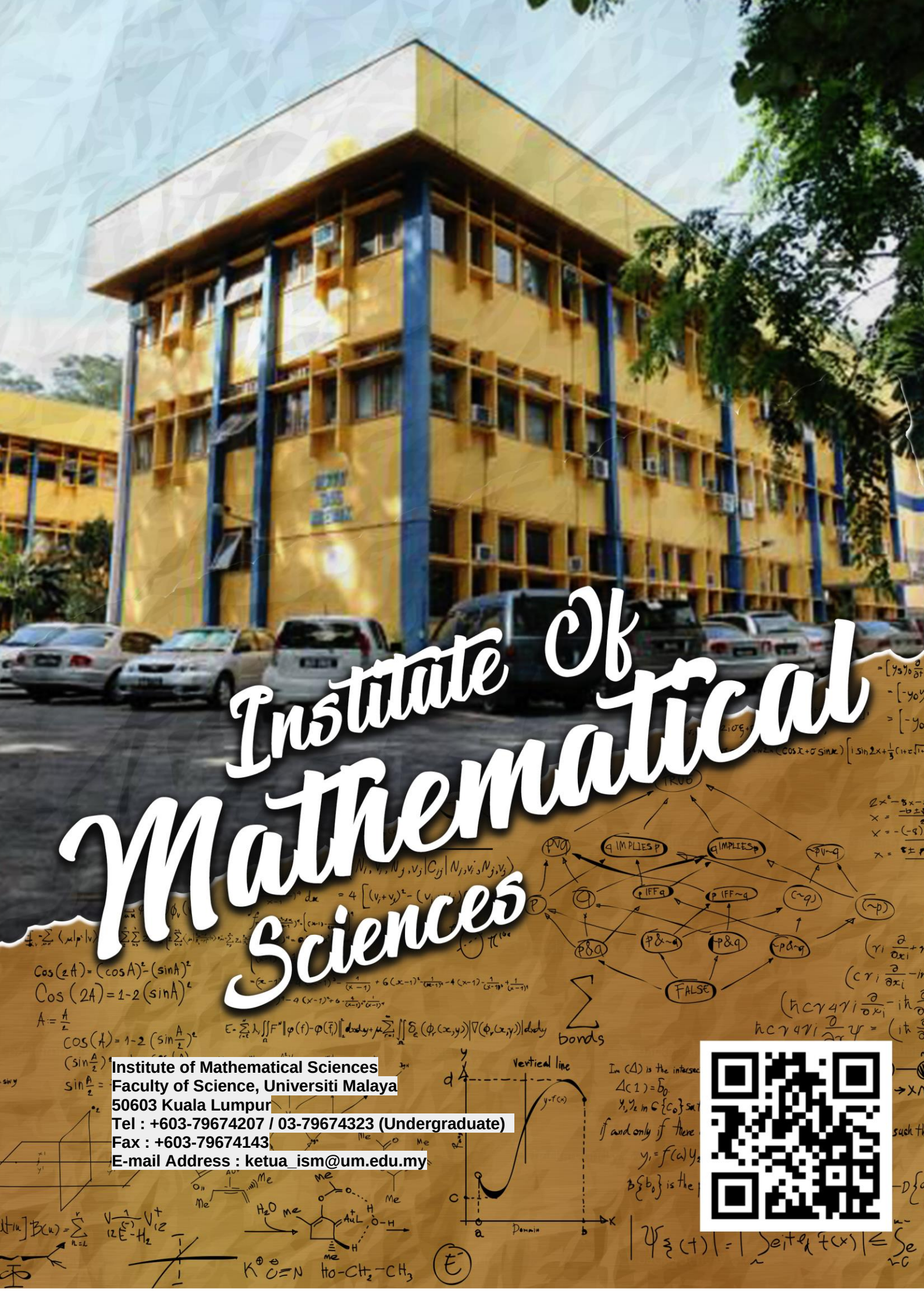

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BACHELOR OF SCIENCE IN MATHEMATICS ACADEMIC SESSION 2022/2023 (134 CREDITS)			
1. UNIVERSITY COURSES (12 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
GLT^{xxxx}	English Courses (subject to MUET bands)	-	4
GKA/GKI/GKK/ GKP/GKS/GKU	Co-curriculum	-	2
GIG1012 / GLT1017	Philosophy and Current Issues / Basic Malay Language (only for international students)	-	2
GIG1013	Appreciation of Ethics and Civilisations	-	2
GIG1003	Basic Entrepreneurship Culture	-	2
2. CORE COURSES (79 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
LEVEL 1 (30 Credits)			
SIX1015	Science, Technology and Society	-	2
SIX1016	Statistics	-	3
SIM1001	Basic Mathematics	-	4
SIM1002	Calculus I	-	4
SIM1003	Calculus II	SIM1002	4
SIM1004	Fundamentals of Computing	-	3
SIM1005	Fundamentals of Spreadsheets	-	2
SIM1006	Ordinary Differential Equations	SIM1002	4
SIT1001	Probability and Statistics I	SIM1002	4
LEVEL 2 (41 Credits)			
SIM2001	Advanced Calculus	SIM1003	4
SIM2002	Linear Algebra	SIM1001	4
SIM2007	Appreciation of Mathematics	SIM1003	2
SIM2010	Numerical Computation	SIM1003	4
SIM2011	Structured Programming	SIM1002	4
SIM2012	Basic Operations Research	SIM1001	4
SIM2013	Introduction to Combinatorics	SIM1001	3
SIM2014	Algebra I	SIM1001	3
SIM2015	Introduction to Analysis	SIM1003	3
SIM2016	Complex Variables	SIM1003	3
SIM2018	Partial Differential Equations	SIM1006	4
SIT2007	Foundations of Data Science	SIT1001	3
LEVEL 3 (8 Credits)			
SIM3020	Industrial Training	SIM2007	8
3. ELECTIVE COURSES (43 CREDITS)			
(I) STUDENT HOLISTIC EMPOWERMENT (8 CREDITS) ‡ **ONE COMPULSORY** course is taken from each cluster.			
CLUSTER			**CREDITS**
CLUSTER 1	Thinking Matters: Mind and Intellect		2
CLUSTER 2	Emotional, Physical and Spiritual Intelligence: Heart, Body and Soul		2
CLUSTER 3	Technology/Artificial Intelligence and Data Analytics: I-techie		2
CLUSTER 4	Global Issues and Community Sustainability: Making the World a Better Place		2
(II) PROGRAM ELECTIVE COURSES (at least 35 CREDITS)			
MATHEMATICAL SCIENCE			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
SIM2017	Geometry	SIM1001	3
SIM2019	Systems of Ordinary Differential Equations	SIM1006	4
SIM2021	Optimization Techniques	SIM2001	4
SIM3001	Graph Theory	SIM2013	4
SIM3002	Combinatorial Mathematics	SIM2013	4
SIM3003	Number Theory	SIM2002	4
SIM3004	Advanced Linear Algebra	SIM2002	4
SIM3005	Matrix Theory	SIM2002	4
SIM3006	Algebra II	SIM2014	4
SIM3007	Ring Theory	SIM2014	4
SIM3008	Group Theory	SIM2014	4
SIM3009	Differential Geometry	SIM2001	4
SIM3010	Topology	SIM2001	4

SIM3011	Complex Analysis	SIM2016	4
SIM3012	Real Analysis	SIM2015	4
