Master of Science
Statistics & Mathematics

Academic Session 2020/2021

UNIVERSITI SAINS MALAYSIA

School of Mathematical Sciences

CONTENTS

ACADEMIC CALENDAR
ACADEMIC SESSION 2020/2021
UNIVERSITI SAINS MALAYSIA

SEM	WEEK	ACTIVITY	DATE	REMARKS
ONE	1	Teaching & Learning (T&L - 7 Weeks)	Monday, 12.10.2020 - Sunday, 18.10.2020	
	2		Monday, 19.10.2020 - Sunday, 25.10.2020	
	3		Monday, 26.10.2020 - Sunday, 01.11.2020	29.10.2020, Thursday - Prophet Muhammad's Birthday
	4		Monday, 02.11.2020 - Sunday, 08.11.2020	
	5		Monday, 09.11.2020 - Sunday, 15.11.2020	11 & 12.11.2020, Wednesday & Thursday - Sultan of Kelantan's Birthday (Kelantan) 14.11.2020, Saturday - Deepavali**
	6		Monday, 16.11.2020 - Sunday, 22.11.2020	
	7		Monday, 23.11.2020 - Sunday, 29.11.2020	
	8	Mid Semester Break	Monday, 30.11.2020 - Sunday, 06.12.2020	
	9	Teaching & Learning (T&L - 7 Weeks)	Monday, 07.12.2020 - Sunday, 13.12.2020	
	10		Monday, 14.12.2020 - Sunday, 20.12.2020	
	11		Monday, 21.12.2020 - Sunday, 27.12.2020	25.12.2020, Friday - Christmas
	12		Monday, 28.12.2020 - Sunday, 03.01.2021	01.01.2021, Friday - New Year of 2021
	13		Monday, 04.01.2021 - Sunday, 10.01.2021	
	14		Monday, 11.01.2021 - Sunday, 17.01.2021	
	15		Monday, 18.01.2021 - Sunday, 24.01.2021	
	16	Revision Week	Monday, 25.01.2021 - Sunday, 31.01.2021	28.01.2021, Thursday - Thaipusam**
	17	Examination (3 Weeks)	Monday, 01.02.2021 - Sunday, 07.02.2021	
	18		Monday, 08.02.2021 - Sunday, 14.02.2021	12 & 13.02.2021, Friday & Saturday - Chinese New Year**
	19		Monday, 15.02.2021 - Sunday, 21.02.2021	
	20	Mid Semester Break / Industrial Training (4 Weeks)	Monday, 22.02.2021 - Sunday, 28.02.2021	22.02.2021, Monday - 14.03.2021, Sunday - PPJJ Intensive Course
	21		Monday, 01.03.2021 - Sunday, 07.03.2021	
	22		Monday, 08.03.2021 - Sunday, 14.03.2021	
	23		Monday, 15.03.2021 - Sunday, 21.03.2021	
TWO	24/1	Teaching & Learning (T&L - 7 Weeks)	Monday, 22.03.2021 - Sunday, 28.03.2021	
	25/2		Monday, 29.03.2021 - Sunday, 04.04.2021	
	26/3		Monday, 05.04.2021 - Sunday, 11.04.2021	
	27/4		Monday, 12.04.2021 - Sunday, 18.04.2021	13.04.2021, Tuesday - Awal Ramadhan (Kelantan)
	28/5		Monday, 19.04.2021 - Sunday, 25.04.2021	
	29/6		Monday, 26.04.2021 - Sunday, 02.05.2021	29.04.2021, Thursday - Nuzul Al-Quran 01.05.2021, Saturday - Labour Day
	30/7		Monday, 03.05.2021 - Sunday, 09.05.2021	
	31/8	Mid Semester Break	Monday, 10.05.2021 - Sunday, 16.05.2021	13 & 14.05.2021, Thursday & Friday - Eid-ul fitr**
	32/9	Teaching & Learning (T&L - 7 Weeks)	Monday, 17.05.2021 - Sunday, 23.05.2021	
	33/10		Monday, 24.05.2021 - Sunday, 30.05.2021	26.05.2021, Wednesday - Wesak Day 30.05.2021, Sunday - Pesta Kaamatan (Sabah)
	34/11		Monday, 31.05.2021 - Sunday, 06.06.2021	31.05.2021, Monday - Pesta Kaamatan (Sabah) 01 & 02.06.2021, Tuesday & Wednesday - Hari Gawai (Sarawak)
	35/12		Monday, 07.06.2021 - Sunday, 13.06.2021	08.06.2021, Tuesday - Agong's Birthday
	36/13		Monday, 14.06.2021 - Sunday, 20.06.2021	
	37/14		Monday, 21.06.2021 - Sunday, 27.06.2021	
	38/15		Monday, 28.06.2021 - Sunday, 04.07.2021	

