prentice Hall.

Hamilton, J.D. 1994. *Time Series Analysis.* Princeton: Princeton University Press.

Tsay, R.S. 2005. *Analysis of Financial Time Series.* Hoboken, NJ: John Wiley & Sons.

Vogelvang, B. 2005. *Econometrics Theory and Applications with EViews*. Harlow: Pearson Education.

STQS6584 Statistical Modeling

This course begins by introducing the concept of modeling through simple linear regression, multiple linear regression and nonlinear regression where error terms is assumed to be normally distributed. Diagnostic checking on fitted model and model assumptions will be further discussed. The course continue to model where the normality assumption is not met. Students will be exposed to the concepts of generalized linear model such as logistic models, Poisson and log-linear models. The concepts of maximum likehood estimation, likehood ratio test and the concept of deviance will be introduced.

References

Myers, R.H., Montgomery, D.C., Vinning, G.G. & Robinson, T.J. 2010. *Generalized Linear Model: With Applications in Engineering and the Sciences.* 2nd ed. New York: John Wiley & Sons.

Daniel T.K. 2009. *Statistical Modeling: A Fresh Approach*. Macalester: Createspace.

David A.F. 2009. *Statistical Models: Theory and Practice*. 2nd ed. Cambridge: University Press.

Dobson, A.J. & Barnett, A. 2008. *An Introduction to Generalized Linear Models*.3rd ed. Florida: Chapman and Hall/CRC.

STQS6988 Research Project

Research project is a compulsory course work involving case study/literature survey/research. The student is required to conduct the research study under supervision of a supervisor. The student is also required to select a pertinent topic as agreed to by the supervisor. The students are required to write up a comprehensive and scientific report on the study that he/she has conducted.

MASTER OF SCIENCE (QUALITY AND PRODUCTIVITY IMPROVEMENT)

Introduction

This program is offered to address the challenging issues of quality and productivity in the industrial environment. The main courses offered range from total management techniques and their philosophy to product quality improvement and services with more emphasis on the application of the statistical methods. The main message is to make the consumers understand that the application of scientific methods and statistics will bring improvement to product quality and services.

Entry Requirements

Candidates applying for the Master of Science (Quality and Productivity Improvement) program must possess:

a) Bachelor of Science degree with a good CGPA in the field of Mathematical Sciences from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
b) Bachelor degree with a good CGPA in the fields of sciences, technology, engineering, management or social sciences from Universiti Kebangsaan Malaysia or other universities approved by the Senate; or
c) Bachelor degree in the fields of sciences, technology, engineering, management or social sciences from Universiti Kebangsaan Malaysia or other universities approved by the Senate with related and suitable working experiences.

PROGRAM EDUCATIONAL OBJECTIVE (PEO)

PEO1: Produce highly skilled, ethical and competitive student;
PEO2: Equip students with the ability to translate and synthesize their understanding towards nature, human and development;
PEO3: Equip students with the awareness towards environment and uphold the established development;
PEO4: Equip students with the ability to utilize the mathematical problem solving method such as analysis, modelling, programming and mathematic software application in addressing the development issues and current changes;
PEO5: Equip students with the scientific approaches in generating and sharing knowledge which is inter- and intra- discipline in nature; and
PEO6: Equip students with the high creativity and innovative ability and able to contribute ideas toward the policy establishment process, decision making and development implementation.

PROGRAM LEARNING OUTCOME (PLO)

PLO1: Able to apply the quality and productivity knowledge.
PLO2: Ability to design the methodology suitable to the problem encountered.
PLO3: Ability to analyse and interpret outputs and generate new ideas based on the outputs.
PLO4: Able to gather, utilize and generate information.
PLO5: Strength to manage emotion.
PLO6: Honour noble character and aesthetical values towards the Creator, customers and society.
PLO7: Able to lead, work in a team and give priority to the success of a team.
PLO8: Able to communicate effectively through speaking and writing both in Bahasa Malaysia and English.
PLO9: Ability to understand mathematical science solution in every dimension of life.
PLO10: Ability to recognize the needs for continuous learning and practice it in the whole life.
PLO11: Possess the entrepreneur characteristics.

Program Structure

Candidates taking the program by Course Work are required to enrol and pass 28 units of courses (core and elective) and to complete 8 units of a Research Project. Candidates are also required to enrol in 1 compulsory course offered by the faculty; STPD6014 Research Methodology.

This program is divided into three modules as follow:

- Public Sector
- Manufacturing Sector
- Service Sector

PUBLIC SECTOR MODULE

SEMESTER	CORE COURSES	ELECTIVE COURSES	TOTAL

I	STPD6014 Research Methodology STQK6114 Quality Assurance and Standardization STQK6134 Total Quality Management STQK6154 Organizational Performance Measurement	Choose two: STQK6124 Process Control and Quality Improvement STQK6514 Quality Management in Service Sector STQK6534 Marketing Research Methods STQK6544 Quality Design and System Reliability	
II	STQK6324 Service Delivery System in the Public Sector STQK6524 Productivity Measurement STQK6988 Research Project		
TOTAL	**32**	**8**	**40**

MANUFACTURING SECTOR MODULE

SEMESTER	CORE COURSES	ELECTIVE COURSES	TOTAL
I	STPD6014 Research Methodology STQK6114 Quality Assurance and Standardization STQK6134 Total Quality Management STQK6144 Organizational Performance Measurement	Choose two: STQK6264 Supply Chain Management STQK6514 Quality Management in Service Sector STQK6534 Marketing Research Methods STQK6544 Quality Design and System Reliability	
II	STQK6124 Process Control and Quality Improvement STQK6524 Productivity Measurement STQK6988 Research Project		
TOTAL	**32**	**8**	**40**

SERVICE SECTOR MODULE

SEMESTER	CORE COURSES	ELECTIVE COURSES	TOTAL

I	STPD6014 Research Methodology STQK6114 Quality Assurance and Standardization STQK6134 Total Quality Management STQK6144 Organizational Performance Measurement	Choose two: STQK6124 Process Control and Quality Improvement STQK6264 Supply Chain Management STQK6534 Marketing Research Methods STQK6544 Quality Design and System Reliability	
II	STQK6514 Quality Management in Service Sector STQK6524 Productivity Measurement STQK6988 Research Project		
TOTAL	**32**	**8**	**40**

