Master of Science
Statistics & Mathematics

Academic Session 2015/2016

School of Mathematical Sciences

CONTENTS

ACADEMIC CALENDAR - ACADEMIC SESSION 2015/2016
FOR ALL SCHOOLS (EXCEPT THE SCHOOL OF MEDICAL SCIENCES AND SCHOOL OF DENTAL SCIENCES)
***Registration for New Students / Orientation Week 1-6 September 2015**

SEM	WEEK	ACTIVITY	DATE	REMARKS
ONE	1	Teaching & Learning Period (T&LP – 9 Week)	Monday, 07.09.2015 - Sunday, 13.09.2015	
	2		Monday, 14.09.2015 - Sunday, 20.09.2015	16.09.2015, Wednesday - Malaysia Day
	3		Monday, 21.09.2015 - Sunday, 27.09.2015	24.09.2015, Thursday - Eid-ul adha
	4		Monday, 28.09.2015 - Sunday, 04.10.2015	
	5		Monday, 05.10.2015 - Sunday, 11.10.2015	
	6		Monday, 12.10.2015 - Sunday, 18.10.2015	14.10.2015, Wednesday - Maal Hijrah
	7		Monday, 19.10.2015 - Sunday, 25.10.2015	
	8		Monday, 26.10.2015 - Sunday, 01.10.2015	
	9		Monday, 02.11.2015 - Sunday, 08.11.2015	
	10	Mid Semester Break	Monday, 09.11.2015 - Sunday, 15.11.2015	10.11.2015, Tuesday - Deepavali
	11	Teaching & Learning Period (T&LP – 5 Week)	Monday, 16.11.2015 - Sunday, 22.11.2015	
	12		Monday, 23.11.2015 - Sunday, 29.11.2015	
	13		Monday, 30.11.2015 - Sunday, 06.12.2015	
	14		Monday, 07.12.2015 - Sunday, 13.12.2015	
	15		Monday, 14.12.2015 - Sunday, 20.12.2015	
	16	Revision Week	Monday, 21.12.2015 - Sunday, 27.12.2015	24.12.2015, Thursday - Maulidur Rasul 25.12.2015, Friday - Christmas
	17	Examinations (3 Week)	Monday, 28.12.2015 - Sunday, 03.01.2016	01.01.2016, Friday - New Year
	18		Monday, 04.01.2016 - Sunday, 10.01.2016	
	19		Monday, 11.01.2016 - Sunday, 17.01.2016	
	20	Mid Semester Break (4 Week)	Monday, 18.01.2016 - Sunday, 24.01.2016	
	21		Monday, 25.01.2016 - Sunday, 31.01.2016	08.02.2016, Monday & 09.02.2016, Tuesday - Chinese New Year
	22		Monday, 01.02.2016 - Sunday, 07.02.2016	
	23		Monday, 08.02.2016 - Sunday, 14.02.2016	
TWO	24	Teaching & Learning Period (T&LP – 7 Week)	Monday, 15.02.2016 - Sunday, 21.02.2016	
	25		Monday, 22.02.2016 - Sunday, 28.02.2016	
	26		Monday, 29.02.2016 - Sunday, 06.03.2016	
	27		Monday, 07.03.2016 - Sunday, 13.03.2016	
	28		Monday, 14.03.2016 - Sunday, 20.03.2016	
	29		Monday, 21.03.2016 - Sunday, 27.03.2016	
	30		Monday, 28.03.2016 - Sunday, 03.04.2016	
	31	Mid Semester Break	Monday, 04.04.2016 - Sunday, 10.04.2016	
	32	Teaching & Learning Period (T&LP – 7 Week)	Monday, 11.04.2016 - Sunday, 17.04.2016	
	33		Monday, 18.04.2016 - Sunday, 24.04.2016	
	34		Monday, 25.04.2016 - Sunday, 01.05.2016	
	35		Monday, 02.05.2016 - Sunday, 08.05.2016	03.05.2016, Sunday - Wesak Day
	36		Monday, 09.05.2016 - Sunday, 15.05.2016	
	37		Monday, 16.05.2016 - Sunday, 22.05.2016	
	38		Monday, 23.05.2016 - Sunday, 29.05.2016	
	39	Revision Week	Monday, 30.05.2016 - Sunday, 05.06.2016	
	40	Examinations (3 Week)	Monday, 06.06.2016 - Sunday, 12.06.2016	04.06.2016, Saturday - Agong's Birthday
	41		Monday, 13.06.2016 - Sunday, 19.06.2016	
	42		Monday, 20.06.2016 - Sunday, 26.06.2016	22.06.2016, Wednesday - Nuzul Al-Quran
*KSCP	43	Long Vacation/ Industrial Training/ KSCP (10 Week)	Monday, 27.06.2016 - Sunday, 03.07.2016	
	44		Monday, 04.07.2016 - Sunday, 10.07.2016	07.07.2016, Thursday & 08.07.2016, Friday - Eid-ul fitr
	45		Monday, 11.07.2016 - Sunday, 17.07.2016	
	46	*T&LP	Monday, 18.07.2016 - Sunday, 24.07.2016	
	47		Monday, 25.07.2016 - Sunday, 31.07.2016	
	48	*Examination	Monday, 01.08.2016 - Sunday, 07.08.2016	
	49		Monday, 08.08.2016 - Sunday, 14.08.2016	
	50		Monday, 15.08.2016 - Sunday, 21.08.2016	
	51		Monday, 22.08.2016 - Sunday, 28.08.2016	
	52		Monday, 29.08.2016 - Sunday, 04.06.2016	31.08.2016, Wednesday - National Day

IMPORTANT DATES FOR FULL TIME CANDIDATES
DISSERTATION COURSES MAT510/20 AND MST566/20

ACADEMIC SESSION 2015/2016

Candidates submit the supervisor confirmation form to the General Office, School of Mathematical Sciences on or before **18 Disember 2015**

Candidates register 2nd Semester course, Academic Session **2015/2016**
**** Candidates are required to have accumulated 12 units***

Deadline for candidates to submit 4 copies (soft cover) for examination **on or before 43th week** of Academic Calender Academic Session **2015/2016**

Seminar & Viva voce will be held **on 45th – 47th week** of Academic Calendar – Academic Session **2015/2016**

IMPORTANT DATES FOR PART TIME CANDIDATES
DISSERTATION COURSES MAT510/20 AND MST566/20
(for 2015/2016 intake)

ACADEMIC SESSION 2015/2016

Candidates submit the supervisor confirmation form to the General Office, School of Mathematical Sciences on or before **31 Julai 2015**

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Candidates register Semester I course, Academic Session **2015/2016**
**** Candidates are required to have accumulated 12 units***

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Deadline for candidates to submit 4 copies (soft cover) for examination on or before **43th week** of Academic Calender Academic Session **2015/2016**

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Seminar & Viva voice will be held **on 45th – 47th week** of Academic Calendar – Academic Session **2015/2016**

Submission date of supervisor confirmation form for part-time students for intake Academic Session **2015/2016** is on or before **17 June 2016**.

MASTERS IN STATISTICS

A. OBJECTIVE

The objective of the program is to produce experts in the field of statistics who are able to undertake research and development activities in addition to the teaching of statistics at the postgraduate level.

B. PROGRAM STRUCTURE

Students are required to obtain at least a B grade for the 20 units taught courses, pass the dissertation course and achieve a CGPA of at least 3.0.

C. COURSES

MST561/4	:	Statistical Inference *(Pentaabiran Statistik)*
MST562/4	:	Stochastic Processes *(Proses Stokastik)*
MST564/4	:	Statistical Reliability *(Kebolehpercayaan Statistik)*
MST565/4	:	Linear Models *(Model Linear)*
MST566/20	:	Dissertation *(Disertasi)*
MST567/4	:	Categorical Data Analysis *(Analisis Data Berkategori)*

For full time students, the minimum period given to complete the program is 12 months with a maximum period of 24 months. For part time students, the minimum period is 24 months and a maximum of 48 months.

Full time students have to register MST561/4, MST562/4, MST564/4 and MST567/4 in the first semester, and MST565/4 and MST566/20 in the second semester. Part time students are encouraged to seek the advice of the Deputy Dean (Research) concerning course registration.