	39/16	Revision Week		Monday,	05.07.2021 - Sunday,	11.07.2021	07.07.2021, Wednesday - Penang Heritage 10.07.2021, Saturday - Penang Governer's Day
	40/17	***Examination (2 Weeks)		Monday,	12.07.2021 - Sunday,	18.07.2021	
	41/18		Examination (3 Weeks)	Monday,	19.07.2021 - Sunday,	25.07.2021	20.07.2021, Tuesday - Eid-ul adha** 21.07.2021, Wednesday - Eid-ul adha** (Kelantan)
	42/19			Monday,	26.07.2021 - Sunday,	01.08.2021	***2 weeks examination for engineering students undergoing Industrial Training
*KSCP / LONG VACATION	43/20	Long Vacation / Industrial Training (10/11 Weeks)		Monday,	02.08.2021 - Sunday,	08.08.2021	
	44/21			Monday,	09.08.2021 - Sunday,	15.08.2021	10.08.2021, Tuesday - Awal Muharram
	45/22			Monday,	16.08.2021 - Sunday,	22.08.2021	
	46/23			Monday,	23.08.2021 - Sunday,	29.08.2021	
	47/24		*T&L	Monday,	30.08.2021 - Sunday,	05.09.2021	31.08.2021, Tuesday - National Day
	48/25			Monday,	06.09.2021 - Sunday,	12.09.2021	*Courses During Long Vacation
	49/26		Examination	Monday,	13.09.2021 - Sunday,	19.09.2021	
	50/27			Monday,	20.09.2021 - Sunday,	26.09.2021	
	51/28			Monday,	27.09.2021 - Sunday,	03.10.2021	
	52/29			Monday,	04.10.2021 - Sunday,	10.10.2021	

IMPORTANT DATES FOR FULL TIME CANDIDATES
DISSERTATION COURSES MAT 510/20 AND MST 566/20

ACADEMIC SESSION 2020/2021

Candidates submit the Confirmation Form
signed by the supervisor to the General Office,
School of Mathematical Sciences
by **18th December 2020**

Candidates register 2nd Semester course,
Academic Session **2020/2021**
**** Candidates are required to have accumulated 12 units***

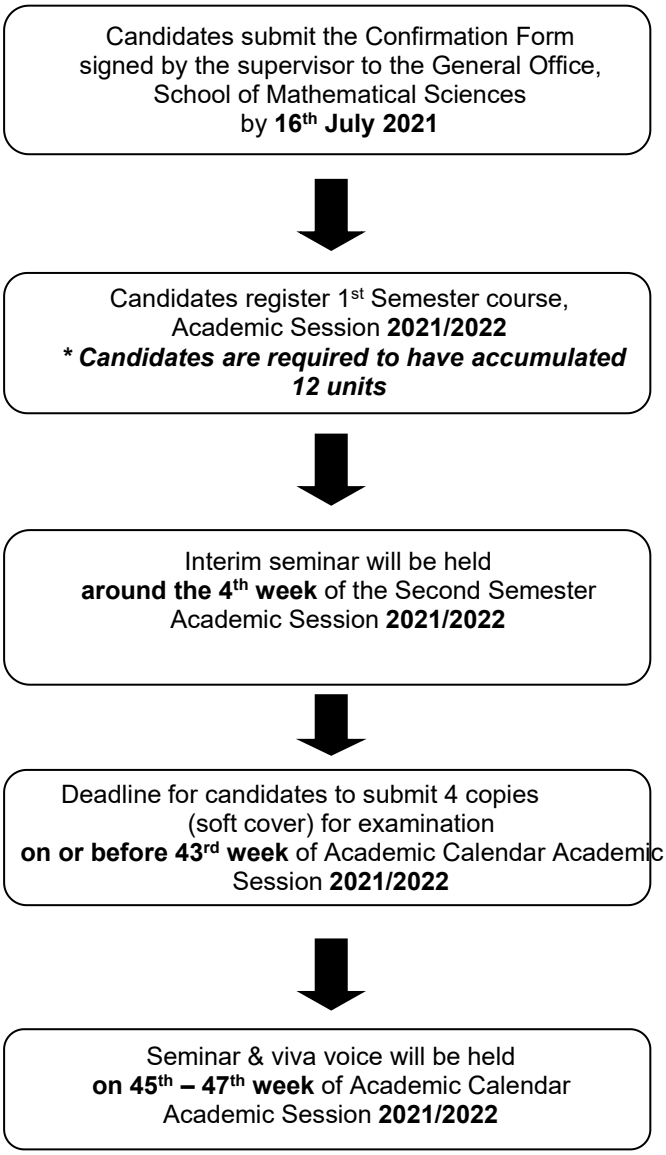
Interim seminar will be held
around the 4th week of the Second Semester
Academic Calendar
Academic Session **2020/2021**