SIM3021	Mathematical Science Project	SIM2011	4
SIM3022	Cryptography	SIT1001 and SIM2011	4
SIQ1001	Introduction to Accounting	-	3
SIQ2001	Microeconomics	-	3
SIQ2002	Macroeconomics	-	3
SIQ2003	Financial Mathematics and Derivatives	SIM1002	4
SIT2001	Probability and Statistics II	SIT1001	4
APPLIED MATHEMATICS			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
SIM2019	Systems of Ordinary Differential Equations	SIM1006	4
SIM2020	Management Mathematics	SIM1002	4
SIM2021	Optimization Techniques	SIM2001	4
SIM3021	Mathematical Science Project	SIM2011	4
SIM3022	Cryptography	SIT1001 and SIM2011	4
SIM3023	Numerical Methods and Analysis	SIM2010	4
SIM3024	Computational Geometry	SIM2011	4
SIM3025	Scientific Computing	SIM2011	4
SIM3026	Production and Inventory Control	SIM2012 and SIM2020	4
SIM3027	Mathematical Programming	SIM2012	4
SIM3028	Industrial Operations Research	SIM2012	4
SIM3029	Computational Fluid Dynamics	SIM2018	4
SIM3030	Dynamical Systems Theory	SIM2019	3
SIQ2001	Microeconomics	-	3
SIQ2002	Macroeconomics	-	3
SIT2001	Probability and Statistics II	SIT1001	4
SIT2010	Stochastic Processes	SIT2001	3
SIT3005	Times Series and Forecasting Methods	SIT2001	4

Students who wish to take SIM3020 are advised to have passed at least 90 credits of the listed courses in the program.

PROGRAM GOAL

To produce graduates with a sound knowledge of mathematics, capable of analysing and solving problems and thinking critically, able to adapt to diverse environments and contribute significantly in various professions.

PROGRAM EDUCATIONAL OBJECTIVES

1. Graduates are able to work in professions related to mathematical sciences or related fields.
2. Graduates are able to practice continuous learning in their careers.
3. Graduates are able to communicate and leverage learned concepts/methods effectively and ethically.

PROGRAM LEARNING OUTCOMES

At the end of the program, graduates with Bachelor of Science in Mathematics are able to:

1. Explain the principles and concepts of mathematics.
2. Demonstrate the ability to apply mathematical knowledge critically and analytically in related field.
3. Apply the principles of mathematics in solving mathematical and real-world problems.
4. Communicate mathematical concepts effectively, accurately and coherently in written and oral forms.
5. Use suitable information, graphical and computational strategies in solving mathematical problems.
6. Work independently and demonstrate leadership quality and sense of responsibility in achieving goals and outcomes.
7. Engage in lifelong learning to advance knowledge and applications of mathematics.
8. Act professionally and ethically to solve practical problems in mathematical professions.