Courses Offered

STPD6014 Research Methodology
STQK6114 Quality Assurance and Standardization
STQK6124 Process Control and Quality Improvement
STQK6134 Total Quality Management
STQK6154 Organizational Performance Measurement
STQK6264 Supply Chain Management
STQK6324 Service Delivery System in the Public Sector
STQK6514 Quality Management in Service Sector
STQK6524 Productivity Measurement
STQK6534 Marketing Research Methods
STQK6544 Quality Design and System Reliability
STQK6988 Research Project

Course Contents

STQK6114 Quality Assurance and Standardization

This course aims at giving students knowledge on the quality system in an organization and its role in assuring quality in products and services. Topics that will be discussed include the Total Quality Control, ISO 9000 and its development, documentation and planning of quality system, quality assurance analysis techniques, and quality audits and accreditation. This course also exposes the students to Quality Management System (QMS) based on Islam perspectives and the Syariah principles in supporting and defining QMS MS 1900:2005. Next, the QMS MS1900:2005 is studied on its implementation in various sectors, and method that can improve their competitiveness by adding Islamic values and halal aspects in the process of producing products and providing services, and in the work environment.

References

Andrew Neely, Chris Adams dan Mike Kennerly. 2022. The Performance Prism: The Scorecard for Measuring and Managing Business Success. Financial Times Prentice Hall.

Arie Halachmi dan Geert Bouckaert. 1996. Organizational performance and measurement in the public sector: toward service, effort and accomplishment reporting. Quorum Book, Connecticut, and London.

Bob Frost. 2nd Rev edition. 2000 Measuring Performance: Using the new metrics to deploy strategy and improve performance. Measurement Intl.

David Parmenter. 2ed 2010. Key Performance Indicators (KPI): Developing, Implementing and Using Winning KPIs. Wiley.

Dean R. Spitzer. 2007. Transforming Performance Measurement: Rethinking the Way We Measure and Drive Organizational Success. AMACOM.

Douglas K. Smith. 1999. Make Success Measurable: A Mindbook-Workbook for Setting Goals and Taking Action. Wiley.

Douglas W. Hubbard. 2007. How to Measure Anything: Finding the Value of "Intangibles" in Business. Wiley.

Marc J Epstien, Jean-Francois Manzoni dan Marc J. Epstein, 2004. Performance Measurement and Richard Y. Chang dan Mark W. Morgan. 2000. Performance Scorecards: Measuring the Right Thing in the Real World. Jossey-Bass.

STQK6124 Process Control and Quality Improvement

The aim of this course is to illustrate students the importance of process control and quality improvement based on 6Sigma concept and how to apply the 6Sigma methodology in order to identify customers and improve process in an organization. The application of 6Sigma will be divided into two general categories; i.e. in manufacturing and management. Topics that will be discussed include the understanding and definition of 6Sigma concepts and its steps, identification of critical factors for success, measurement strategies including measurement tools, analyze phase, control phase including some control charts such as multivariate charts, CUSUM, EWMA, decision barrier scheme and reliability test, reference measurement, break even analysis of the quality values, learning curve and process improvement.

References

David S. Chambers & Donald J. Wheeler. 1992. *Understanding Statistical Process Control*. 2nd ed. SPC PRESS (Statistical Process Control)

Donald J. Wheeler. 2004. *Advanced Topics in Statistical Process Control: The Power of Shewhart's Charts*. 2nd ed. SPC PRESS (Statistical Process Control)

Douglas C. Montgomery, 6th ed. 2008. *Introduction to Statistical Quality Control.* John Wiley.

John S. Oakland. 2008. *Statistical process control*. 6th ed. Burlington: Elsevier

Nur Riza Mohd Suradi, Zainol Haji Mustafa dan Faridatul Azna Ahmad Shahbudin. 2000. *Kawalan Proses Statistik: Aplikasi di Industri*. Penerbit UKM

Pete Pande & Larry Holpp. 2011. *What is Six Sigma?* McGraw-Hill.

STQK6134 Total Quality Management

This course introduces students to the concepts of Total Quality Management (TQM) from the aspects of history, philosophy, principles, needs, measurement, reports and its usage. Topics that will be discussed include the historical development of TQM; TQM philosophy, needs and principles of TQM; customer concentration, human resource management, process management, ISO 9000 and its development, documentation and planning of quality system, quality audits and accreditation, and benchmarking.

Reference

Camp, R.C. 2006. *Benchmarking: The Search for Industry Best Practices That Lead To Superior Performance.* Milwaukee, Wisconsin: ASQC Quality Press.

Evans, J.R. & Lindsay, W.M. 2004. *The Management and Control of Quality.* 6th. Ed. South-Western: South-Western College Pub.

Leonard, D. & Mcguire, M. 2007. *The Executive Guide To Understanding and Implementing The Baldrige Criteria: Improve Revenue and Create Organizational Excellence (ASQ*

Quality Management Division Economics of Quality Book Series). Milwaukee, Wisconsin: ASQ Quality Press.

Patricia Keehley, P. & Abercrombie, N. 2008. *Benchmarking in The Public and Nonprofit Sectors: Best By Practices For Achieving Performance Breakthroughs.* San Francisco, CA: Jossey-Bass.

Thomas, F.S. 2002. *Managing Quality: An Integrative Approach.* Upper saddle River, NJ: Prentice Hall.

STQK6154 Organizational Performance Measurement

This course aims at giving students knowledge of the concepts of measuring an organization's performance, either in public or private sector. Emphasize will be given on the questions of why performance measurement is an essential element in an organization and how it can be done. One of the performance principles that are important is the Key Performance Indicators (KPI) and its linkages to the organization's strategic planning. Other performance principle that will be highlighted is the Balanced Scorecard (BSC) that measures performance in 4 major perspectives: Internal Process, Customer, Finance and Human Capital. Implementation aspects of BSC and its challenges will also be discussed. Several case studies will be presented in order to enhance the knowledge of students towards the performance measurement through BSC implementation.