SYNOPSIS OF STATISTICS COURSES

1.0 MST561/4 Statistical Inference *(Pentaabiran Statistik)*

Aim

To introduce the students to basic statistical theory at an advanced level.

Description

This course will cover basic statistical theory at an advanced level. Point estimation theory, interval estimation theory, Bayesian procedures and hypothesis testing theory will be done at a theoretical level.

Syllabus

Revision of Probability Theory is required. Change of Variables. Order Statistics. Limiting Distributions. Limit Theorems. Sample Moments and Their Distributions. Distributions of Functions of Random Variables.

Estimation theory : Point Estimation : Sufficiency, completeness, consistency, unbiasedness, efficiency. Neyman-Fisher Factorization Criterium, Rao-Blackwell's Theorem, Lehmann-Scheffe's Theorem. Uniform Minimum Variance Unbiased Estimation. Cramer-Rao Inequality. Method of moments. Method of Maximum Likelihood. Bayes Estimation. Quasi Maximum Likelihood Estimation.

Interval Estimation: Confidence Intervals for Small and Large Samples. Methods of Constructing Confidence Interval.

Hypothesis Testing: Type I & Type II errors, non-randomized test, randomized test critical region, critical function, power of a test**,** power function, Most Powerful Test, Uniformly Most Powerful Test, Unbiased Test, Invariant Test, Likelihood Ratio Test. Generalized Likelihood Ratio Test.

Skills and Knowledge Acquired

At the end of the course the students will have a better appreciation of statistical theory. They will see that many of the statistical procedures that are taught at an elementary level are actually optimal.

References

1. Rohatgi, V. K. & Saleh, A. K. Md Ehsanes (2001). *An Introduction to Probability and Statistics*, 2nd Edition, John Wiley, New York.
2. Mood, A. M., Graybill, F. A. & Boes, D. C. (1974). *Introduction to the Theory of Statistics*, 3rd Edition, McGrawHill, New York.
3. Hogg, R. V., Craig, A.T. & McKean, J. W. (2004). *Introduction to Mathematical Statistics*, 6th Edition., Prentice Hall, New Jersey.
4. Rohatgi, V. K. (1984). *Statistical Inference*, John Wiley, New York.
5. Dudewicz, E. J. & Mishra, S. N. (1988). *Modern Mathematical Statistics*, John Wiley, New York.
6. Lehmann, E. L. & Casella, G. (1998). *Theory of Point Estimation*, 2nd Edition. Springer, New York.
7. Lehmann, E. L. & Romano, J. P. (2005). *Testing Statistical Hypothesis*, 3rd Edition., Springer, New York.

2.0 MST562/4 Stochastic Processes *(Proses Stokastik)*

Aim

To introduce the students to basic stochastic processes.

Description

This course will cover stochastic processes. Students will be exposed to Markov processes and its applications. Poisson processes, branching processes, birth and death processes will be discussed. Applications to Queuing Theory will be given.

Syllabus

Conditional Probability. Conditional Expectation.
Convergence in Distribution. Convergence in Probability. Convergence with Probability One. Limiting Distributions.
Stochastic Processes : RandomWalks. Discrete Time Markov Chains. Continuous Time Markov Chains. Classification of States.
Equilibrium and Limiting Behaviour.
Recurrence Times.
Discrete Time Markov Processes. Continuous Time Markov Processes.
Poisson Processes. Counting Processes. Branching Processes. Birth and Death Processes. Queuing Models. Brownian Processes. Stationary Processes.
Simulation.

Skills and Knowledge Acquired

At the end of the course, the students will have a better appreciation of stochastic processes. They will be able to identify many of the phenomena that occur as random processes and apply the tools taught to these problems.

References

1. Ross, S. M. (1996). *Stochastic Processes*. Wiley, 2nd editon.
2. Ross, S. M. (2014). *Introduction to Probability Models*. 11th edition. Academic Press.
3. Bhat, U. N. (2002). *Elements of Applied Stochastic Processes*, 3rd edition. Wiley-Interscience.
4. Isaacson, D. L. & Madsen, R. W. (1976). Markov Chains : *Theory and Applications. Wiley*.
5. Karlin, S. & Taylor, H. M. (1975). *A First Course in Stochastic Processes*, 2nd edition. Academic Press.
6. Pinsky, M. A. & Karlin, S. (2011). *An Introduction to stochastic Modeling*. 4rd edition. Academic Press.

3.0 MST564/4 Statistical Reliability *(Kebolehkepercayaan Statistik)*

Aim

To introduce the models and statistical methods for survival data analysis, both in biomedical and reliability research.

Description

This course introduces the basic and most commonly used statistical methods of analyzing lifetime data. Both parametric and nonparametric models and procedures are included with applications in various fields, especially in the biomedical sciences and reliability engineering. This course also considers system lifetimes and system structure.

Syllabus

Introduction to reliability/survival concepts, examples of reliability data and the different types of censoring.

Lifetime Distribution: survivor/reliability function, hazard function and cumulative hazard function, mean lifetime and residual lifetime (MTTF/MTBF), distribution classes (IFR and DFR), likelihood function construction under different types of censoring.

Parametric Lifetime Models: exponential distribution, Weibull distribution, lognormal distribution, extreme value distribution and other distributions such as the gamma, logistic and the loglogistic distribution.

Estimation of survival function and other related functions, estimation from censored data (Kaplan-Meier) and the confidence interval, tests on survival function.

Probability plotting: linearizing the exponential, Weibull and other distributions, graphical goodness-of-fit.

Parametric Estimation of Models: for complete and censored data; exponential, Weibull and other models, planning life tests, estimation and test procedures under different types of censoring.

Regression Models: accelerated lifetime model and the proportional hazards model.

System Reliability: structure functions, block diagram, minimal path and cut sets, reliability functions.

Repairable Systems: point processes and availability.

Industrial visit or industrial talk will be one of the component in this course focusing on the application of statistical reliability in industry and real life situation.

Skills and Knowledge Acquired

The students should be able to handle the appropriate method to analyse survival data using statistical packages.

References

1. Lawless, J. F. (2003), *Statistical Models and Methods for Lifetime Data*, 2nd Edition, John Wiley & Sons, Inc.
2. Lee, E. T. & Wang, J. W. (2003). *Statistical Methods for Survival Data Analysis*. 3rd Edition, John Wiley & Sons Inc.
3. Meeker, W. Q. & Escobar, L. A. (1998), *Statistical Methods for Reliability Data*, John Wiley & Sons, Inc.
4. Bunday, B. D. (1991), *Statistical Methods in Reliability Theory and Practice*, Ellis Horwood, New York.
5. Leemis, L. M. (1995), *Reliability : Probabilistic Models and Statistical Methods*, Prentice – Hall, New Jersey.
6. Bain, L. J. (1991), *Statistical Analysis of Reliability and Life-testing Model*: Theory and Methods, 2nd Edition, Marcel Dekker Inc., N. Y.
7. Elisa, T. L. (1992), *Statistical Methods for Survival Data Analysis*, 2nd Edition, John Wiley & Sons, Inc.

4.0 MST565/4 Linear Models *(Model Linear)*

Aim

To introduce the basic theory of linear models to the students with applications to analysis of variance models and linear regression analysis.

Description

Basic theory of Linear Models will be developed. Applications to ANOVA and Regression models will be discussed. This course will cover various types of Linear Models along with corresponding estimation procedures and testing of hypotheses. Statistical software packages will be used in this course.

Syllabus

Introduction to Linear Models: Simple Linear Regression Model, Multiple Linear Regression Model, Analysis of Variance Models.

Revision of Matrix Algebra Concepts: Matrix Operations, Transpose, Inverse, Orthogonality, Rank, Eigenvalues and Eigenvectors, Idempotent Matrices, Trace.

Quadratic Forms and Their Distributions: Sums of Squares, Mean and Variance of Quadratic Forms, Distribution of Quadratic Forms, Independence of Linear Forms and Quadratic Forms

Simple Linear Regression: The Model, Estimation of Parameters, Hypothesis Test and Confidence Interval for Parameters, Coefficient of Determination.

Multiple Regession: The Model, Estimation of Parameter and Variance, Properties of Least Squares Estimators, Maximum Likelihood Estimation, Coefficient of Multiple Determination.