LIST OF COURSES ACCORDING TO SEMESTER
(PLANNING OF COURSES)
BACHELOR OF SCIENCE IN MATHEMATICS

COMPONENT	YEAR 1				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
University Courses	GLT^{xxxx} English Courses (subject to MUET bands)	2	GLT^{xxxx} English Courses (subject to MUET bands)	2	**8**
	GIG1012 / GLT1017* Philosophy and Current Issues / Basic Malay Language*	2	GIG1013 Appreciation of Ethics and Civilisations	2	
Core Courses	SIX1016 Statistics	3	SIX1015 Science, Technology and Society	2	**26**
	SIM1001 Basic Mathematics	4	SIM1006 Ordinary Differential Equations	4	
	SIM1002 Calculus I	4	SIM1003 Calculus II	4	
	SIM1004 Fundamentals of Computing	3	SIM1005 Fundamentals of Spreadsheets	2	
Elective Courses	Student Holistic Empowerment (SHE) Cluster 1: Thinking Matters: Mind and Intellect	2	Student Holistic Empowerment (SHE) Cluster 2: Emotional, Physical and Spiritual Intelligence: Heart, Body and Soul	2	**4**
TOTAL CREDITS		**20**		**18**	**38**

*only for international students

COMPONENT	YEAR 2				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
University Courses	GIG1003 Basic Entrepreneurship Culture	2			**4**
	GKA/GKI/GKK/ GKP/GKS/GKU Co-Curriculum	2			
Core Courses	SIT1001 Probability and Statistics I	4	SIT2007 Foundations of Data Science	3	**31**
	SIM2001 Advanced Calculus	4	SIM2015 Introduction to Analysis	3	
	SIM2002 Linear Algebra	4	SIM2016 Complex Variables	3	
	SIM2007 Appreciation of Mathematics	2	SIM2010 Numerical Computation	4	
			SIM2011 Structured Programming	4	
Elective Courses	Student Holistic Empowerment (SHE) Cluster 3: Technology/Artificial Intelligence and Data Analytics: I-techie	2	Student Holistic Empowerment (SHE) Cluster 4: Global Issues and Community Sustainability: Making the World a Better Place	2	**4**
TOTAL CREDITS		**20**		**19**	**39**

COMPONENT	YEAR 3				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
Core Courses	SIM2013 Introduction to Combinatorics	3			**14**
	SIM2014 Algebra I	3			
	SIM2012 Basic Operations Research	4			
	SIM2018 Partial Differential Equations	4			
Elective Courses	Elective Course 1	4	Elective Course 2	4	**20**
			Elective Course 3	4	
			Elective Course 4	4	
			Elective Course 5	4	
TOTAL CREDITS		**18**		**16**	**34**

COMPONENT	YEAR 4				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
Core Courses	SIM3020 Industrial Training	8			**8**
Elective Courses			Elective Course 6	4	**15**
			Elective Course 7	4	
			Elective Course 8	4	
			Elective Course 9	3	
TOTAL CREDITS		**8**		**15**	**23**