References

Franceschini, F., Galetto, M. & Maisano, D. 2007. *Management By Measurement: Designing Key Indicators and Performance Measurement Systems*. Heidelberg, Berlin: Springer-Verlag.

Kaplan, R.S & Norton, D.P. 1996. *The Balanced Scorecard: Translating Strategy* Into Action. Boston, MA: Harvard Business School Press.

Lawson, R., Desroaches, D. & Hatch, T. 2008. *Scorecard Best Practices: Design, Implementation, and Evaluation.* Hoboken, NJ: John Wiley & Sons.

Niven, P.R. 2006. *Balanced Scorecard Step-By-Step: Maximizing Performance and Maintaining Results.* 2nd. Ed. Hoboken, NJ: John Wiley & Sons

Parmenter, D. 2007. *Key Performance Indicators: Developing, Implementing, And Using Winning KPIS*. Hoboken, NJ: John Wiley & Sons.

STQK6264 Supply Chain Management

This course is an introduction to the supply chain concept and will explore the management of supply chains to improve an organization's overall supply efficiency. Other concepts included are the definitions of supply chains, identification procedures, an overview of methods, processes, and systems that are used in the operation of supply chains, and the applications of methods, processes, and systems to improve supply chain performance.

References

Chopra, S. & Meindl, P. 2006. *Supply Chain Management: Strategy, Planning & Operations*. 3rd. Ed. New Jersey: Prentice Hall.

Hugos, M. 2006. *Essentials of Supply Chain Management*. New York: John Wiley & Sons.

Madu, C.N. 2005. *ERP and Supply Chain Management*. Connecticut: Chi Publishers Inc.

Schoenfeldt, T. 2008. *A Practical Application of Supply Chain Management Principles*. Milwaukee, Wisconsin: ASQC Quality Press.

Stadtler, H. 2004. *Supply Chain Management and Advanced Planning: Concepts, Models, Software & Case Studies*. 3rd. Ed. New York: Springer-Verlag.

STQK6324 Service Delivery System in the Public Sector

In this course, student will be exposed to the service delivery system of the government agencies. Students need to understand various policies, regulation and circulation about

various types and level of public service released by the Public Service Department of Malaysia. The history aspects of the public service and its evolution in Malaysia also will be discussed. Among important approaches in the public service that will be discussed includes 'Best Value Review'. Comparison with various service delivery systems from other countries, particularly from Australia, United Kingdom, USA and Canada will also be touched. Case study on the public service system in the government agencies will also be discussed

References

Anwar Shah. 2005. *Public Services Delivery* (*Public Sector, Governance, and Accountabilityseries*). Washington, DC: World Bank Publication.

Anwar Shah. 2009. *Tools for Public Sector Evaluation* (*Public Sector, Governance, and Accountability series*). Washington, DC: World Bank Publication.

Christopher H. Lovelock. 2008. *Services Marketing*. 7th. Ed. Upper Saddle River, NJ: Prentice-Hall.

Light, P.C. 1999. *The New Public Service*. New York: Brooking Institution Press.

Mat Zin Mat Kib. 2006. *Penyampaian Perkhidmatan Pihak Berkuasa Tempatan: Isu Dan Cabaran*. Universiti Teknologi MARA, Shah Alam: Pusat Penerbitan Universiti.

STQK6514 Quality Management in Service Sector

This course explains to students the definition of 'customer service' and 'service excellence', basis of service excellent and the importance of services excellent in an organization. The importance aspect is how an organization can manage the customer complaint and solve the problem that being complaint by the customer. It also discusses the barrier to service excellence. The aim of this course is also to introduce students the methods of Customer Relationship Management (CRM) which is one of the important business strategies for an organization which put customers as the main focus. Students will get to understand the meaning and concepts of CRM and its importance to any organization, especially business organizations. Implementation of CRM in an organization includes aspects such as customer profiling, customer data warehousing and customer data mining, and also problems often encountered whilst implementing it will be discussed. Other aspects are customer satisfaction measurement, customer loyalty, customer equity concept and value equity. The usage of information technology makes the implementation of automatic CRM easier and establishment of Call Centre or Customer Service Centre is also discussed.

References

Fitzsimmons, J.A. & fitzsimmons, M. J. 2011. *Service Management: Operations, Strategy, Information Technology.* Edisi ke-7. New York: McGraw-Hill.

Johnston, R. & Clark, G. 2005. *Service Operations Management.* Edisi ke-2. New Jersey: Prentice Hall.

Van Looy, B., Gemmel, P. & Van Dierdock, R. 2003. *Service Marketing: An Integrated Approach.* Edisi ke-2. New Jersey: Prentice Hall.

Zeithaml, V. A., Bitner, M. J. & Gremler, D. D. 2009. *Service Marketing: Integrating Customer Focus Across the Firm.* New York: McGraw-Hill.

Zemke, R. & Woods, J. A. 1999. *Best Practice in Customer Service.* New York: American Management Association.

STQK6524 Productivity Measurement

This course introduces the concept of measuring the productivity of a firm, which efficiently convert inputs into outputs. Productivity measurement is a way which provides an excellent medium to monitor the status of productivity, and to explicitly relate productivity to its other strategic objectives. Topics discussed include productivity indicators, Data Envelopment Analysis (DEA) method, Index numbers and Malmquist Index. Several applications of the DEA method and Malmquist Index will be discussed.

References

Aft, L.S. 1991. *Productivity Measurement and Improvement.* Upper Saddle River, NJ: Prentice Hall.

Coelli, T.J., Rao, D.S.P., O'Donnell, C.J. & Battese, G.E. 2005. *An Introduction To Efficiency and Productivity Analysis.* 2nd. Ed. New York: Springer Science & Business Media, Inc.

Norman, M. & Stoker B. 1991. *Data Envelopment Analysis: The Assessment Of Performance*. Chichester: John Wiley & Sons.