Tests of Hypotheses for Multiple Regression Parameters: Test of Overall Regression, Test on a Subset of Parameters, The General Linear Hypothesis Tests, Testing One or Several Parameters,

Confidence Intervals and Prediction Intervals, Likelihood Ratio Tests, Generalized Least Squares.

Model Validation and Diagnostics: Residuals, The Hat Matrix, Outliers, Influential Observations and Leverages.

Analysis of Variance Models: Non-full Rank Models, Estimation, Testing of Hypotheses.

One-Way Analysis of Variance: The Model, Estimable Functions, Estimation of Parameters, Testing of Hypotheses.

Two-Way Analysis of Variance: The Model, Estimable Functions, Estimation, Tests of Hypothes.

Skills and Knowledge Acquired

At the end of the course, the students will be able to use the knowledge acquired to solve statistical problems related to a wide range of linear models in various fields of applications.

Recommended Text: Rencher, A.C. (2008). *Linear Models in Statistics. 2nd Edition* Wiley, New York.

References

1. Seber, G. A. F. (1977). *Linear Regression Analysis*. Wiley, New York.
2. Graybill, F. A. (1976). *Theory and Application of Linear Models*. Duxbury Press, Mass.
3. Guttman, I. (1982). *Linear Models : An Introduction*. Wiley, New York.
4. Draper, N. & Smith, H. (1981). *Applied Regression Analysis*, Second Edition. Wiley, New York.
5. McCullagh, P. & Nelder, J. A. (1989). *Generalized Linear Models. Chapman Hall*, New York.
6. Ryan, T. P. (1997). *Modern Regression Methods*. Wiley, New York.
7. Neter, J., Wasserman, W. and Kutner, M. H. (1990). *Applied Linear Statistical Models*. Third Edition. Irwin, Boston.

5.0 MST566/20 Dissertation *(Disertasi)*

All students are required to submit the **Dissertation Supervisor Confirmation Form (APPENDIX B)** no later than **week 10 of the first semester of the academic session (November).** For all students, a minimum of 12 units have to be accumulated before they are allowed to register for this course in the month of **February** (during the second semester registration). There will be an interim viva/presentation around the **4th week of the second semester** consisting of the background study, objectives and methodology to determine the direction of the research.

Full time and part time students are required to submit their dissertation (after confirmation by their respective supervisors) no later than **a date that will be determined in June 2014**. Within 1 – 2 weeks after this date, there will be a seminar presentation (30 mins) and finally the viva. The viva will begin with a short oral presentation by the student regarding his/her achievements followed by a question and answer session.

Details are available in the **GUIDE FOR DISSERTATION PREPARATION.**

The above-mentioned dates are subjected to changes and further information on this matter will be displayed on the School of Mathematical Sciences notice board from time to time.

6.0 MST567/4 Categorical Data Analysis (*Analisis Data Berkategori*)

Aim

To expose students the proper method of analyzing categorical data, interpreting parameters in the model and checking adequacy of models using statistical packages such as SPSS and SAS.

Description

Introduction to the analysis of discrete data, fitting log-linear models; linear logistic regression models; goodness of fit tests; residual analysis; applications with the use of statistical packages.

Syllabus

Introduction to the analysis of frequency data. General goodness -of-fit test: Pearson chi-square test and likelihood ratio test. Test of fit. Estimation and inference on two-way contingency tables. Test of independence. Exact inference for the odds ratio in 2x2 tables.

Three-way contingency tables, marginal and conditional independence; Simpson's paradox; Common odds ratio estimate in stratified 2x2 tables; Measures of association in IxJ tables. Log-linear model: representation, interpretation. Fitting log-linear model: likelihood method; test of goodness of fit. Model building strategies, models for ordinal data, test of conditional independence based on models.

Introduction to Generalized Linear Models. Concepts, Models, Link Functions, Likelihood Function, Estimation, Goodness of Fit Tests.

Logistic regression model for binary outcome: model interpretation; parameter estimation and inference. Goodness of fit and residual analysis. Logistic regression for case-control design; matched case-control design and conditional logistic regression.

Log-linear Model- Representation, Interpretation, Log-linear Models for Two-Way Tables and Three-Way Tables, Fitting Log-Linear Model: Likelihood Method, Test of Goodness of Fit, Model Building Strategies

Skills and Knowledge Acquired

After following the course, students should be able to handle the appropriate method to analyse categorical data and to interpret the results.

References

1. Agresti, A. (2002). *Categorical Data Analysis*, 2nd Edition, New York : J. Wiley & Sons
2. Anderson, E. B. (1997). *Introduction to the Statistical Analysis of Categorical Data* , Eidelberg: Springer Verlag
3. Bishop, Y. M. M, Fienberg, S. E, & Holland, P. W. (1975). *Discrete Multivariate Analysis : Theory and Practice*, Cambridge, MIT Press
4. Christiensen, R.(1990). *Log-linear Models,* New York: Springer Verlag
5. Hosmer, D. W. & Lemeshow, S. (2000). *Applied Logistic Regression, 2nd Edition,* New York : J. Wiley & Sons.

LIST OF DISSERTATION SUPERVISORS (MST566/20)

BIL.	NAME	FIELD OF SPECIALIZATION	ROOM NO./ E-MAIL/ EXT.
1.	ADAM BAHARUM BSc, MSc W. MICHIGAN	Mathematical Programming, Inventory Control, Reliability and Maintenance Modelling	Room No. : 121 adam@ usm.my Ext. No. : 3942
2.	ADLI MUSTAFA BSc, MSc W. MICHIGAN PhD NUS	Network Flows, Data Envelopment Analysis, Multiple Criteria Decision Modelling	Room No : 136 adli.mustafa@usm.my Ext. No. : 3968
3.	FAM PEI SHAN BSc, MSc, PhD UM	Categorical Data Analysis	Room No. : 09 (Kabin B) fpeishan@usm.my Ext. No. : 5908
4.	JOSHUA IGNATIUS BSc, MSc, PhD USM	Business Research Methods, Stuctural Equations Modeling Supply Chain Analysis, Industrial Engineering Optimization Processes	Room No. : 031 josh@usm.my Ext. No. : 4769
5.	HUSNA HASAN BSc IOWA MSc W. MICHIGAN PhD USM	Branching Process, Applied Statistics	Room No. : 026 husnahasan@usm.my Ext. No. : 3969
6.	LOW HENG CHIN BSc, PhD LIVERPOOL	Statistical Theory, Practical Applications of Statistics	Room No. : 037 hclow@usm.my Ext. No. : 3641
7.	MICHAEL KHOO BOON CHONG B.App.Sc, PhD USM	Statistical Process Control, Statistical Inference	Room No. : 120 mkbc@usm.my Ext. No. : 3941
8.	MOHD TAHIR ISMAIL B.App.Sc, MSc USM PhD UKM	Financial Time Series	Room No. : 131 m.tahir@usm.my Ext. No. : 2071

BIL.	NAME	FIELD OF SPECIALIZATION	ROOM NO./ E-MAIL/ EXT.
9.	NORHASHIDAH AWANG BSc USM MSc NUS PhD UPM	Spatial Statistics	Room No. : 041 shidah@usm.my Ext. No. : 4774
10.	NORLIDA MOHD. NOOR Ijazah Kepujian ITM MSc USM	Applied Statistics	Room No. : 039 norlida@usm.my Ext. No. : 3958
11.	NUZLINDA ABDUL RAHMAN BSc, MSc USM PhD UKM	Spatial Statistics	Room No : 126 nuzlinda@usm.my Ext No : 4781
12.	ONG HONG CHOON BSc, Dip Ed UM MSc, PhD USM	Neural Networks, Data Mining	Room No : 019 hcong@usm.my Ext No : 4763
13.	ROSMANJAWATI ABD. RAHMAN BSc (Ed) USM MSc UKM, PhD USM	Applied Statistics	Room No : 119 rosmanjawati@usm.my Ext No : 4778
14.	SEK SIOK KUN B.Econ, MSc UKM PhD Germany	Econometrics	Room No : 113 sksek@usm.my Ext No : 5338
15.	SHAMSUL RIJAL MUHAMMAD SABRI BSc, MSc UKM PhD UM	Applied Statistics	Room No : 115 rijal@usm.my Ext No : 3964
16.	SITI AMIRAH ABD RAHMAN B.Sc. UTM M.Sc. Tech., PhD UNSW	Discrete Optimisation	Room no: 020 amirahr@usm.my Ext: 2355
17.	SURAIYA KASSIM BSc IOWA MSc USM	Applied Statistics, Generalized Estimating Equations	Room No : 038 suraiya@cs.usm.my Ext No : 4773
18.	ZAINUDIN ARSAD BSc HERIOT-WATT MSc SHEFFIELD PhD HERIOT-WATT	Time Series Analysis, Econometric Modelling, Statistical Tourism	Room No : 108 zainudin.arsad@usm.my Ext No : 2069
19.	ZALILA ALI BSc, MSc W. MICHIGAN	Design of Experiments	Room No : 042 zalila_ali@usm.my Ext No : 4775

MASTER IN MATHEMATICS

A. OBJECTIVE

The objective of the program is to produce experts in the field of Computational and Applied Mathematics who are able to undertake research and development activities in addition to teaching of Computational and Applied Mathematics at the postgraduate level.