BACHELOR OF SCIENCE IN STATISTICS ACADEMIC SESSION 2022/2023 (134 CREDITS)			
1. UNIVERSITY COURSES (12 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
GLT[xxxx]	English Courses (subject to MUET bands)	-	4
GKA/GKI/GKK/ GKP/GKS/GKU	Co-curriculum	-	2
GIG1012 / GLT1017	Philosophy and Current Issues / Basic Malay Language (only for international students)	-	2
GIG1013	Appreciation of Ethics and Civilisations	-	2
GIG1003	Basic Entrepreneurship Culture	-	2
2. CORE COURSES (76 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
LEVEL 1 (26 Credits)			
SIX1015	Science, Technology and Society	-	2
SIM1001	Basic Mathematics	-	4
SIM1002	Calculus I	-	4
SIM1003	Calculus II	SIM1002	4
SIT1001	Probability and Statistics I	SIM1002	4
SIT1002	Statistical Programming	-	4
SIT1003	Analysis of Data and Statistical Report Writing	-	4
LEVEL 2 (28 Credits)			
SIM2001	Advanced Calculus	SIM1003	4
SIM2002	Linear Algebra	SIM1001	4
SIT2001	Probability and Statistics II	SIT1001	4
SIT2007	Foundations of Data Science	SIT1001	3
SIT2008	Further Mathematical Statistics	SIT2001	4
SIT2009	Regression Analysis	SIT1001	4
SIT2010	Stochastic Processes	SIT2001	3
SIT2011	Statistics and Community	SIT1003	2
LEVEL 3 (22 Credits)			
SIT3005	Time Series and Forecasting Methods	SIT2001	4
SIT3015	Introduction to Multivariate Analysis	SIT2001	3
SIT3016	Generalized Linear Models	SIT2001 and SIT2009	4
SIT3017	Statistical Learning and Data Mining	SIT2007	3
SIT3021	Industrial Training	SIT3017	8
3. ELECTIVE COURSES (46 CREDITS)			
(I) STUDENT HOLISTIC EMPOWERMENT (8 CREDITS) ‡ **ONE COMPULSORY** course is taken from each cluster.			
CLUSTER			**CREDITS**
CLUSTER 1	Thinking Matters: Mind and Intellect		2
CLUSTER 2	Emotional, Physical and Spiritual Intelligence: Heart, Body and Soul		2
CLUSTER 3	Technology/Artificial Intelligence and Data Analytics: I-techie		2
CLUSTER 4	Global Issues and Community Sustainability: Making the World a Better Place		2
(II) PROGRAM ELECTIVE COURSES (at least 38 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
SIM2010	Numerical Computation	SIM1003	4
SIM2012	Basic Operations Research	SIM1001	4
SIQ1001	Introduction to Accounting	-	3
SIQ2001	Microeconomics	-	3
SIQ2002	Macroeconomics	-	3
SIQ2003	Financial Mathematics and Derivatives	SIM1002	4
SIT3003	Computer Intensive Methods in Statistics	SIT2001	4
SIT3004	Applied Stochastic Processes	SIT2010	4
SIT3008	Introduction to Survey Sampling	SIT2001	4
SIT3009	Statistical Process Control	SIT2001	4
SIT3012	Design and Analysis of Experiments	SIT1001 and SIT2009	4
SIT3013	Analysis of Failure and Survival Data	SIT2001	4
SIT3018	Non-Parametric Statistics	SIT1001	4
SIT3019	Introduction to Bayesian Statistics	SIT2001	4
SIT3020	Python for Data Science	SIT3017	4
SIT3022	Probability Theory	SIM2001 and SIT2008	4

SIT3023	Statistical Laboratory	SIT1002 and SIT2007	3
SIT3024	Statistical Consultancy and Data Analysis	SIT3021	3
SIT3025	Statistical Science Project	SIT1002 and SIT2007	4
The exact number of program elective courses offered in each year may differ.			

PROGRAM GOAL

To produce graduates who have sound knowledge in statistics and mathematics, strong problem-solving skills and capability to adapt to diverse environment, with life-long learning habits.

PROGRAM EDUCATIONAL OBJECTIVES

To produce:

1. Graduates who work in a profession directly related to statistics or any other related field;
2. Graduates who are involved in continuous learning in statistics or other related fields;
3. Graduates who are able to communicate statistical concepts and methods effectively and ethically.

PROGRAM LEARNING OUTCOMES

At the end of the program, graduates with Bachelor of Science in Statistics are able to:

1. Explain the principles and concepts of statistics and mathematics as the foundation for data-driven decision-making;
2. Demonstrate the ability to apply statistical and mathematical knowledge critically and analytically to complete a task;
3. Apply the principles of statistics and mathematics in solving real world problems;
4. Communicate statistical and mathematical concepts effectively, accurately and coherently in written and oral forms;
5. Access, manage and process data effectively and efficiently using suitable graphical and computational strategies;
6. Work in teams, and demonstrate leadership quality and sense of responsibility in achieving goals and outcomes;
7. Engage in life-long learning to advance knowledge and applications of statistics and mathematics;
8. Act professionally and ethically in the course of analysis and decision-making to solve problems.

LIST OF COURSES ACCORDING TO SEMESTER
(PLANNING OF COURSES)
BACHELOR OF SCIENCE IN STATISTICS

COMPONENT	YEAR 1				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
University Courses	GLT^{xxxx} English Courses (subject to MUET bands)	2	GLT^{xxxx} English Courses (subject to MUET bands)	2	**8**
	GIG1012 / GLT1017* Philosophy and Current Issues / Basic Malay Language*	2	GIG1013 Appreciation of Ethics and Civilisations	2	
Core Courses	SIT1002 Statistical Programming	4	SIM1003 Calculus II	4	**26**
	SIM1001 Basic Mathematics	4	SIT1001 Probability and Statistics I	4	
	SIM1002 Calculus I	4	SIT1003 Analysis of Data and Statistical Report Writing	4	
			SIX1015 Science, Technology and Society	2	
Elective Courses	Student Holistic Empowerment (SHE) Cluster 1: Thinking Matters: Mind and Intellect	2			**2**
TOTAL CREDITS		**18**		**18**	**36**