Deadline for candidates to submit 4 copies
(soft cover) for examination
on or before 43rd week of Academic Calendar
Academic Session **2020/2021**

Seminar & viva voce will be held
on 45th – 47th week of Academic Calendar
Academic Session **2020/2021**

IMPORTANT DATES FOR PART TIME CANDIDATES
DISSERTATION COURSES MAT 510/20 AND MST 566/20
(for 2020/2021 intake)

ACADEMIC SESSION 2020/2021



Submission date of supervisor confirmation form for part-time students for intake Academic Session **2021/2022** is by **16th July 2021**.

MASTER OF SCIENCE (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 to graduate.

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, Innovation and Industry-Community Engagement) 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, McGraw Hill, 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 Edition.
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 *(Kebolehpercayaan 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 Log-Logistic 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 analyze 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 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 Regression: 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 Hypotheses.

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*, *2nd*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. & Kutner, M. H. (1990). *Applied Linear Statistical Models*. *3rd* Edition. Irwin, Boston.

5.0 MST566/20 Dissertation *(Disertasi)*

Students are required to submit the **Dissertation Supervisor Confirmation Form (APPENDIX A)** no later than **week 15 of the first semester of the academic session (December).** 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 2021**. Please note that starting from 2019/2020 academic session, students are required to submit a research paper from a compilation of their dissertation to be appended in their dissertation report. The template for the research paper will be provided via the School's website. The submitted dissertation will be assessed by a committee of examiners and, 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 **GUIDELINES FOR PREPARATION OF DISSERTATION or via** https://math.usm.my.

The above-mentioned dates are subjected to change 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 analyze 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 Regressio.n, 2nd Edition,* New York : J. Wiley & Sons.

LIST OF DISSERTATION SUPERVISORS (MST566/20)

BIL.	NAME	FIELD OF SPECIALIZATION	ROOM NO./ E-MAIL/ EXT.
1.	FAM PEI SHAN B.Sc., M.Sc., Ph.D.(UM)	Categorical Data Analysis	Room No. : 136 fpeishan@usm.my Ext. No. : 5908
2.	CHONG ZHI LIN Ph.D. (USM)	Statistical Quality Control, Statistical Process Control	Room No. : 121 chongzl@usm.my Ext. No. : 4764
3.	HUSNA HASAN B.Sc. (IOWA) M.Sc. (W. MICHIGAN) Ph.D. (USM)	Branching Process, Applied Statistics	Room No. : 038 husnahasan@usm.my Ext. No. : 4773
4.	JOHNNY LIM KHAI YANG M. Sc.(ANU) AU Ph.D (UoA) AU	Index Theory, K-Theory	Room No. : 015 johnny.lim@usm.my Ext. No. : 5285
5.	MAJID KHAN BIN MAJAHAR ALI B. Sc., Ph.D (UMS)	Game Theory, Agricultural Statistical Modelling and Solar Drying System	Room No. : 130 majidkhanmajaharali@usm.my Ext. No. : 4782
6.	MICHAEL KHOO BOON CHONG B.App.Sc., Ph.D.(USM)	Statistical Process Control, Statistical Inference	Room No. : 120 mkbc@usm.my Ext. No. : 3941
7.	MOHD TAHIR ISMAIL B.App.Sc., M.Sc.(USM) Ph.D.(UKM)	Financial Time Series	Room No. : 131 m.tahir@usm.my Ext. No. : 2071
8.	NOOR SAIFURINA NANA KHURIZAN B.Sc. (USM) M.Sc. (SOUTHAMPTON) Ph.D. (USM)	Data Envelopment Analysis, Multi-Criteria Decision Making	Room No. : 013 saifurina@usm.my Ext. No. : 4989
9.	NORHASHIDAH AWANG B.Sc. (USM) M.Sc. (NUS) Ph.D. (UPM)	Spatial Statistics	Room No. : 041 shidah@usm.my Ext. No. : 4774