B. PROGRAMME STRUCTURE

Students are required to obtain at least a B grade for the 20 units taught courses, pass the dissertation course and achieve a CGPA of at least 3.0.

C. COURSES

MAT510/20	:	Dissertation *(Disertasi)*
MAT514/4	:	Mathematical Modelling *(Pemodelan Matematik)*
MAT515/4	:	Computational Mathematics *(Matematik Pengiraan)*
MAT516/4	:	Curve and Surface for CAGD *(Kaedah Lengkung dan Permukaan untuk RGBK)*
MAT517/4	:	Computational Linear Algebra *(Aljabar Linear Pengiraan)*
MAT518/4	:	Numerical Methods For Differential Equation *(Kaedah Berangka untuk Persamaan Pembezaan)*

For full time students, the minimum period given to complete the program is 12 months with a maximum period of 24 months. For part time students, the minimum period is 24 months and a maximum of 48 months.

Full time students have to register MAT514/4, MAT515/4, MAT517/4 and MAT518/4 in the first semester, and MAT516/4 and MAT510/20 in the second semester. Part time students are encouraged to seek the advice of the Deputy Dean (Research) concerning course registration.

SYNOPSIS OF MATHEMATICS COURSES

1.0 MAT510/20 Dissertation *(Disertasi)*

All students are required to submit the **Dissertation Supervisor Confirmation Form (APPENDIX B)** no later than **week 10 of the first semester of the academic session (November).** For all students, a minimum of 12 units have to be accumulated before they are allowed to register for this course in the month of **February** (during the second semester registration). There will be an interim viva/presentation around the **4th week of the second semester** consisting of the background study, objectives and methodology to determine the direction of the research.

Full time and part time students are required to submit their dissertation (after confirmation by their respective supervisors) no later than **a date that will be determined in June 2014**. Within 1 – 2 weeks after this date, there will be a seminar presentation (30 mins) and finally the viva. The viva will begin with a short oral presentation by the student regarding his/her achievements followed by a question and answer session.

Details are available in the **GUIDE FOR DISSERTATION PREPARATION.**

The above-mentioned dates are subjected to changes and further information on this matter will be displayed on the School of Mathematical Sciences notice board from time to time.

2.0 MAT514/4 Mathematical Modelling (*Pemodelan Matematik*)

Aim

The aim of this course is to equip students with the techniques and skills for developing and interpreting mathematical models.

Description

This course will concentrate on development and interpretation of mathematical models in the physical and life sciences.

Syllabus

This course will concentrate on some the following topics:

1. Mathematical Modelling with ordinary differential equations.
2. Ecological models.
3. Fluid flow and water resources modelling.
4. Environmental Modelling.
5. Convective heat and mass transfer.

The topics may also be adjusted from time to time by the lecturer.

Skills and Knowledge Acquired

At the end of the course, students will have acquired the skills for developing and interpreting mathematical models.

References

1. Thomann, R. V & Mueller. J. A. (1987), *Principle of Surface Water Quality Modeling* and *Control*, Haper & Row, NY.
2. Orlob, G. T. (1983), *Mathematical Modeling of Water Quality : Streams, Lakes and Reservoir*, John Wiley.
3. Okubo, A. (1980), *Diffusion and Ecological Problems : Mathematical Mode*ls, Springer-Verlag, NY.
4. Crank, J. (1975), *The Mathematics of Diffusion*, Clarendon Press, Oxford.
5. DeAngelis, D. L. (1992), *Dynamics of Nutrient Cycling and Food Web*, Chapman & Hall.
6. DeAngelis, D. L. & Gross L. J. (Ed). (1992), *Individual Based Models and Approaches* in *Ecology*, Chapman & Hall.
7. Dream, P. B, Murty, T. S. & Stronach, J. A. (1998), *Mathematical Modelling of Tides and Estuarine Circulation* (Lecture Notes on Coastal and Estuarine Studies, vol. 30), Stringes-Verlag.
8. Kraijenhoff, D. A. & Moll, J. R. (Ed). (1986), *River Flow Modelling and Forecasting*, D. Reidel Pnb. Co.
9. Kays W., Crawford M. & Weigand B. (2005), *Convective Heat and Mass Transfer*, 4th edition, Mc. Graw Hill.
10. Bejan A. (1995), *Convection Heat Transfer*, 2nd edition, John Wiley & Sons.
11. Burmeister L. C. (1993), *Convective Heat Transfer*, 2nd edition, John Wiley & Sons.

3.0 MAT515/4 Computational Mathematics *(Matematik Pengiraan)*

Aim

To introduce the student to the use of mathematical software *(Mathematica)* as an investigative tool in the field of scientific computing, with special emphasis being put on experimental techniques involving graphical and numerical displays.

Description

The course is split into two distinct but related parts: the lectures on numerical analysis topics and the practical laboratory sessions. The scientific computing topics listed below are intended to introduce the student to important areas of the subject.

The laboratory sessions have the important function of allowing the student to experiment with and investigate mathematical problems. Some of the laboratory time is taken up with the investigation of techniques and problems arising from the lectures. Emphasis will be on built in functions of the software, together with their strengths and weaknesses.

Syllabus

Introduction to Mathematica

1. *Mathematica* syntax
2. List, vectors and matrices
3. Procedural programming
4. Functional programming
5. Rule-based programming
6. Recursion
7. Visualisation and graphics

Numerical Analysis Topics

1. Basic concepts
2. System of linear and nonlinear equations
3. Polynomials approximation
4. Numerical Integration and Differentation
5. IVP and BVP for Ordinary Differention Equations
6. Fast Fourier Transform
7. Random Numbers and Stochastic Simulation
8. Advanced topics

Skills and Knowledge Acquired

To be able to use mathematical software, not just for mathematics, but as a general investigative tool in many areas of applicable mathematics, such as that found in industries.

References

1. Mangano, S. (2010), *Mathematica Cookbook*, O' Reilly Media, Inc.
2. Wellin, P., Kamin, S. & Gaylord, R. (2005), *An Introduction to Programming with Mathematica*, Cambridge University Press.
3. Wagon, S. (2010), *Mathematica in Action*, 3rd ed., Springer.
4. Press, W. H., Teukolsky, S. A., Vetterling, W. T. & Flannery, B.P. (2007), *Numerical Recipes*, 3rd ed., Cambridge University Press.
5. Heath, M. T. (2002), *Scientific Computing : An Introductory Survey*, 2nd ed., McGraw-Hill.
6. Gander, W. & Hrebicek, J. (2004), *Solving Problems in Scientific Computing using Maple and MATLAB*, 4th ed., Springer-Verlag.
7. Chapman, S. J. (2008), *MATLAB Programming for Engineers*, 4th ed., Thomson Learning.
8. Moler, C. (2004), *Numerical Computing with MATLAB*; SIAM.

4.0 MAT516/4 Curve and Surface Methods for CAGD *(Kaedah Lengkung dan Permukaan untuk RGBK)*

Aim

To provide the basic theoretical concepts underlying curve and surface design in CAGD.

Description

This course introduces theory and methods for the approximation and representation of curves and surfaces that arise when these objects are processed by a computer.