*only for international students

COMPONENT	YEAR 2				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
University Courses	GIG1003 Basic Entrepreneurship Culture	2			**2**
Core Courses	SIM2001 Advanced Calculus	4	SIT2008 Further Mathematical Statistics	4	**31**
	SIM2002 Linear Algebra	4	SIT2010 Stochastic Processes	3	
	SIT2001 Probability and Statistics II	4	SIT2009 Regression Analysis	4	
	SIT2007 Foundations of Data Science	3	SIT3015 Introduction to Multivariate Analysis	3	
	SIT2011 Statistics and Community	2			
Elective Courses	Student Holistic Empowerment (SHE) Cluster 2: Emotional, Physical and Spiritual Intelligence: Heart, Body and Soul	2	Student Holistic Empowerment (SHE) Cluster 3: Technology/Artificial Intelligence and Data Analytics: I-techie	2	**8**
			Elective Course 1	4	
TOTAL CREDITS		**21**		**20**	**41**

COMPONENT	YEAR 3				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
University Courses	GKA/GKI/GKK/ GKP/GKS/GKU Co-Curriculum	2			**2**
Core Courses	SIT3005 Time Series and Forecasting Methods	4	SIT3021 Industrial Training	8	**19**
	SIT3016 Generalized Linear Models	4			
	SIT3017 Statistical Learning and Data Mining	3			
Elective Courses	Elective Course 2	4			**6**
	Student Holistic Empowerment (SHE) Cluster 4: Global Issues and Community Sustainability: Making the World a Better Place	2			
TOTAL CREDITS		**19**		**8**	**27**

COMPONENT	YEAR 4				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
Elective Courses	Elective Course 3	4	Elective Course 7	4	**30**
	Elective Course 4	4	Elective Course 8	4	
	Elective Course 5	4	Elective Course 9	4	
	Elective Course 6	3	Elective Course 10	3	
TOTAL CREDITS		**15**		**15**	**30**

BACHELOR OF ACTUARIAL SCIENCE ACADEMIC SESSION 2022/2023 (145 CREDITS)			
1. UNIVERSITY COURSES (12 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
GLT[xxxx]	English Courses (subject to MUET bands)	-	4
GKA/GKI/GKK/ GKP/GKS/GKU	Co-curriculum	-	2
GIG1012 / GLT1017	Philosophy and Current Issues / Basic Malay Language (only for international students)	-	2
GIG1013	Appreciation of Ethics and Civilisations	-	2
GIG1003	Basic Entrepreneurship Culture	-	2
2. CORE COURSES (87 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
LEVEL 1 (24 Credits)			
SIX1015	Science, Technology and Society	-	2
SIX1016	Statistics	-	3
SIM1001	Basic Mathematics	-	4
SIM1002	Calculus I	-	4
SIM1003	Calculus II	SIM1002	4
SIQ1001	Introduction to Accounting	-	3
SIT1001	Probability and Statistics I	SIM1002	4
LEVEL 2 (31 Credits)			
SIM2001	Advanced Calculus	SIM1003	4
SIM2002	Linear Algebra	SIM1001	4
SIM2007	Appreciation of Mathematics	SIM1003	2
SIM2011	Structured Programming	SIM1002	4
SIQ2001	Microeconomics	-	3
SIQ2002	Macroeconomics	-	3
SIQ2003	Financial Mathematics and Derivatives	SIM1002	4
SIT2001	Probability and Statistics II	SIT1001	4
SIT2007	Foundations of Data Science	SIT1001	3
LEVEL 3 (32 Credits)			
SIQ3001	Actuarial Mathematics I	SIQ2003	4
SIQ3002	Portfolio Theory and Asset Models	SIQ2003	4
SIQ3003	Actuarial Mathematics II	SIQ3001	4
SIQ3004	Mathematics of Financial Derivatives	SIQ2003	4
SIQ3005	Life Insurance and Takaful	-	4
SIQ3006	Risk Theory	SIT2001	4
SIQ3007	Industrial Training	SIQ3001	8
3. ELECTIVE COURSES (46 CREDITS)			
(I) STUDENT HOLISTIC EMPOWERMENT (8 CREDITS) ‡ **ONE COMPULSORY** course is taken from each cluster.			
CLUSTER			**CREDITS**
CLUSTER 1	Thinking Matters: Mind and Intellect		2
CLUSTER 2	Emotional, Physical and Spiritual Intelligence: Heart, Body and Soul		2
CLUSTER 3	Technology/Artificial Intelligence and Data Analytics: I-techie		2
CLUSTER 4	Global Issues and Community Sustainability: Making the World a Better Place		2
(II) PROGRAM ELECTIVE COURSES (at least 38 CREDITS)			
COURSE CODE	**COURSE NAME**	**PRE-REQUISITE**	**CREDITS**
SIM1004	Fundamentals of Computing	-	3
SIM1005	Fundamentals of Spreadsheets	-	2
SIM1006	Ordinary Differential Equations	SIM1002	4
SIM2010	Numerical Computation	SIM1003	4
SIM2012	Basic Operations Research	SIM1001	4
SIM3021	Mathematical Science Project	SIM2011	4
SIQ3008	Foundation of Islamic Finance	-	4
SIQ3009	Pension Mathematics	SIQ3001	4
SIQ3010	Survival Models	SIT2001	4
SIQ3011	Business Finance	-	3
SIQ3012	Financial and Business Management	-	3
SIQ3013	Stochastic Models	SIT2001	4
SIT2008	Further Mathematical Statistics	SIT2001	4