BIL.	NAME	FIELD OF SPECIALIZATION	ROOM NO./ E-MAIL/ EXT.
10.	NORLIDA MOHD. NOOR Ijazah Kepujian ITM M.Sc. (USM)	Applied Statistics	Room No. : 039 norlida@usm.my Ext. No. : 3958
11.	NUZLINDA ABDUL RAHMAN B.Sc., M.Sc. (USM) Ph.D. (UKM)	Spatial Statistics	Room No : 126 nuzlinda@usm.my Ext No : 4781
12.	ROSMANJAWATI ABD. RAHMAN B.Sc. (Ed) (USM) M.Sc.(UKM), Ph.D.(USM)	Applied Statistics	Room No : 119 rosmanjawati@usm.my Ext No : 4778
13.	SEK SIOK KUN B.Econ., M.Sc. (UKM) Ph.D.(Germany)	Econometrics	Room No : 113 sksek@usm.my Ext No : 5338
14.	SHAMSUL RIJAL MUHAMMAD SABRI B.Sc., M.Sc.(UKM) Ph.D.(UM)	Applied Statistics	Room No : 115 rijal@usm.my Ext No : 3964
15.	SITI AMIRAH ABD RAHMAN B.Sc. (UTM) M.Sc. Tech., Ph.D.(UNSW)	Discrete Optimisation	Room no: 020 amirahr@usm.my Ext: 2355
16.	SITI NOOR FARWINA BT MOHAMAD ANWAR ANTONY B.Sc. (USM) Ph.D.(USM)	Number theory, Cryptography	Room no: 113 farwina@usm.my Ext: 3965
17.	ZAINUDIN ARSAD B.Sc.(HERIOT-WATT) M.Sc.(SHEFFIELD) Ph.D.(HERIOT-WATT)	Time Series Analysis, Econometric Modelling, Statistical Tourism	Room No : 108 zainudin.arsad@usm.my Ext No : 2069

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. 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 to graduate.

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 Pengkomputeran)*
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, Innovation & Industry-Community Engagements) 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 A)** no later than **week 15 of the first semester of the academic session (December).** 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 2021**. Please note that starting from 2019/2020 academic session, students are required to submit a research paper from a compilation of their dissertation to be appended in their dissertation report. The template for the research paper will be provided via the School's website. The submitted dissertation will be assessed by a committee of examiners and, 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 **GUIDELINES FOR PREPARATION OF DISSERTATION or via** https://math.usm.my.

The above-mentioned dates are subjected to change 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

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 of 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. De Angelis, D. L. (1992), *Dynamics of Nutrient Cycling and Food Web*, Chapman & Hall.
6. De Angelis, 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), Stringer-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*, 4thedition, 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 differentiation
5. IVP and BVP for ordinary differential 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 TriangularBezier patches. Shape preserving splines, focusing 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*, 4thed., Academic Press, Inc.
3. Hoschek, J. &Lasser, D. (1993), *Fundamental of Computer Aided GeometricDesign*, A. K. Peters, Wellesley, Massachusetts.
4. Marsh, D. (1999), *Applied Geometry for Computer Graphics and 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 Pengkomputeran)

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. T.& David B.(1997), *Numerical Linear Algebra*, SIAM.
3. Steven, J. L., (2006),*Linear Algebra with applications*, 7th Ed. Prentice Hall.
4. Anton, h. (2000),*Elementary Linear Algebra with Applications*,John Wiley & Sons.
5. Burden,R. L && Faires, J. D. (2011),*Numerical Analysis*, Brooks/Cole.
6. Golub, G. H.& Van Loan, C. H.(2012),*Matrix Computations*, 4th John Hopkins University Press.