Schaffer, R.H. 2006. *Managing Productivity.* New York: Jaico Publishing House.

Sherman, H.D. & Joe, S. 2006. *Service Productivity Management.* New York: Springer Science & Business Media, Inc.

STQK6534 Marketing Research Methods

This course discusses the research in marketing. Students will be exposed to the scientific research methods in order to understand and be able to analyze any problem in an organization. Comprehension of problem statement, research issues, research design, collection and analysis of data will be discussed in detail. The best approach in producing an 'Executive Summary' will also be discussed. The use of SPSS statistical package to analyze data and the interpretation of the outcomes of the statistical analysis will be delivered to students. In this case, several concepts and statistical analysis techniques will be discussed using collected data from a selected real life problem.

References

Burns, A.C & Bush, R.F 2006. *Marketing Research*. 5th. Ed. Upper Saddle River, NJ: Pearson Prentice Hall.

Malhotra, N.K. 2007. *Marketing Research: An Applied Orientation*. 5th. Ed. Upper Saddle River, NJ: Pearson Prentice Hall.

McDaniel, C & Gates, R. 2007. *Marketing Research.* 7th. Ed. Hoboken, NJ: John Wiley & Sons.

Scheaffer, R.L. & Mendenhall, W. 1990. *Elementary Survey Sampling.* 4th. Ed. Boston: PWS-KENT Publ. Co.

Zikmund, W.G. 1991. *Exploring Market Researc*h. 4th. Ed. Chicago: Dryden Press.

STQK6544 Quality Design and System Reliability

This course explores how statistics is used for controlling quality of product design and the process in manufacturing industry and furthermore for reliability assurance in production system. Experiments done by most researchers from various fields will be made an example in teaching and learning of this course. The outcomes from the analysis of these experiments depend and rely on the factors (whether the factors are fixed or randomly chosen) and experiment errors. Data collected from the experimental design are not only important to be analyzed statistically but also the ability to interpret the results becoming more important for more established experimental design development having taken into account suitable errors and factors. The topics that will be discussed are design of experiments in quality improvement and control; analysis of variance, f-test, multiple comparison, completely randomised design, factorial design, orthogonality, optimal blocked and design; Taguchi quality definition, Taguchi method, signal-noise ratio, robust design, loss function and output tolerance, reliability and failure function; life time distribution, model selection and fitting; repairable systems; fault tree; life testing plan; accelerated life testing; failure rating models and regression.

References

Dhillon, B. 1999.*Design reliability: fundamentals and applications*. Boca Raton, Fl: CRC Press.

Douglas C. Montgomery. 2012. *Design and Analysis of Experiments*. 8th ed. John Wiley

George E. P. Box, J. Stuart Hunter, William G. Hunter. 2005. *Statistics for Experimenters: Design, Innovation, and Discovery*. 2nd ed. Wiley-Interscience.

Jiju Antony. 2003. *Design of Experiments for Engineers and Scientists*. Butterworth-Heinemann.

Mark J. Andersondan Patrick J. Whitcomb.2007. *DOE Simplified: Practical Tools for Effective Experimentation*. 2nd ed. Productivity Press;

Paul G. Mathews. 2005. *Design of Experiments with MINITAB*. ASQ QualityPress.

Ranjit K. Roy.2001. *Design of Experiments Using the Taguchi Approach: 16 Steps to Product and Process Improvement*. John Wiley

Warren Brussee. 2004. *Statistics for Six Sigma Made Easy*.1st ed. McGraw-Hill.

STQK6988 Research Project

Research project is a compulsory course work involving case study/literature survey/research. The student is required to conduct the research study under supervision of a supervisor. The student is also required to select a pertinent topic as agreed to by the supervisor. The students are required to write up a comprehensive and scientific report on the study that he/she has conducted.

MASTER OF SCIENCE (DATA SCIENCE AND ANALYTICS)

Introduction

Data science is a multidisciplinary field of study that involves scientific methods, processes and systems in extracting both explicit and implicit information from a variety of data structures. It combines the knowledge of mathematics and statistics, programming and data analytics. This master programme offers a variety of courses with emphasis on data analytics. Candidates are free to choose from three different learning modules: Data Computing, Data Analytic, and Finance & Business Analytic to match their interests and career paths. The aim of the programme *is* to produce knowledgeable, ethical and competitive graduates who can contribute to the nations.

Entry Requirements

Candidates who wish to apply must have the following qualifications:

a) Bachelor of Science degree with a good CGPA (3.00 and above) from Universiti Kebangsaan Malaysia or other universities approved by the Senate; atau
b) Bachelor of Science degree with minimum CGPA of 2.75 from Universiti Kebangsaan Malaysia or other universities approved by the Senate with relevant work experience; atau
c) Bachelor's degree in the field of Social Sciences with a good CGPA (3.00 and above) from Universiti Kebangsaan Malaysia or other universities approved by the Senate. This should include a pass with credit in Mathematics or Statistics subject at undergraduate level, OR a distinction in Mathematics or a pass in *A*dditional Mathematics at SPM level.

For candidates who have already obtained a degree as mentioned above in more than TEN (10) years, you are required to sit in preparatory classes before starting the master's course.

PROGRAM EDUCATIONAL OBJECTIVE (PEO)

PEO1: To produce students with the national aspiration who are able to master and apply mathematics, statistics and computing knowledge to meet the needs of the stakeholders and the public.
PEO2: Equip students with the ability to utilise the data science problem solving methods in translating and synthesizing their understanding towards issues on nature, human, current changes and development.
PEO3: Equip students with highly creative and innovative abilities and able to contribute ideas towards the process of policy establishment, decision making and development implementation.

PROGRAM LEARNING OUTCOME (PLO)

PLO1: Able to relate mathematical, statistical and computing knowledge to various aspects of life.
PLO2: Able to analyse and interpret the solutions obtained using the suitable model and software in accordance with the data processing environment to generate new ideas.
PLO3: Able to think and argue maturely with stable emotion and be socially responsible towards society and the environment.
PLO4: Possess moral values, ethics and professionalism.
PLO5: Able to communicate effectively visually and verbally, as well as to lead and work in a team.
PLO6: Able to use analytical and algorithmic techniques on big data to retrieve the hidden information.
PLO7: Able to assess problem, make critical analysis, find solution and make decision in a variety of conditions through *a* scientific approach.
PLO8: Able to understand the impact of data science solution in every dimension of life.