SIT2009	Regression Analysis	SIT1001	4
SIT2010	Stochastic Processes	SIT2001	3
SIT3003	Computer Intensive Methods in Statistics	SIT2001	4
SIT3004	Applied Stochastic Processes	SIT2010	4
SIT3005	Time Series and Forecasting Methods	SIT2001	4
SIT3015	Introduction to Multivariate Analysis	SIT2001	3
SIT3016	Generalized Linear Models	SIT2001 and SIT2009	4
SIT3017	Statistical Learning and Data Mining	SIT2007	3
SIT3018	Non-Parametric Statistics	SIT1001	4
SIT3019	Introduction to Bayesian Statistics	SIT2001	4
SIT3020	Python for Data Science	SIT3017	4
SIT3022	Probability Theory	SIM2001 and SIT2008	4
Students who wish to take SIQ3007 are advised to have passed at least 110 credits of the listed courses in the program.			

PROGRAM GOAL

To produce graduates with sound knowledge in the actuarial field through exploration in the theoretical and application of mathematics, statistics, economics and finance, able to think critically in problem solving as well as capable to increase competitiveness in the national and international levels.

PROGRAM EDUCATIONAL OBJECTIVES

1. Graduates build professions related to actuarial science or related fields.
2. Graduates engage in lifelong learning and interdisciplinary learning in industry or academic institutions based on actuarial science in industry.
3. Graduates contribute to sustainable development and well-being of the community.

PROGRAM LEARNING OUTCOMES

At the end of the program, graduates with Bachelor of Actuarial Science are able to:

1. Explain the principles and concepts of actuarial science, finance, economics, statistics and mathematics;
2. Demonstrate the ability to apply actuarial, financial, economical, statistical and mathematical knowledge critically and analytically in actuarial or related fields;
3. Apply the principles of actuarial science, finance, economics, statistics and mathematics in solving real-world problems;
4. Communicate actuarial, financial, economical, statistical and mathematical concepts effectively, confidently, accurately and coherently in written and oral forms;
5. Use a broad range of information, media and technology application in solving problems;
6. Work in teams, and demonstrate leadership quality and sense of responsibility in achieving goals and outcomes;
7. Engage in lifelong learning to advance knowledge and applications of actuarial science, finance, economics, statistics and mathematics;
8. Act professionally and ethically in the course of analysis and decision-making to solve problems.

LIST OF COURSES ACCORDING TO SEMESTER
(PLANNING OF COURSES)
BACHELOR OF ACTUARIAL SCIENCE

COMPONENT	YEAR 1				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
University Courses	GLT^{xxxx} English Courses (subject to MUET bands)	2	GLT^{xxxx} English Courses (subject to MUET bands)	2	**12**
	GIG1012 / GLT1017* Philosophy and Current Issues / Basic Malay Language*	2	GIG1013 Appreciation of Ethics and Civilisations	2	
	GIG1003 Basic Entrepreneurship Culture	2	GKA/GKI/GKK/ GKP/GKS/GKU Co-Curriculum	2	
Core Courses	SIM1001 Basic Mathematics	4	SIQ1001 Introduction to Accounting	3	**24**
	SIM1002 Calculus I	4	SIM1003 Calculus II	4	
	SIX1016 Statistics	3	SIT1001 Probability and Statistics I	4	
			SIX1015 Science, Technology and Society	2	
Elective Courses	Student Holistic Empowerment (SHE) Cluster 1: Thinking Matters: Mind and Intellect	2			**2**
TOTAL CREDITS		**19**		**19**	**38**

*only for international students

COMPONENT	YEAR 2				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
Core Courses	SIM2011 Structured Programming	4	SIM2001 Advanced Calculus	4	**31**
	SIQ2001 Microeconomics	3	SIM2002 Linear Algebra	4	
	SIQ2003 Financial Mathematics and Derivatives	4	SIM2007 Appreciation of Mathematics	2	
	SIT2001 Probability and Statistics II	4	SIQ2002 Macroeconomics	3	
	SIT2007 Foundations of Data Science	3			
Elective Courses	Student Holistic Empowerment (SHE) Cluster 2: Emotional, Physical and Spiritual Intelligence: Heart, Body and Soul	2	Elective Course 1	4	**9**
			Elective Course 2	3	
TOTAL CREDITS		**20**		**20**	**40**

COMPONENT	YEAR 3				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
Core Courses	SIQ3001 Actuarial Mathematics I	4	SIQ3003 Actuarial Mathematics II	4	**24**
	SIQ3002 Portfolio Theory and Asset Models	4	SIQ3004 Mathematics of Financial Derivatives	4	
	SIQ3005 Life Insurance and Takaful	4	SIQ3006 Risk Theory	4	
Elective Courses	Elective Course 3	4	Student Holistic Empowerment (SHE) Cluster 3: Technology/Artificial Intelligence and Data Analytics: I-techie	2	**16**
	Elective Course 4	4	Student Holistic Empowerment (SHE) Cluster 4: Global Issues and Community Sustainability: Making the World a Better Place	2	
			Elective Course 5	4	
TOTAL CREDITS		**20**		**20**	**40**