Syllabus

Basic concepts of vector geometry and differential geometry. Polynomial interpolation including Lagrange form, Newtons form, Aitken's algorithm and Hermite form. Concepts of Bezier curves with Bernstein polynomials basis. Curves evaluation with de Casteljau algorithm. Derivatives of Bezier curves, degree elevation and reduction. Continuity issues of composite curves focused on parametric and geometric continuity. Different representation of spline curves and surfaces such as piecewise Bezier form, piecewise Hermite form and B-Spline. B-Spline evaluation using subdivision method and de Boor Cox algorithm. Rational Bezier and B-Spline curves and surfaces. Representation of conic segments by rational curves. Coons patches and Triangular Bezier patches. Shape preserving splines, focussing on positivity (or non positivity) and monotonocity.

Skills and Knowledge Acquired

At the end of the course, students would have acquired the fundamental theory and knowledge of methods for the design of curves and surfaces.

References

1. Davis, P. J. (1969), *Interpolation and Approximation*, Blaisdell.
2. Farin, G. (1996), *Curves and Surfaces for Computer Aided Geometric Design*, 4th ed., Academic Press, Inc.
3. Hoschek, J. & Lasser, D. (1993), *Fundamental of Computer Aided Geometric Design*, A. K. Peters, Wellesley, Massachusetts.
4. Marsh, D. (1999), *Applied Geometry for Computer Graphics an CAD*, Springer.
5. Mortenson, M. E. (1997), *Geometric Modeling*, John Wiley & Sons.
6. Rogers, D. F. & Adams, J.A. (1989), *Mathematical Elements for Computer Graphics*, 2nd ed., McGraw-Hill Publishing Company.
7. Schumaker, L. L. (1981), *Spline Functions : Basic Theory*, John Wiley & Sons.
8. Yamaguchi, F. (1988), *Curves and Surfaces in Computer Aided Geometric Design*, Springer.
9. Salomon, D. (2005). *Curve and Surface for Computer Graphics*, Springer.
10. Sarfraz, M. (2008). *Interactive Curve Modeling with Applications to Computer Graphics, Vision and Image Processing*, Springer.

5.0 MAT517/4 Computational Linear Algebra *(Aljabar Linear Pengiraan)*

Aim

The course deals with computational methods in solving linear algebra problems. In particular, it evolves around the following aspects :

i) the fundamental & numerical properties;
ii) algorithm development;
iii) factorization techniques;
iv) conditioning and stability.

Description

The course is divided into four parts to reflect different aspects of the course :

PART 1 (PRELIMINARIES)

- Numerical Computations, Floating Point Operations, Round-off error, absolute error, relative error;
- Some MATLAB examples;
- Revision of important linear algebra concepts;
- Algorithm, efficiency, stability, conditioning;
- Perturbation analysis of the linear system problem.

PART II (FACTORIZATION METHODS)

- Gaussian elimination, the algorithm, pivoting strategies;
- Gaussian elimination & matrix factorization, elementary matrices, LU Factorization, $\mathbf{LDL}^T$ and Cholesky Factorization ($\mathbf{LL}^T$);
- Orthogonal Factorization Methods : Gram-Schmidt orthogonalization and QR factorization, modified Gram-Schmidt;
- Orthogonal matrices : Orthogonal transformations, Householder matrix, Givens matrices;
- QR factorization using Householder & Givens matrices;
- Solution of linear system of equation using QR factorization;
- Eigenvalue Decomposition, Singular Value Decomposition (SVD), Golub-Kahan-Reinsch algorithm.

PART III (THE LEAST SQUARES PROBLEM)

- Orthogonal projection and best approximation, the normal equation, pseudoinverse;
- Computational Issues in solving the normal equation;
- QR Method for Computing Full Rank, Overdetermined Least Squares Solution;
- Computation of Rank Deficient, Overdetermined Least Squares Solution using SVD.

PART IV (EIGENVALUE PROBLEM)

- Computational difficulties in computing eigenvalues;
- Important definitions & theories: Similarity transformation, eigen decomposition, the Bauer-Fike theorem, Gersgorin Circle;
- Power Iteration;
- Power Method : Basic algorithm, rate of convergence and acceleration, Power method with shift;
- Deflation;
- QR Method for Symmetric Eigenvalue Problem: Special properties of the symmetric eigenvalue problem, basic QR iteration for symmetric matrices, QR algorithm using Givens matrices;
- Accelerating convergence : QR method with shift.

Skills and Knowledge Acquired

At the end of the course, students would have acquired the fundamental theory and knowledge of advanced techniques in Computational Linear Algebra.

References

1. Datta B. (2009), Numerical Linear Algebra. SIAM.
2. Lloyd N. Trefthen & David Bau (1997) Numerical Linear Algebra, SIAM.
3. Steven J. Leon, (2006) Linear Algebra with applications, 7th Ed. Prentice Hall.
4. Howard Anton, (2000) Elementary Linear Algebra with Applications,John Wiley & Sons.
5. Richard L. Burden & J. Douglas Faires, (2011) Numerical Analysis, Brooks/Cole.
6. Gene H. Golub & Charles F. Van Loan, (2012) Matrix Computations, 4th John Hopkins University Press.

6.0 MAT518/4 Numerical Methods for Differential Equations *(Kaedah Berangka untuk Pesamaan Pembezaan)*

Aim

The aim of this course is to increase students knowledge of numerical methods for the solution of differential equations.

Description

Differential equations form the basis for the mathematical modeling of various phenomena. This course will focus on the theory and implementation of numerical methods for the solution of differential equations (in particular partial differential equations).

Syllabus

Numerical methods for ordinary differential equations

- Initial value problems : one step, multi-step methods; systems; stability; stiff equations;
- Boundary value problems : shooting, finite difference, Rayleigh-Ritz methods.

Numerical methods for parabolic and hyperbolic partial differential equations

- Finite difference schemes : derivation and implementation; error analysis, stability, consistency, convergence, applications.

Finite Difference Discretization for the solution of Elliptic PDEs
Iterative Methods for Systems Arising from Elliptic PDEs

- Jacobi, Gauss-Seidel, S.O.R methods.

Convergence Properties and Rate of Convergence of Basic Iterative Methods.
Block Iterative Methods.
Other Advanced Point Iterative Methods.

- Simultaneous Displacement Method, Second Order Methods, Gradient Method Preconditioning;
- Preconditioned Conjugate Gradient Method.

Skills and Knowledge Acquired

At the end of this course, students should have the knowledge and skills to efficiently use numerical methods for solving differential equations. The students will also understand the theoretical foundations of the numerical methods discussed.

References

1. Saad, Y. (2002), *Iterative Methods for Sparse Linear Systems*, SIAM.
2. Mattheij, R. M. M., Rienstra S.W. & Thije Boonkkamp J. H. M. (2005), *Partial Differential Equations-Modeling, Analysis, Computation*, SIAM.
3. Byrne,C. L. (2008), Applied Iterative Methods, A.K Peters Ltd.
4. Geiser, J. (2011), Iterative Splitting Methods for Differential Equations, Chapman & Hall Book.

LIST OF DISSERTATION SUPERVISORS (MAT510/20)

BIL.	NAME	FIELD OF SPECIALIZATION	ROOM NO./ E-MAIL/ EXT.
1.	ABD. RAHNI MT. PIAH BA KNOX COLLEGE MSc USM PhD DUNDEE	Approximation Theory, Computer Aided Geometric Design	Room No. : 135 arahni@usm.my Ext. No. : 3945
2.	ADAM BAHARUM BSc, MSc W. MICHIGAN	Mathematical Programming, Inventory Control, Reliability and Maintenance Modelling	Room No. : 121 adam@usm.my Ext. No. : 3942
3.	ADLI MUSTAFA BSc, MSc W. MICHIGAN PhD NUS	Network Flows, Data Envelopment Analysis, Multiple Criteria Decision Modelling	Room No. : 136 adli.mustafa@usm.my Ext. No. : 3968
4.	AHMAD LUTFI AMRI RAMLI BSc USM MSc BRUNEL UNIVERSITY, UK PHD DURHAM, UK	Computer Aided Geometric Design	Room No. : 022 alaramli@usm.my Ext. No. : 2065
5.	AMIRAH AZMI BSc, MSc UTM PhD UNIVERSITY OF WOLLONGONG	Solitary Waves Optical Solition Nonlinear PDE	Room No. : 114 amirahazmi@usm.my Ext. No. : 2671
6.	ANDREW RAJAH A/L BALASINGAM GNANARAJ BSc, PhD USM	Algebra, Groups and Moufang Loops	Room No. : 124 andy@usm.my Ext. No. : 4780
7.	ANG MIIN HUEY BA (Education), MSc USM PhD NUS	Coding Theory, Cryptography, Algebra	Room No. : 036 mathamh@usm.my Ext. No. : 4772
8.	AZHANA AHMAD BSc USM MSc UKM PhD UTM	Group Theory	Room No. : 035 azhana@usm.my Ext. No. : 4771
9.	ENA JAMAL BSc, MSc USM	Algebra, Groups and Moufang Loops	Room No. : 034 ena@usm.my Ext. No. : 3658