Program Structure

This programme is divided into three modules as follows:

1. **Data Computing**
2. **Data Analytic**
3. **Finance and Business Analytic**

Candidates must register and pass at least 36 credit hours (core and elective courses) and complete a capstone project of 9 credit hours.

Data Computing Module

SEMESTER	CORE COURSES	ELECTIVE COURSES
I	STQD6014 Data Science STQD6214 Mathematical Statistics with Computing STQD6414 Data Mining	Choose four: STQD6124 Data Visualization and Communication STQD6324 Data Management STQD6114 Unstructured Data Analytics STQS6444 Time Series Modelling and Forecasting STQM6154 Network Science STQD6334 Multicriteria Decision Making STQD6524 Statistical Methods for Computational Biology
II	STQD6024 Machine Learning STQP6014 Research Methodology and Industrial Seminar	
III	STQD6889 Capstone Project	
TOTAL	**29**	**16**
	45	

Data Analytic Module

SEMESTER	CORE COURSES	ELECTIVE COURSES
I	STQD6014 Data Science STQD6214 Mathematical Statistics with Computing STQD6414 Data Mining	Choose four: STQD6124 Data Visualization and Communication STQS6284 Multivariate Analysis STQD6114 Unstructured Data Analytics STQD6134 Business Analytics STQS6444 Time Series Modelling and Forecasting STQS6234 Bayesian Inference STQM6154 Network Science STQD6334 Multicriteria Decision Making STQD6524 Statistical Methods for Computational Biology
II	STQD6024 Machine Learning STQP6014 Research Methodology and Industrial Seminar	
III	STQD6889 Capstone Project	
TOTAL	**29**	**16**
	45	

Finance and Business Analytic Module

SEMESTER	CORE COURSES	ELECTIVE COURSES
I	STQD6014 Data Science STQD6214 Mathematical Statistics with Computing STQD6414 Data Mining	Choose four: STQD6124 Data Visualization and Communication STQD6134 Business Analytics STQD6114 Unstructured Data Analytics STQS6444 Time Series Modelling and Forecasting STQD6334 Multicriteria Decision Making STQA6014 Investment Analysis and Portfolio Management STQA6034 Issues in Risk Management and Insurance
II	STQD6024 Machine Learning STQP6014 Research Methodology and Industrial Seminar	
III	STQD6889 Capstone Project	
TOTAL	**29**	**16**
	45	

Courses Offered

STQA6014 Investment Analysis and Portfolio Management
STQA6034 Issues in Risk Management and Insurance
STQD6014 Data Science
STQD6024 Machine Learning
STQD6114 Unstructured Data Analytics
STQD6124 Data Visualization and Communication
STQD6134 Business Analytics
STQD6214 Mathematical Statistics with Computing
STQD6324 Data Management
STQD6334 Multicriteria Decision Making
STQD6414 Data Mining
STQD6524 Statistical Methods for Computational Biology
STQD6889 Capstone Project
STQM6154 Network Science
STQP6014 Research Methodology and Industrial Seminar
STQS6234 Bayesian Inference
STQS6284 Multivariate Analysis
STQS6444 Time Series Modelling and Forecasting

Course Contents

STQA6014 Investment Analysis and Portfolio Management

The focus of this course is on the investment decision making. It presents the applications of various investment instruments and its role in risk management. The concept of risks and returns are covered comprehensively. Efficient diversification is discussed with the emphasis on the construction of efficient portfolio. The different kinds of investment instruments are assessed and weighted. Share valuation methods and portfolio theories such as the Markowitz theory, the Single Index model, the Capital Asset Pricing Model are discussed. The fundamental and technical analyses are also explained. The behavioral finance theory such as the Efficient Market Hypothesis is included. Students will participate in learning activities consisting of article journal discussion and project presentations.

References

Bodie, Z., Kane, A. & Marcus, A. 2014. *Investments and Portfolio Management*. 10th Edition. McGraw-Hill International Edition: Singapore.

Brealey, R., Myers, S. & Allen, F. 2013. *Principles of Corporate Finance*. 11th Edition. McGraw-Hill/Irwin

Hirschey, M. & Nofsinger, J. 2010. *Investments: Analysis & Behavior*. 2nd Edition. McGraw-Hill International Edition: New York, U.S.A.

Stewart, S.D., Piros, C.D. & Heisler, J.C. 2011. *Running Money: Professional Portfolio Management.* McGraw-Hill International Edition: Singapore.

Mohamed Ariff, Shamsher Mohamad, Taufiq Hassan & Annuar Md Nassir. 2008. *Capital Markets In Malaysia*. McGraw-Hill Education: Malaysia.

STQA6034 Issues in Risk Management and Insurance

This course has two main objectives; the first is to provide students with a broad perspective of risk management that emphasize traditional risk management and insurance while introducing other types of risk management, while the second is to equip students with the tools needed for the analysis of mathematical models that describe the loss process. The major topics that will be covered are risk management (objectives, measurement, diversification and retention), hedging, corporate risk management, enterprise risk management, estimation methods (for complete and incomplete data) and model selection. The students will also be trained to use R and Excell software for computing relevant mathematical analysis. At the end of semester, students are required to make a presentation on an article from an agreed journal so that they will appreciate the applicability of concepts and methodologies covered in this course.

References

Denuit, M., Marechal, X., Pitrebois, S. & Walhin, J.F. 2007. *Actuarial Modeling of Claim Counts*. London: John Wiley & Sons.

Harrington, S., Niehaus, G. 2003. *Risk Management and Insurance*. Ed. ke-2. Boston: McGraw-Hill.

Klugman, S.A., Panjer, H.H., Willmot, G.E. 2012. Loss Models, From Data to Decisions. Ed. ke-4. Hoboken, NJ: John Wiley & Sons.