COMPONENT	YEAR 4				TOTAL CREDITS
	SEMESTER 1		SEMESTER 2		
	COURSE	CREDIT	COURSE	CREDIT	
Core Courses	SIQ3007 Industrial Training	8			**8**
Elective Courses			Elective Course 6	4	**19**
			Elective Course 7	4	
			Elective Course 8	4	
			Elective Course 9	4	
			Elective Course 10	3	
TOTAL CREDITS		**8**		**19**	**27**

INSTITUTE OF MATHEMATICAL SCIENCES

The Institute of Mathematical Sciences (ISM) was established as a department in the Faculty of Science when the University of Malaya was founded in Kuala Lumpur in 1959. It has grown into three branches, i.e., pure mathematics, applied mathematics, and statistics.

For the 2022/2023 session, ISM offers the following three first degree programs:

- Bachelor of Science in Mathematics
- Bachelor of Science in Statistics
- Bachelor of Actuarial Science

The three Bachelor of Science programs are set up to provide more opportunities for an undergraduate to major in the field of mathematics according to his or her interests. All these programs will assist to fulfill the vacancies of skilled workforce in science and technology in the public and private sectors in line with Malaysia's aspiration to become a developed nation.

STAFF

ISM has a group of experienced lecturers in teaching. They are also active in doing research and have been publishing many writings in local and international journals. The research activities encompass a broad spectrum, from findings and knowledge which are abstract in nature, to those with direct applications in the industry. ISM also strives to establish and forge a close relationship with industry and other research institutions. This strengthens the quality of teaching and supervising of projects/theses for students in bachelor's, Master's and doctoral levels.

HEAD:
Associate Prof. Dr. Zailan Siri, *BSc, MSc(UPM), PhD(UKM)*

DEPUTY HEADS:
Prof. Dr. Wong Kok Bin, *BSc, MSc, PhD(UM)*
Associate Prof. Dr. Ng Kok Haur, *BSc(UPM), MSc(UPM), PhD(UM)*
Associate Prof. Dr. Noor Fadiya Mohd Noor, *BSc(UTM), MSc(UTM), PhD(UKM)*
Associate Prof. Dr. Rossita Mohamad Yunus, *BSc, MSc(UM), PhD(USQ)*
Dr. Muhamad Hifzhudin Noor Aziz, *BSc(UM), MSc, PhD(Glasgow)*

MATHEMATICS UNIT

COORDINATOR (B.Sc. in MATHEMATICS):
Dr. Chooi Wai Leong, *BSc, MSc, PhD(UM)*

PROFESSORS:
Dr. Angelina Chin Yan Mui, *BSc, MSc(UM), PhD(Q'ld)*
Dr. Wan Ainun Mior Othman, *BSc(UNCC), MSc(N Carolina State), PhD(USM)*
Dr. Wong Kok Bin, *BSc, MSc, PhD(UM)*

ASSOCIATE PROFESSORS:
Dr. Chooi Wai Leong, *BSc, MSc, PhD(UM)*
Dr. Noor Fadiya Mohd Noor, *BSc(UTM), MSc(UTM), PhD(UKM)*
Dr. Zailan Siri, *BSc, MSc(UPM), PhD(UKM)*

LECTURERS:
Dr. Amizah Malip, *BSc(UIA), MSc, PhD(UK)*
Dr. Elayaraja Aruchunan, *BSc(UMS), MSc(UMS), PhD(Australia)*
Dr. Kwa Kiam Heong, *BSc, MSc(UM), PhD(Ohio State)*
Dr. Kohilavani Naganthran, *BSc(UNISEL), MSc, PhD(UKM)*
Dr. Loo Tee How, *BSc, MSc, PhD(UM)*
Mr. Mohamad Bakri Zubir, *BSc, MSc(Exeter)*
Dr. Mohd Zahurin Mohamed Kamali, *BSc, MSc, PhD(UM)*
Dr. Muhamad Hifzhudin Noor Aziz, *BSc(UM), MSc, PhD(Glasgow)*
Dr. Ong Siew Hui, *BSc, MSc, PhD(UM)*
Dr. Oon Shea Ming, *BSc, MSc, PhD(UHP)*
Dr. Ruhaila Md. Kasmani, *BSc(UKM), MSc(UTM), PhD(UM)*
Dr. Shahizat Amir, *BSc(UKM), MPhil, PhD(UM)*
Dr. Siti Suzlin Supadi, *BSc, MSc, PhD(UM)*
Dr. Tan Ta Sheng, *BA, CASM, MMath, MA, PhD(Cambridge)*