BIL.	NAME	FIELD OF SPECIALIZATION	ROOM NO./ E-MAIL/ EXT.
10.	FARAH AINI ABDULLAH BSc, MSc USM PhD UNIVERSITY OF QUEENSLAND	Mathematical Computing Biomathematics	Room No. : 024 farahaini@usm.my Ext. No. : 4765
11.	HAILIZA KAMARULHAILI BSc USM MSc, PhD LIVERPOOL	Analytical Number Theory, Cryptography	Room No. : 040 hailiza@usm.my Ext. No. : 3648
12.	KONG VOON PANG BSc, MSc, PhD USM	Computer Aided Geometric Design	Room No. : 125 kongvp@usm.my Ext. No. : 3943
13.	LEE SEE KEONG BSc, MSc USM PhD LSU	Stochastic Analysis	Room No. : 111 sklee@usm.my Ext. No. : 2070
14.	MAISARAH HAJI MOHD BSc, MSc USM, PhD UKM	Complex Analysis, Geometric Function Theory	Room No. : 110 maisarah_hjmohd@usm.my Ext. No. : 4488
15.	NOOR ATINAH AHMAD BSc BRISTOL PhD SOUTHAMPTON	Mathematical Modeling, Numerical Linear Algebra, Mathematical algorithms for signal processing	Room No. : 027 nooratinah@usm.my Ext. No. : 4767
16.	NOOR HAYATI MARZUKI BSc MALAYA MSc USM	History of Mathematics	Room No. : 023 nhayatim@usm.my Ext No : 2356
17.	NORHASHIDAH HJ. MOHD. ALI BSc W. ILLINOIS MSc VIRGINIA TECH PhD UKM	Partial Differential Equations, Parallel Numerical Algorithms	Room No : 043 shidah_ali@usm.my Ext. No. : 3960
18.	DATO' ROSIHAN M. ALI BSc NEVADA, RENO MSc, PhD TEXAS TECH	Univalent Function Theory, Complex Analysis, Mathematical Education (Hand-held Technology)	Room No. : 129 rosihan@usm.my Ext. No. : 3966
19.	SARATHA a/p SATHASIVAM BSc Ed, MSc USM PhD UM	Neural Networks, Computational Logic, Data Mining	Room No. : 033 saratha@usm.my Ext. No. : 2428

BIL.	NAME	AREAS OF RESEARCH	ROOM NO./ E-MAIL/ EXT.
20.	SYAKILA AHMAD BSc, MSc UKM PhD UPM	Mathematical Modelling, Fluid Dynamics, Convective Heat Transfer	Room No. : 130 syakilaahmad@usm.my Ext. No. : 4782
21.	TEH SU YEAN BSc, MSc, PhD USM	Environmental and Ecosystem Modelling, Mathematical Modelling	Room No. : 032 syteh@usm.my Ext. No. : 4770
22.	TEH WEN CHEAN BSc, MSc, USM PhD OHIO STATE UNIVERSITY, USA	Combinatorics Logic	Room No. : 117 dasmenteh@usm.my Ext. No. : 4777
23.	ONG WEN ENG BSc, MSc, UM PhD CANTERBURY	Surface Approximation Shortest Path Algorithm	Room No. : 112 weneng@usm.my Ext. No. : 4776
24.	YAHYA ABU HASAN BSc, MSc, PhD LONDON	Cryptography, Computational Intelligence, Algorithmic Modelling	Room No. : 134 ah.yahya@usm.my Ext. No. : 4783
25.	YAZARIAH MOHD YATIM BSc, MSc USM PhD STRATHCLYDE	Thin-Film Flows, Newtonian and Non -Newtonian Fluid Mechanics Travelling Ware and Similarity Solutions	Room No. : 133 yazariahmy@usm.my Ext. No. : 3384
26.	ZARITA ZAINUDDIN BSc MONMOUTH COLLEGE MSc OHIO PhD USM	Neural Networks Learning Algorithms, Mathematical Modelling	Room No. : 044 zarita@usm.my Ext. No. : 3940

Note:

The staf from the Operational Research Group of the School of Mathematical Sciences can also be contacted to obtain appropriate dissertation topics.

GUIDELINES FOR CANDIDATES OF MAT510/20 – DISSERTATION OR MST566/20 – DISSERTATION REGISTERED IN SEMESTER I (Part time Candidates) and

SEMESTER II (Full time Candidates)

Introduction

The Dissertation should be completed within the stipulated time. Candidates who fail to submit their Dissertation for examination at the time set by their school will be awarded a Grade F for this course and are required to repeat the course with a new topic. This set of guidelines explains the minimum requirements that have to be fulfilled by candidates as well as the process and the aspects of examination of the Dissertation in partial fulfillment of the Master of Science (Mathematics) or Master of Science (Statistics) Degree (Mixed Mode).

Submission of Dissertation

1. Dissertations may be written either in Bahasa Malaysia or English.

2. All candidates have to submit 4 copies of their Dissertation (bound in red with soft cover) for the purpose of examination together with the Submission of Dissertation Form that has been signed and approved by the Supervisor to the Dean's Office **will be determined in June 2014**. The topic of the Dissertation and its translation should be stated in the Submission of Dissertation Form (refer to Appendix B) for confirmation and approval by the Council of The School of Mathematical Sciences. The Dissertation will not be examined until the candidate fulfills all the requirements.

Format

3. The full title of the dissertation, full name of the candidate, name of the School of Mathematical Sciences, Universiti Sains Malaysia and the year of submission of the Dissertation for examination has to be typed in capital letters of size **18 on the front cover** as shown in the example below:

LONGITUDINAL DATA ANALYSIS
(Font size 18)

NORAINI BINTI ABIDIN
(Font size 18)

SCHOOL OF MATHEMATICAL SCIENCES (Font size 18)
UNIVERSITI SAINS MALAYSIA (Font size 18)

2016

or as follows (if the dissertation is written in Bahasa Malaysia):

ANALISIS DATA LONGTITUD

NORAINI BINTI ABIDIN

PUSAT PENGAJIAN SAINS MATEMATIK
UNIVERSITI SAINS MALAYSIA

2016

4. Every Dissertation comprises four parts: **Introduction, Text, Reference** and **Appendix.** Every part has sections that have to be organized in a specific order. The heading of each section should be in capital letters, centralized without any punctuation marks and 5cm from the top of the page; the text and list begin four spaces below.

5. Only good quality plain white paper (80 g/m²) of A4 size (210 × 297 mm) should be used. Materials must be typed or printed on one side of the paper only using a 'laser printer'. All photocopies must be clear to ensure the quality of printing. Carbon copies are not acceptable. All copies must be clean and legible. The text should be typed, double-spaced using the 'Microsoft Word 2000/Latex' word processor or the latest version. Candidates are encouraged to use the font, **'Times New Roman'** and the acceptable **font size for the whole Dissertation is 10-12 points. Single-spacing** is recommended for long tables, long quotations, notes, footnotes, multi-line captions and bibliographic entries. No crossing-out of letters or words is permitted. All sections erased must be clean. The use of transparent tape as a form of patching is not allowed.

6. The **Introduction** begins with the Title page as shown in the example below:

LONGITUDINAL DATA ANALYSIS
(Font size 14)

by
(Font size 12)

NORAINI BINTI ABIDIN
(Font size 14)

Dissertation submitted in partial fulfillment
of the requirements for the degree
of Master of Science in Statistics
(Font size 12/single spacing/centre)

August 2016
(Font size 14)

or as follows (if the dissertation is written in Bahasa Malaysia):

ANALISIS DATA LONGTITUD

oleh

NORAINI BINTI ABIDIN

Disertasi diserahkan untuk memenuhi
sebahagian keperluan bagi
Ijazah Sarjana Sains Statistik

Ogos 2016

7. The **Introduction** is made up of a number of sections such as the Acknowledgment, Table of Contents, List of Tables (if any), List of Figures (if any), List of Diagrams (if any), List of Symbols (if any), Abbreviations or Wordlist (if any) and lastly the Abstract. All pages in the Introduction are numbered using lower case Roman numerals (i, ii, iii, etc). The title page of the Dissertation is considered as page i, but the number is not printed on the page.