Lee, H.L. 1997. *The Insurance Industry in Malaysia: A Study in Financial Development and Regulation*. Kuala Lumpur: Oxford University Press.

Redja, G.E. 2013. Principles of Risk Management and Insurance. Ed. ke-12. New York: Addison-Wesley.

STQD6014 Data Science

This course aims to expose students to the basic principles of data science and Python programming. Students will be introduced with the concept of big data and the various types of data related to it. This course would also covers the algorithms, processes, methods and analyses used in the field of data science with examples and discussions using Python. Other topics covered are the current data technologies available for storing and archiving data.

References

Grus, J. 2015. *Data Science from Scratch: First Principles with Python*. California: O'Reilly Media, Inc.

Lutz, M. 2013. *Learning Python*. Edisi ke-5. California: O'Reilly Media, Inc.

Nielsen, L. & Burlingame, N. 2012. *A Simple Introduction to Data Science*. Wickford: New Street Communications, LLC.

O'Neil, C & Schutt, R. 2013. *Doing Data Science: Straight Talk from the Frontline*. California: O'Reilly Media, Inc.

Stanton, J. 2013. *An Introduction to Data Science*. Edisi ke-3. New York: Portions.

STQD6024 Machine Learning

This course aims to expose students on concepts, techniques and algorithms in machine learning. Machine learning revolves around the development of a computer system, which is able to self-learning and improving through experience and recorded data. This course is among main technologies in Big Data and its applications in various fields. Among common topics covered are neural network, decision tree and support vector machines. Among advanced topics covered are ensemble and unsupervised learning also reinforcement and evolutionary learning.

References

Bishop, C. 2007. *Pattern Recognition and Machine Learning*. New York: Springer.

Duda, R., Hart, P. & Stork, D. 2001. *Pattern Classification.* New York: Wiley-Interscience.

Hastie, T., Tibshirani, R. & Friedman, J. 2009. *The Elements of Statistical Learning*. 2nd Ed. Corr. 7th printing 2013 Ed. New York: Springer.

Murphy, K. 2012. *Machine Learning: A Probabilistic Perspective*. Massachusetts Institute of Technology.

Shalev-Shwartz, S. & Ben-Davi, S. 2014. *Understanding Machine Learning: From Theory to Algorithms*. New York: Cambridge University Press.

STQD6114 Unstructured Data Analytics

The aim of this course is to introduce students to basic and current methods used to compile, summarize and analyze unstructured and semi-structured data. Unstructured data includes texts, images and audios. Focus are given to algorithms and techniques for mining, exploring and analyzing unstructured data using suitable packages. Students are also exposed to sources for unstructured data. Related applications of unstructured data such as sentiment analysis, document clustering and information extraction are also discussed.

References

Miner, G. 2012. Practical Text Mining and Statistical Analysis for Non-structured Text Data Application. Academic Press.

Ingersoll, G.S., Morton, T.S. & Farris, A.L. 2013. *Taming Text*. Manning Publications.

Russell, M.A. 2011. *Mining the Social Web: Analyzing Data from Facebook, Twitter, LinkedIn, and Other Social Media Sites*. O'Reilly.

Sarkar, D. 2016. *Text Analytics with Python: A Practical Real-World Approach to Gaining Actionable Insights from your Data*. Bangalore: Apress.

Struhl, S. 2015. *Practical Text Analytics: Interpreting Text and Unstructured Data for Business Intelligence (Marketing Science)*. London: Kogan Page.

STQD6124 Data Visualization and Communication

This course introduces students to the basic principles of data visualization and communication. Students are exposed to the principle of designing visualizations, human perception, colour theory and effective data storytelling. Suitable graphs and charts to convey information clearly are taught. Students will be trained to use visualization softwares such as R, ggplot, MatplotLib, D3 and others. Some specific graphical techniques will be introduces such as visualizing multivariate, time series, spatial, texts, hierarchical and network data.

References

Börner, K. & Polley, D.E. 2014. *Visual Insights: A Practical Guide to Making Sense of Data*, MIT Press.

Few, S. 2012, *Show Me the Numbers: Designing Tables and Graphs to Enlighten*, 2nd. Edition, Analytics Press.

Gohil, A. 2015. *R Data Visualization Cookbook*. Birmingham: Packt Publishing.

Iliinsky, N. & Steele, J. 2011. *Design Data Visualizations: Representing Informational Relationships.* Sebastopol: O' Reilly Media

Munzner, T. 2014. *Visualization Analysis and Design*, CRC Press.

Tufte, E.R. 2001. *The Visual Display of Quantitative Information,* 2nd. Edition, Graphics Press.

STQD6134 Business Analytics

This course aims to expose students on the techniques and tools for the transformation of raw data into meaningful and useful information for business analysis purposes. It is divided into customer, operation and people analytics. Customer analytics focuses on how data is used to describe, explain, and predict customer behavior. Meanwhile, operation analytics focuses on how the data can be used to profitably match supply with demand in various business settings. This also covers on how to model future demand uncertainties, how to predict the outcomes of competing policy choices and how to choose the best course of action in the face of risk. Finally, people analytics is a data - driven approach to managing people at work.

References

Eckerson, W.W. 2011. *Performance Dashboards: Measuring, Monitoring, and Managing Your Business.* 2nd Edition. John Wiley & Sons, Inc, Hoboken, New Jersey.

Howson, C. 2014. *Successful Business Intelligence, Second Edition: Unlock The Value of BI and Big Data*. McGraw Hill Education, USA.

Kimball R. & Margy, R. 2010. *The Kimball Group Reader: Relentlessly Practical Tools for Data Warehousing and Business Intelligence*. Wiley Publishing, Indianapolis, Indiana.

Provost, F. & Fawcett, T. 2013. Data Science for Business: What you need to know. O'Reilley Media, CA.

Siegel, E. & Davenport, T.H. 2013. *Predictive Analytics: The Power to Predict Who Will Click, Buy, Lie or Die*. John Wiley & Sons, Inc, Hoboken, New Jersey.