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

Aim

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 MethodPreconditioning;
- 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.

eiser, 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.	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
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3.	ANDREW RAJAH A/L BALASINGAM GNANARAJ B.Sc., Ph.D.(USM)	Algebra, Groups and Moufang Loops	Room No. : 124 andy@usm.my Ext. No. : 4780
4.	ANG MIIN HUEY B.A. (Education), M.Sc.(USM) PhD NUS	Coding Theory, Cryptography, Algebra	Room No. : 036 mathamh@usm.my Ext. No. : 4772
5.	AZHANA AHMAD B.Sc.(USM) M.Sc.(UKM) Ph.D.(UTM)	Group Theory	Room No. : 035 azhana@usm.my Ext. No. : 4771
6.	CHONG ZHI LIN Ph.D.(USM)	Statistical Quality Control, Statistical Process Control	Room No. : 121 chongzl@usm.my Ext. No. : 4764
7.	FARAH AINI ABDULLAH B.Sc., M.Sc.(USM) Ph.D.(UNIVERSITY OF QUEENSLAND)	Mathematical Computing, Biomathematics	Room No. : 024 farahaini@usm.my Ext. No. : 4765
8.	HAILIZA KAMARULHAILI B.Sc.(USM) M.Sc., Ph.D.(LIVERPOOL)	Analytical Number Theory, Cryptography	Room No. : 040 hailiza@usm.my Ext. No. : 3648
9.	JOHNNY LIM KHAI YANG M.Sc.(ANU) AU Ph.D UoA AU	Index Theory, K-Theory	Room No. : 015 johnny.lim@usm.my Ext. No. : 5285
10.	KONG VOON PANG B.Sc., M.Sc., Ph.D.(USM)	Computer Aided Geometric Design	Room No. : 125 kongvp@usm.my Ext. No. : 3943
11.	LEE SEE KEONG B.Sc., M.Sc.(USM) Ph.D.(LSU)	Stochastic Analysis	Room No. : 111 sklee@usm.my Ext. No. : 2070

12.	MAISARAH HAJI MOHD B.Sc., M.Sc.(USM) Ph.D.(UKM)	Complex Analysis, Geometric Function Theory	Room No. : 110 maisarah_hjmohd@usm.my Ext. No. : 4488
13.	MD YUSHALIFY BIN MISRO B. Sc., M.Sc., Ph.D (USM)	Computer Aided Geometric Design	Room No. : 034 yushalify@usm.my Ext. No. : 3658
BIL.	**NAME**	**FIELD OF SPECIALIZATION**	**ROOM NO./ E-MAIL/ EXT.**
14.	MOHD HAFIZ MOHD B.Sc. (IMPERIAL COLLEGE LONDON,ARCS) M.Sc. (USM) Ph.D. (CANTERBURY NZ)	Mathematical Modelling, Numerical Continuation and Dynamical Systems and Individual – Based Models in Ecology/Biology	Room No.: 116 mohdhafizmohd@usm.my Ext. No.: 5059
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16.	NG ZHEN CHUAN B.Sc., M.Sc. (UM) Ph.D. (USM)	Geometric Functions Theory, Complex Function Theory	Room No. : 109 zhenchuanng@usm.my Ext. No. : 5337
17.	NOOR ATINAH AHMAD B.Sc.(BRISTOL) Ph.D.(SOUTHAMPTON)	Mathematical Modeling, Numerical Linear Algebra, Mathematical Algorithms for Signal Processing	Room No. : 027 nooratinah@usm.my Ext. No. : 4767
18.	NORAZRIZAL ASWAD BIN ABDUL RAHMAN B.Sc., (USM) Ph.D. (UNIMAP)	Fuzzy Set Theory, Fuzzy Mathematics, Multi Criteria Decision Making	Room No. : 123 aswad.rahman@usm.my Ext. No. : 3944
19.	NORSHAFIRA RAMLI B.Sc.(BIRMINGHAM) M.Sc., Ph.D.(USM)	Boundary layer flow, heat transfer, mathematical modelling	Room No : 019 norshafiraramli@usm.my Ext. No. : 4763
20.	NUR NADIAH ABD HAMID B.Sc. (MICHIGAN STATE UNIVERSITY, US) M.Sc. (USM), Ph.D. (USM)	Numerical Analysis Computer Aided Geometric Design	Room No.: 023 nurnadiah@usm.my Ext. No.: 2356
21.	SARATHA A/P SATHASIVAM B.Sc. Ed., M.Sc.(USM) Ph.D.(UM)	Neural Networks, Computational Logic, Data Mining	Room No. : 033 saratha@usm.my Ext. No. : 2428