8. Consistency in pagination is more important than the position of the page number.

9. An Abstract in both Bahasa Malaysia and English must be provided, the former version appearing before the latter. If the dissertation is written in Bahasa Malaysia, the English version of the Abstract must have an English title and vice-versa. The Abstract is a summary of the entire Dissertation and should provide a brief exposition of the research problems and aims, approaches taken to solve the problems and a summary of findings in the context of the whole area of study. Subsequent research proposals may be incorporated. This section should be double-spaced and the length of each version should not exceed 400 words. The Abstract should be placed immediately before the First Chapter of the Dissertation.

10. The **Text** is made up of a number of sections. **The organisation of this section is to be determined by the student and his/her supervisor(s).** As a general guideline, the length of the text should not exceed 25,000 words. For example, the **Text** can start with an introduction that highlights the problem(s) under investigation by describing the status of the problem(s) conceptually and theoretically. Besides that, the candidate can state the scope and objectives of the study and outline the plan of action or research protocol based on the status of the problem(s). The literature review may be written as a separate chapter and the materials that have been quoted or extracted should be relevant to the research topic, objectives, method or the research protocol and the basic theory or the approach used. The literature review should include the latest research findings from books, journals, magazines, research reports and the latest materials from the internet/websites. The subsequent chapters or sections in the **Text** may include research methods, results, discussion, summary or conclusion and recommendations for future research.

11. The standard margins for the general text, tables and diagrams are as follows:

Top	:	2.5cm
Right	:	2.5cm
Left	:	3.5cm
Bottom	:	2.5cm

12. The **Bibliography** or **Reference** is the section after the **Text** that begins on a fresh page bearing the heading in capital letters, centralized without any punctuation marks, 5 cm from the top. The list of references begins four spaces below the heading, double-spaced between entries but single-spaced within each entry. A 3-space indentation should be used for any entry exceeding a single line. References must be presented according to the Harvard System (refer to Appendix C). If a candidate makes use of other works in his/her project, either in direct quotation or by reference, these sources must be listed in the bibliography.

13. The **Appendix** is a section that is separated from the preceding material by a cover sheet bearing the heading **APPENDICES** in capital letters (or, if there is only one, **APPENDIX)**, centralized without any punctuation marks. This sheet is not numbered and also not included in the total number of pages. Appendices present materials that are referred to in the text. It contains supplementary illustrative material, notes on the interview/questionnaires, data or quotations too long for inclusion in the text or long explanations about a particular method/experiment. Appendices may be divided into Appendix A, Appendix B, etc., such divisions being treated as first order subdivisions. Each appendix with its title, if it has one, should be listed separately in the Table of Contents as a first order subdivision under the heading APPENDICES. Tables and figures in the Appendices must be numbered and have captions and also listed in the List of Tables and List of Figures in the Introduction.

Examination of the Dissertation

14. The Supervisor and Internal Examiner appointed by the Board of the School of Mathematical Sciences will be given a copy each of the Dissertation for examination purposes, to be completed within 3 weeks.

15. Candidates need to hold a seminar on the Dissertation that has been submitted for examination on a specific date. The seminar may include the presentation of the research background, framework, hypothesis, findings, discussions and recommendations. Each candidate is given 20 minutes for the presentation and 10 minutes for the question and answer session.

16. Candidates have to attend a viva in the presence of the Panel of Dissertation Examiners at the School of Mathematical Sciences. The viva will begin with a 5-minute oral presentation by the candidate regarding his/her dissertation.

17. The Panel of Dissertation Examiners comprises :

    a. Dean (Chairperson);
    b. Deputy Dean (Research);
    c. Supervisor;
    d. Internal Examiner;
    e. Assistant Registrar (Secretary).

    The overall Dissertation Grade is either a Grade P (PASS) or a Grade F (FAIL).

18. After the viva, all copies of the Dissertation will be returned to the candidate.

19. Candidates who are required to re-submit their Dissertations for re-examination and / or attend a viva must submit 3 copies of the amended Dissertation together with the re-submission of Dissertation Form (refer to Appendix D) filled by the candidate and approved by the Supervisor

20. After all corrections (if any) and the decision of the Panel of Examiners are implemented, candidates who PASS should submit 3 hard cover “deposit copies” of their Dissertation bound in red buckram or rexine together with the Submission of Final Dissertation Form (refer to Appendix E). The full Dissertation title, name of candidate, name of the university and year of submission of the Dissertation should be **printed in gold, font size 18, on the cover page.** The name of the candidate, the full title (if not too long), year of submission of the Dissertation and the degree to be awarded should also be printed in gold of a suitable font size on the spine as shown below:

LONGITUDINAL DATA ANALYSIS
(Font size 18)

NORAINI BINTI ABIDIN
(Font size 18)

SCHOOL OF MATHEMATICAL SCIENCES(Font size 18)
UNIVERSITI SAINS MALAYSIA (Font size 18)

2016
(Font size 18)

* Dissertation front cover.

* Spine of the Dissertation.

APPENDIX A

The Harvard System

Under the Harvard System, reference is made by giving the author's surname together with the year of publication. In the text, the year of publication appears within parenthesis after the author's surname if it forms part of the sentence; for example, Ch'ng (1986) or Salleh and Zainuddin (1987) or where there are more than two authors, Nagendran *et al.* (1990). If several papers by the same author and from the same year are cited, the letters a, b, c, etc. should be placed after the year of publication; for example Karel and Labuza (1988b).

In contrast, both the author's surname and the year of publication appear within brackets if the author's surname does not form part of the sentence; for example: ……(Omar & Tan, 1989).

In any particular sentence, if several publications are cited, the references should be cited in chronological order. However, if several publications in the same year are cited, the references should be made in alphabetical order and with publications by a single author taking precedence over those by co-authors.

Under the heading Bibliography or Reference, all references are cited in alphabetical order. The references do not need to be numbered. References to periodicals should be listed as follows: authors' surnames and initials (instead of first author *et al.*) year of publication in brackets, exact title of paper, abbreviated title of the periodical in italics (or underlined), volume number in Arabic numerals, underlined twice (or in bold print) and initial and final page numbers of the article. For example:

Kalatos, T. M. & Lee, A. R. (1990). A simple device to illustrate angular momentum conservation and instability. *Am. J. Phys.* **58** (1), 80 – 81.

In the Harvard System, the titles of books are in italics (or underlined), followed by the city and publisher. For example:

Conn, E. E., Stumpf, P. K., Bruening, G. & Doi, R. H. (1987), *Outlines of Biochemistry*, 5th ed. New York: John Wiley & Sons.

Reference from edited books may be written as follows:

Hocking, A. D. (1988). Moulds and yeasts associated with foods of reduced water activity: Ecological Interactions. In *Food Preservation by Moisture Control* (Seow, C. C., ed.), p. 57 – 72. London: Elsevier Applied Sci. Publ.

References from other materials are as follows:

Web page without author

Feminist Collections A Quaterly of Women's Studies Resources (2002) [Online], [Accessed 9th May 2002]. Avaible from World Wide Web :
http://www.library.wisc.edu/libraries/Womens Studies/fcmain.htm

Web page with author

Harking, S. (2000) *Profesor Stephen Hawking's website* [Online]. [Accessed 9th May 2002]. Avaible from World Wide Web :
Http://www.hawking.org.uk/home/hindex.html

Thesis

Gill, M. R. (1997) *The relationship between the physical properties of human articular cartilage and tissue biochemistry and ultrastucture*. Ph.D thesis, University of Leeds.

Proceedings/ Conference paper

Robertson, J. (1986) The economics of local recovery : In : *The Other Economics Summit*, 17/18 April 1986, Tokyo. London : The Other Economics Summit.