STQD6214 Mathematical Statistics with Computing

This course aims to expose students to the fundamentals of mathematical statistics including descriptive statistics, graphical displays, sampling distributions, hypothesis testing and other methods in data analysis. This course also reflects the integral role of R in computing statistical problems. Basic simulation concepts are discussed with examples. Students will learn how to generate data, analyze data using statistical methods and interpret the results obtained.

References

Bickel, P.J. & Doksum, K.A. 2015. *Mathematical Statistics: Basic Ideas and Selected Topics, Volume 1.* Edisi ke-2. Boca Raton: CRC Press.

Brandt, S. 2014. *Data Analysis: Statistical and Computational Methods for Scientists and Engineers.* Edisi ke-4. Heidelberg: Springer.

Devore, J.L. 2012. *Modern Mathematical Statistics with Applications.* Edisi ke-2. New York: Springer.

James, G. & Witten, D. 2013. *An Introduction to Statistical Learning: with Applications in R.* New York: Springer.

Miller, I. & Miller, M. 2012. Edisi ke-8. *John E. Freund's Mathematical Statistics with Applications.* England: Pearson.

STQD6324 Data Management

This course aims to provide the fundamental and state of the art on the technologies used in data management big data solutions. Students will be introduced to data model, databases, querying and big data processing. It covers data security, data centre and the development of big data solutions such as the Hadoop ecosystem, including MapReduce and HDFS. Apache Spark will also be introduced, including Spark's architecture, data distribution and parallelisation of tasks. Students will have a better understanding on how to optimise the information in the big data using Spark's memory caching, as well as using the more advanced operations available in Spark.

References

Geng, H. 2014. *Data Center Handbook*. Hoboken: John Wiley & Sons.

Karau, H., Konwinski A., Wendell, P. & Zaharia M. 2015. *Learning Spark: Lightning-Fast Big Data Analysis*. O'Reilly Media.

Marz, N. & Warren, J. 2015. *Big Data: Principles and best practices of scalable realtime data systems.* Manning Publications.

Redmond, E. & Wilson, J. R. 2012. *Seven Databases in Seven Weeks*. Pragmatic Bookshelf.

White, T. 2015. *Hadoop: The Definitive Guide.* 4th Ed. O'Reilly Media.

STQD6334 Multicriteria Decision Making

The purpose of this course is to introduce the concepts and techniques in solving Multi-criteria Decision Making problems. The methods to be used to solve the problems depend on the type of problems. Topics included are decision making without probabilities, decision making with probabilities, decision making with sample information, decision making under uncertainties, Analytic Hierarchy Process, TOPSIS, VIKOR, PROMETHEE and ELECTRE.

References

Anderson, D. R., Sweeney, D. J., Williams, T. A., Camm, J. D. & Cochran, J. J. 2015. *An Introduction to Management Science: Quantitative Approaches to Decision Making*. 14th Ed. Boston: Cengage Learning.

Ishizaka, A. & Nemery, P. 2013. *Multi-criteria Decision Analysis: Methods and Software*. West Sussex, UK: John Wiley & Sons.

Triantaphyllou, E. 2013. *Multi-criteria Decision Making Methods: A Comparative Study*. New York: Springer Science & Business Media.

Tzeng, G. H. & Huang, J-J. 2011. *Multiple Attribute Decision Making: Methods and Applications.* Florida: CRC Press**.**

Ragsdale, C. T. 2014. *Spreadsheet Modeling and Decision Analysis: A Practical Introduction to Business Analytics*. 7th Ed. Stamford: Cengage Learning.

STQD6414 Data Mining

This course explains in detail about the process of exploration in the database (KDD) and data mining. This course discusses the process of data preparation which includes data cleaning, integration, transformation, reduction and discretization. This course covers the the general concept of data mining process on various types of data stream, sequence, time series, text, spatial and web-data.

References

Aggarwal, C.C. 2015. *Data Mining: The Textbook*. New York: Springer.

Garcia, S., Luengo, J. & Herrera, F. 2014. *Data Preprocessing in Data Mining.* Heidelberg: Springer.

Han, J., Kamber, M. & Pei, J. 2012. *Data Mining: Concepts and Techniques.* Edisi ke-3. Massachusetts: Elsevier.

Larose, D.T. & Larose, C.D. 2014. *Discovering Knowledge in Data: An Introduction to Data Mining*. Edisi ke-2. New Jersey: John Wiley & Sons, Inc.

Zaki, M.J. & Jr. W.M. 2014. *Data Mining and Analysis: Fundamental Concepts and Algorithms*. Edisi pertama. New York: Cambridge University Press.

STQD6524 Statistical Methods for Computational Biology

The aim of this course is to give exposure on statistical methods and computation in biology and bioinformatics. Focus is given on the understanding of basic statistical concepts and inferential statistics as well as their use in solving biological problems. This course covers topics such as introduction to genetic data, gene expression data, DNA sequential data, Protein and RNA, sequential analysis,

phylogenetic, gene expression analysis and micro array data analysis. Statistical methods that will be covered are inferential statistics methods, hypothesis testings, multivariate, statistical modelling, experimental design, robust statistical techniques, Bayesian and Markov Chain Monte Carlo.

References

Yang, Z. 2014. *Molecular Evolution: A Statistical Approach*. New York: Oxford University Press.

Ewens, W.J. & Grant, G. 2010. *Statistical Methods in Bioinformatics: An Introduction*. New York: Springer.

Cristianini, N. & Hahn, M.W. 2007. *Introduction to Computational Genomics*. New York: Cambridge University Press.

Lemey, P., Salemi M. & Vandamme A-M. 2010. *The Phylogenetics Handbook: A Practical Approach to Phylogenetic Analysis and Hypothesis Testing*. New York: Cambridge University Press.

Wiley, E. O. & Lieberman, B. S. 2011. *Phylogenetics: Theory and Practice of Phylogenetic Systematics*. New Jersey: Wiley-Blackwell.