22.	SHAMANI SUPRAMANIAM B.Sc., M.Sc, Ph.D(USM)	Univalent Function Theory, Complex Analysis	Room No.: 133 shamani@usm.my Ext. No.: 3384
23.	SYAKILA AHMAD B.Sc., M.Sc.(UKM) Ph.D.(UPM)	Mathematical Modelling, Fluid Dynamics, Convective Heat Transfer	Room No. : 135 syakilaahmad@usm.my Ext. No. : 3945
24.	TEH SU YEAN B.Sc., M.Sc., Ph.D.(USM)	Environmental and Ecosystem Modelling, Mathematical Modelling	Room No. : 031 syteh@usm.my Ext. No. : 4770
25.	TEH WEN CHEAN B.Sc., M.Sc., (USM) Ph.D.(OHIO STATE UNIVERSITY, USA)	Combinatorics Logic	Room No. : 117 dasmenteh@usm.my Ext. No. : 4777
26.	ONG WEN ENG B.Sc., M.Sc., (UM) Ph.D.(CANTERBURY)	Surface Approximation Shortest Path Algorithm	Room No. : 112 weneng@usm.my Ext. No. : 4776
27.	YAZARIAH MOHD YATIM B.Sc., M.Sc.(USM) Ph.D.(STRATHCLYDE)	Thin-Film Flows, Newtonian and Non -Newtonian Fluid Mechanics Travelling Ware and Similarity Solutions	Room No. : 134 yazariahmy@usm.my Ext. No. : 4783
28.	SITI NOOR FARWINA BT MOHAMAD ANWAR ANTONY M.Sc.(USM) Ph.D (USM)	Number Theory, Cryptography	Room No. : 113 farwina@usm.my Ext. No. : 3965

Note:

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

GUIDELINES FOR PREPARATION OF DISSERTATION
(MAT 510/20 AND MST 566/20)
FOR CANDIDATES REGISTERED IN
SEMESTER 1 (PART-TIME) AND SEMESTER 2 (FULL-TIME)

Introduction

The Dissertation should be completed within the stipulated time. Candidates who fail to submit their Dissertation for examination at the time set by the 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).

Please visit www.math.usm.my for the latest guidelines.

Submission of Dissertation

Dissertations can be written either in Bahasa Malaysia or English.

All candidates have to submit 4 copies of their Dissertation (bound in red with soft cover) for the purpose of examination together with the Dissertation Submission Form that has been signed and approved by the Supervisor to the Dean's Office. The submission date **will be determined in June 2020**. The title of the Dissertation and its translation should be stated in the Dissertation Submission 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

1. 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 must be typed in capital letters of size **18 on the front cover** as shown in the following example:

LONGITUDINAL DATA ANALYSIS
(Font size 18/single spacing)

NORAINI BINTI ABIDIN
(Font size 18/single spacing)

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

2021
(Font size 18)

If the Dissertation is written in Bahasa Malaysia, the example is as shown below:

ANALISIS DATA LONGITUD

NORAINI BINTI ABIDIN

PUSAT PENGAJIAN SAINS MATEMATIK
UNIVERSITI SAINS MALAYSIA

2021

2. 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; the text and list begin four spaces below.

3. Only good quality plain white paper (80 gsm) 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. All copies must be clean and legible. The **Text**should be typed, **double-spaced** using the latest version of Microsoft Word/LaTeX word processor. Candidates are encouraged to use the font**Times New Roman** and the acceptable **font size for the whole Dissertation is 11-12 points. Single-spacing** is used for long tables, long quotations, notes, footnotes, multi-line captions and bibliographic entries.