Electronic journal

Royall C. P., Thiel B. L. & Donald A. M. (2001) Radiation damage of water ini environmental scanning electron microscopy. *Journal of Microscopy*. [Online]. 2004(3), Accessed 9th May 2002], p. 185. Available from World Wide Web : http://www.blackwell-synergy.com/

CD-ROM

Who's who 1987-1998 electronic resource (1998) [CD-ROM] London : Oxford University Press.

Note:

1. There are various systems of abbreviating titles of periodicals. As a general guideline, students can adopt the system provided in the book "The World List of Scientific periodicals" or refer to their respective supervisors.

2. When listing the references, the titles of articles should be reproduced exactly as they appear in the original.

3. Consistency is the keyword in any system of referencing.

APPENDIX B

UNIVERSITI SAINS MALAYSIA

PUSAT PENGAJIAN SAINS MATEMATIK

RANCANGAN SARJANA SAINS [STATISTIK/MATEMATIK]
(Mod Campuran)

Sidang Akademik ……

BORANG PENGESAHAN PENYELIA KURSUS DISERTASI
(Dissertation Supervisor Confirmation Form)

Kod Kursus : MST 566/20/MAT 510/20

Nama Pelajar : …….. No. K/Pengenalan : …….. No. Matrik : ……. Tandatangan Pelajar : …….. No. Tel : ……. E-mail : …….. Tarikh : ……
Tajuk Disertasi : …….. …… ……
Saya mengesahkan bahawa saya bersetuju untuk menyelia pelajar di atas pada Sidang Akademik : …….. Nama Penyelia : ……. Tandatangan Penyelia : …….. Tarikh : ……...

APPENDIX C

UNIVERSITI SAINS MALAYSIA

PUSAT PENGAJIAN SAINS MATEMATIK
SCHOOL OF MATHEMATICAL SCIENCES

BORANG PENYERAHAN DISERTASI
(Dissertation Submission Form)

KURSUS MAT510/20 & MST566/20

Kepada : Dekan
Pusat Pengajian Sains Matematik
Universiti Sains Malaysia
11800 Pulau Pinang

Nama : ……..

Taraf Pencalonan (sila tandakan) : **Sambilan/Penuh Masa**

No. Matrik : …….

Alamat Terkini : ……
……
No. Tel. : …… E-Mel : ……

Tarikh : ……..

Bersama-sama ini saya kemukakan **4 naskhah disertasi** dalam bentuk berjilid dengan pembalut yang lembut untuk tujuan penilaian.

Tajuk Disertasi : ……..……..
…….....

Terjemahan : …….....
…….....

1. Saya ingin mengesahkan bahawa disertasi tersebut telah pun disemak oleh Penyelia saya dan komen beliau adalah seperti yang terdapat di **Bahagian B** borang ini.

Sekian,terima kasih.

……
(Tandatangan Calon)

BAHAGIAN B
(untuk diisi oleh Penyelia Disertasi)

Nama Penyelia :
……

Saya telah menyemak disertasi Encik/Puan/Cik……
seorang calon Rancangan Ijazah Tinggi Sarjana Sains Matematik/Statistik.

1. Saya ingin mengesahkan bahawa saya berpuashati dengan kemajuan yang dicapai oleh calon tersebut dan dilihat dari segi kualiti dan mutu bahasa, saya tiada halangan disertasi tersebut diserahkan untuk tujuan penilaian.

……. …….
(Tandatangan Penyelia) (Tarikh)

……

BAHAGIAN C
(untuk diisi oleh Timbalan Dekan [Penyelidikan])

Saya ingin mengesahkan perakuan yang dibuat oleh Penyelia Disertasi calon ini seperti yang tercatat di Bahagian B di atas.

…… ……..
(Tandatangan Timbalan Dekan (Penyelidikan)) (Tarikh)

APPENDIX D

UNIVERSITI SAINS MALAYSIA

PUSAT PENGAJIAN SAINS MATEMATIK
SCHOOL OF MATHEMATICAL SCIENCE

BORANG PENYERAHAN SEMULA
DISERTASI UNTUK PEMERIKSAAN
Dissertation Re-Submission Form for Examination

BAHAGIAN A
(Untuk diisi oleh calon)

Kepada : Dekan
Pusat Pengajian Sains Matematik
Universiti Sains Malaysia
11800 Pulau Pinang

Nama :_____

Alamat(terkini): _____

Tel.Rumah : _____ Tel. Pejabat : _____

E-Mel:_____ Tarikh : _____

Bersama-sama ini saya kemukakan disertasi dalam bentuk berjilid untuk penyerahan dan pemeriksaan semula :-

Tiga (3) naskhah Disertasi Ijazah Sarjana Sains [**Matematik/Statistik**] dengan pembalut lembut (berwarna merah) :

_____

_____

Terjemahan :-

_____

_____

1. Saya ingin mengesahkan bahawa semua pindaan/pembetulan telah dilaksanakan disertasi tersebut dan telahpun disemak oleh penyelia saya komen beliau adalah seperti yang terdapat pada Bahagian B borang ini.

Sekian, terima kasih.

…….

(Tandatangan Calon)

BAHAGIAN B

(Untuk diisi oleh Penyelia Utama)

Nama Penyelia : _____

Pusat Pengajian

Saya telah menyemak semua pembetulan/pindaan yang dibuat oleh Encik/Puan/Cik ……...dalam disertasinya yang diserah semula untuk pemeriksaan sebagaimana yang dipersetujui oleh Jemaah Pemeriksaan Disertasi. .

1. Saya ingin mengesahkan bahawa saya berpuas hati dengan pembetulan/pindaan yang dibuat oleh calon dan tiada halangan disertasi tersebut diserahkan untuk pemeriksaan semula.

Sekian, terima kasih.

…….. ……

(Tandatangan Penyelia) (Tarikh)

BAHAGIAN C

(Untuk diisi oleh Timbalan Dekan [Penyelidikan])

Saya ingin mengesahkan perakuan yang dibuat oleh penyelia disertasi calon ini seperti yang tercatat di Bahagian B di atas:-

……. …….

Tandatangan Timbalan Dekan (Tarikh)
[Penyelidikan]

APPENDIX E

UNIVERSITI SAINS MALAYSIA

PUSAT PENGAJIAN SAINS MATEMATIK
SCHOOL OF MATHEMATICAL SCIENCES

BORANG PENYERAHAN DISERTASI MUTAKHIR
(TIGA (3) NASKHAH)
((Final Dissertation Submission Form)

BAHAGIAN A
(Untuk diisi oleh calon)

Nama :……..

Bidang Pengajian : Sarjana Sains Statistik/Matematik (tandakan yang berkenaan)

Alamat (terkini) :…….
…….

No. Tel. :……. E-Mel : . ……..

Tarikh :…….

Bersama-sama dengan ini saya kemukakan :-

i) Tiga (3) naskhah berjilid dengan pembalut khas dan satu (1) cakera padat disertasi Ijazah Sarjana Sains [**Matematik/Statistik**] bertajuk :-

……

……..……...…

……

Terjemahan :-

……..

……..

……..……

ii) Saya ingin mengesahkan bahawa disertasi tersebut telahpun disemak oleh Penyelia Utama saya dan Dekan Pusat Pengajian, komen mereka adalah seperti yang terdapat pada Bahagian B dan C borang ini.

Sekian, terima kasih.

…….
(Tandatangan Calon)

BAHAGIAN B

(Untuk diisi oleh Penyelia Utama)

Nama Penyelia :……

Pusat Pengajian ……

Saya telah menyemak semua pembetulan/pindaan yang dilaksanakan oleh Encik/Puan/Cik …….. mengenai disertasinya sebagaimana yang dipersetujui oleh Jemaah Pemeriksaan Disertasi.

1. Saya ingin mengesahkan bahawa saya berpuas hati dengan pembetulan/pindaan yang dilaksanakan oleh calon.

Sekian, terima kasih.

…….. ……

(Tandatangan Penyelia) (Tarikh)

BAHAGIAN C

(Untuk diisi oleh Dekan Pusat Pengajian)

Saya, …… Dekan Pusat Pengajian Sains Matematik ingin :-

(i) Mengesahkan perakuan yang dibuat oleh Penyelia Calon ;

(ii) Mengesahkan bahawa saya berpuashati dengan pembetulan/pindaan yang dilaksanakan oleh calon sebagaimana yang dipersetujui oleh Jemaah Pemeriksaan Disertasi.

…….. ……

(Tandatangan Dekan) (Tarikh)