STQD6889 Capstone Project

Capstone project provides experiential learning opputinity and gives students space to produce a product which is evaluated by potential employers. The project is obtained from real world problems and executed in collaboration with industry, government or private agencies, or academics. Students will use knowledge and skills which they have obtained throughout their study to help solve real problems. During the course of the project, students will be involved with the whole process of identifying and defining problems, giving solutions and limitations, perform analysis, reporting and presenting results and giving suggestions.

References

Pusat Panduan Siswazah: Panduan menulis tesis: gaya UKM. Edisi Semak kedua Tahun 2010. Percetakan Watan Sdn Bhd.

Bell, J. 2014. *Doing Your Research Project: A guide for first-time researchers*. McGraw-Hill Education (UK).

Blaxter, L. 2010. *How to research*. McGraw-Hill Education (UK).

McMillan, K. & Jonathan W. J. 2013. *How to Cite, Reference & Avoid Plagiarism at University*. Pearson Higher Ed.

Saunders, M. N., Saunders, M., Lewis, P. & Thornhill, A. (2011). Research methods for business students, 5/e. Pearson Education India.

STQM6154 Network Science

This course introduces mathematical theories in network science. Network science is a multidiscipline field which investigate problems that can be understood through network approach. Among the aims of network science are to find cross-network equations and increase understanding of systems which are represented by networks through data analysis. The use of network science can be found in mathematics, social networks, biological systems and transportations.

References

Barabasi, A. 2016. *Network Science.* Cambridge: Cambridge University Press.

Barrat, A., Barthelemy, M. & Vespignani, A. 2012. *Dynamical Processes on Complex Networks*. Cambridge: Cambridge University Press.

Newman, M. E. J. 2010. *Networks: An Introduction.* New York: Oxford University Press.

Newman, M. E. J., Barabasi, A. & Watts, D. J. 2011. *The Structure and Dynamics of Networks.* Princeton: Princeton University Press.

Steen, M. V. 2010. *Graph Theory and Complex Networks: An Introduction. Amsterdam:* Maarten van Steen.

STQP6014 Research Methodology and Industrial Seminar

The aim of this course is to give a background and method to perform scientific research in Data Dcience field. Research ethics, research principes, research designs and the role of researhers are discussed. Research methodologies, sampling and data collection as well as critical literature review are exposed to the students. Students will also be exposed to current issues and recent research in Data Science through a series of Data Science Seminar by inviting researchers and main industry practitioners in this field.

References

Cresswell, J.W. 2014. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, 4th Edition, SAGE Publications.

Davenport, T. H. 2014. *Big Data at Work: Dispelling the Myths, Uncovering the Opportunities*, Harvard Business Publishing.

Foreman, J. W. 2014. *Data Smart: Using Data Science to Transform Information into Insight*, 1st Edition, Wiley Publications.

Machi, L. A. & McEvoy, B.T. 2012. *The Literature Review: Six Steps to Success*,2nd Edition, SAGE Publishings.

Wallace, M. & Wray, A. 2011. *Critical Reading and Writing for Postgraduates*, 2nd Edition, SAGE Publishings.

STQS6234 Bayesian Inference

This course introduces to the students on Bayesian's theories. Bayesian inference for normal distributions is also discussed. Other than that, Bayesian inference for distributions other than normal, for example Binomial and Poisson is also explained. Other topics include hierarchical Bayesian model, empirical Bayesian, hypothesis testing, correlation, regression and analysis of variance.

References

Koduvely, H. M. 2015. *Learning Bayesian Models with R*. Birmingham: Packt Publishing.

Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari & A. Rubin, D. B. 2013. *Bayesian Data Analysis*, 3rd Edition. Boca Raton: Taylor & Francis Group.

Barber, D. 2012. *Bayesian Reasoning and Machine Learning*. Cambridge: Cambridge University Press.

Kruschke, J. K. 2015. *Doing Bayesian Data Analysis: A tutorial with R, JAGS and Stan*. 2nd Ed. London: Academic Press.

Lee, P. M. 2012. *Bayesian Statistics: An Introduction*. 4th Ed. London: John Wiley.

STQS6284 Multivariate Analysis

This course intends to introduce statistical mehods for multivariate data. Students are emphasized on the comprehension of the concepts and theories in multivariate analysis. Among topics covered in this course are matrix algebra, multivariate normal distribution, hypothesis testing for multivariate data, principal component analysia, factor analysis, discriminant analysis and cluster analysis.

References

Afifi, A., May, S. & Clark, V.A. 2011. *Practical Multivariate Analysis*. 5th Ed. Chapman & Hall.

Everitt, B. & Hothorn, T. 2011. *An Introduction to Applied Multivariate Analysis with R*. Springer.

Hair, J.F., Black, B., Babin, B. & Anderson, R.E. 2010. *Multivariate Data Analysis*. Prentice Hall.

Rencer, A. & Christensen, W. 2012. *Methods of Multivariate Analysis*. 3rd Ed. Wiley.

Tabachnick, B.G. & Fidell, L.S. 2013. *Using Multivariate Statistics*, 6th Ed. Boston: Pearson.

STQS6444 Time Series Modelling and Forecasting

The objectives of this course are estimating simple regression models, explaining the techniques for modeling trend and volatility in time series data, explaining the cointegrating relation between two or more time series, and at the same time highlighting several major issues in time series analysis that are related to stationarity, trend, volatility, and cointegration. In particular, for modeling trend and volatility, the focus will be on the ARCH-GARCH models. As for cointegration, the error-correction mechanism and the Johansen approach will be discussed. At the end of the semester, the students will be required to write one short report on the application of statistical testing methods and model analyses that are covered during the semester.

References

Enders, W. 2004. *Applied Econometric Time Series*. 2nd ed. Hoboken, NJ: John Wiley & Sons.

Greene, W.H. 2007. *Econometric Analysis*. 4th ed. Upper Saddle River, NJ: Prentice Hall.

Hamilton, J.D. 1994. *Time Series Analysis.* Princeton: Princeton University Press.

Tsay, R.S. 2005. *Analysis of Financial Time Series*. Hoboken, NJ: John Wiley & Sons.

Vogelvang, B. 2005. *Econometrics Theory and Applications with Eviews*. Harlow: Pearson Education.