4. The **Introduction** begins with the title page as shown in the example below:

LONGITUDINAL DATA ANALYSIS
(Font size 14/single spacing)

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)

August 2021
(Font size 14)

If the dissertation written in Bahasa Malaysia, the example is as shown below:

ANALISIS DATA LONGITUD

oleh

NORAINI BINTI ABIDIN

Disertasi diserahkan untuk memenuhi
sebahagian keperluan bagi
Ijazah Sarjana Sains (Statistik)

Ogos 2021

5. 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 Symbols (if any), List ofAbbreviations (if any), Abstrak 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.

6. All page numbers are without punctuation and placed 1 cm from bottom centre. All pages including those with figures, tables, etc. must have a page number.

7. An **Abstract** in both Bahasa Malaysia and English must be provided, the former version appearing before the latter. Both versions must have their respective titles. 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.

8. 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.

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

Top	:	2.5cm
Right	:	2.5cm
Left	:	4.0cm
Bottom	:	2.5cm

10. The **Bibliography** is the section after the **Text** that begins on a fresh page bearing theheading in capital letters, centralized without any punctuation marks. 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. The style in which the references are presented and cited must be consistent throughout the Dissertation. If a candidate makes use of other works in his/her dissertation, either in direct quotation or by reference, these sources must be listed in the Bibliography. This includes tables and figures.

11. 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

1. The Supervisor and the Internal Examiner appointed by the school board will be given a copy of the Dissertation for examination purposes and to be completed within 3 weeks.

2. Candidates need to present 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.

3. 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.

4. The Panel of Dissertation Examiners comprises :

    (a) Dean (Chairperson);
    (b) Deputy Dean (Research, Innovation & Industry-Community Engagement);
    (c) Supervisor;
    (d) Internal Examiner;

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

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

6. Candidates who are required to re-submit their Dissertations for re-examination and/or attend a viva must submit 4 copies of the amended Dissertation together with the Dissertation Resubmission for Examination Form (refer to Appendix C) filled by the candidate and approved by the Supervisor.

7. After all corrections (if any) and the decision of the Panel of Examiners are implemented, candidates who PASS should submit 2 hard cover Dissertation bound binding in red buckram or rexine together with the Final Dissertation Submission Form (refer to Appendix D). 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, 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 follows:

LONGITUDINAL DATA ANALYSIS
(Font size 18/single spacing)

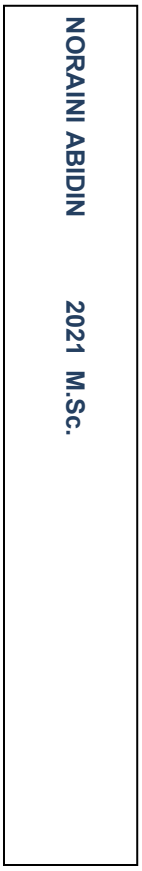
NORAINI BINTI ABIDIN
(Font size 18/single spacing)

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

2021
(Font size 18)

* Dissertation front cover.

* Spine of the Dissertation.



APPENDIX A UNIVERSITI SAINS MALAYSIA

PUSAT PENGAJIAN SAINS MATEMATIK
SCHOOL OF MATHEMATICAL SCIENCES

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-mel : _____

Tarikh : _____

Tajuk Disertasi : _____

_____

_____

Saya mengesahkan bahawa saya bersetuju untuk menyelia pelajar di atas pada

Sidang Akademik : _____

Nama Penyelia : _____

Tandatangan Penyelia : _____

Tarikh : _____

APPENDIX B

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 berpuas hati 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, Inovasi & Libatsama Industri-Komuniti])

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

_____ _____
Tandatangan Timbalan Dekan
(Penyelidikan, Inovasi & Libatsama Industri-Komuniti) (Tarikh)

APPENDIX C

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 :-

Empat (4) 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, Inovasi & Libatsama Industri-Komuniti])

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

_____ _____

Tandatangan Timbalan Dekan (Tarikh)

[*Penyelidikan, Inovasi & Libatsama Industri-Komuniti*]

APPENDIX D

PUSAT PENGAJIAN SAINS MATEMATIK
SCHOOL OF MATHEMATICAL SCIENCES

BORANG PENYERAHAN DISERTASI MUTAKHIR
(DUA (2) 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) **Dua (2)** 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/Timbalan Dekan Pusat Pengajian)

Saya _____ Dekan/Timbalan 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/Timbalan Dekan) (Tarikh)