STATISTICS AND ACTUARIAL SCIENCE UNIT

COORDINATOR (B.Sc. in STATISTICS):
Dr. Nur Anisah Mohamed, *BSc, MSc(UM), PhD(Newcastle)*

COORDINATOR (B. ACTUARIAL SCIENCE):
Mdm. Nadiah Zabri, *BSc(UW Madison), MSc(Kent), AIA*

PROFESSOR:
Dr. Ibrahim Mohamed, *BSc(Bristol), MSc(Reading), PhD(UiTM)*

ASSOCIATE PROFESSORS:
Dr. Adriana Irawati Nur Ibrahim, *BSc(USM), MSc(UM), PhD(Bath)*
Dr. Khang Tsung Fei, *BSc, MSc(UM), PhD(NUS)*
Dr. Ng Kok Haur, *BSc(UPM), MSc(UPM), PhD(UM)*
Mr. Ravee Menon, *B.Eng (Hons) (UM), M. Actuarial Sc (Georgia State US), ASA, AIAA*
Dr. Rossita Mohamad Yunus, *BSc, MSc(UM), PhD(USQ)*

LECTURERS:
Dr. Dharini Pathmanathan, *BSc, MSc, PhD(UM)*
Dr. Koh You Beng, *BSc(UMS), MSc(UM), PhD(HKU)*
Dr. Mohd Azmi Haron, *BSc, MBA(UPM), PhD(UPM)*
Mdm. Nadiah Zabri, *BSc(UW Madison), MSc(Kent), AIA*
Dr. Ng Choung Min, *BSc(UTM), MSc, PhD(UM)*
Dr. Nur Anisah Mohamed, *BSc, MSc(UM), PhD(Newcastle)*
Dr. Shaiful Anuar Abu Bakar, *BSc(UiTM), MSc(Heriot-Watt), PhD(Manchester)*

COORDINATOR (B.Sc. Ed. Mathematics):
Dr. Shahizat Amir, *BSc, MSc, PhD(UM)*

RESEARCH AREAS

Research areas at ISM include:

differential geometry, group theory, ring theory, linear preserver problems, functional identities, linear and multilinear algebra, matrix theory, combinatorial graph theory, graph theory, social network analysis, supply chain management, operations research, numerical analysis, computational statistics, robust statistics, probability distribution theory, nonlinear time series, image processing, regression analysis, and mathematical biology.

COMPUTER FACILITIES

Currently, ISM has a computer lab equipped with 10 laptops, 17 workstations, 121 desktops, 3 laser printers, 1 colour printer, and 3 heavy-duty dot matrix printers, all of which being interconnected in a network system. The lab is also equipped with 4 LCD projectors, 2 visualizers, and 3 scanners. The lab utilizes state-of-the-art software such as MATLAB (with various toolboxes), SPSS, Wolfram Mathematica, MathType, Minitab, Microsoft Visual C++, Dev-C++, and S-PLUS. In addition, three of the lecture halls and tutorial rooms are each equipped with a LCD projector and a visualizer.

BACHELOR OF SCIENCE PROGRAMS

Please refer to Program Structure for courses.

FURTHER DEGREE

Apart from teaching and supervising at the bachelor's level, the staff members of the institute also supervise research projects that lead to Master's and doctorate degrees in the three branches of mathematics.

JOB OPPORTUNITIES

The learning of mathematics will help increase one's skills in problem solving and analysis. It trains one's mind to manipulate information, to form accurate, complicated and abstract ideas and to enable one to discern complicated arguments. The training to think quantitatively, logically and analytically in problem solving may prove valuable in one's chosen career.

Since the use of mathematics is all encompassing in human endeavour, a graduate's career opportunities are almost limitless and not only confined to teaching and research. Many graduates from this Institute have been employed in the financial sectors (banking, accountancy and insurance for instance), management, business, industry and computing sectors.

SYNOPSIS OF COURSES

SIX1016 STATISTICS (FACULTY OF SCIENCE)

Introduction to statistics; Experimental and observational studies; Display and organisation of data; Descriptive statistics; Population and samples; Sampling methods; Basic probability theory; Useful probability distributions: binomial, Poisson and normal; Sampling distributions; Central Limit Theorem; Point estimation and confidence interval; Hypothesis testing for mean and proportion in one and two populations; Chi-square tests; Simple linear regression and correlation analysis.

Assessment:
Continuous Assessment: 100%

References:
1. McClave, J.T. & Sincich, T.T. (2016). *Statistics* (13th ed.). Upper Saddle River, NJ: Pearson.
2. Mann, P. S. (2010). *Introductory Statistics* (7th ed.). New York: Wiley.
3. Freedman, D., Pisani, R. & Purves, R. (2007). *Statistics* (4th ed.). New York: W.W. Norton.

SIM1001 BASIC MATHEMATICS

Introductory logic. Mathematical statements. Quantifiers. Rules of inference. Mathematical induction, binomial theorem. Sets, Cartesian products, equivalence relations, functions, bijections, inverse functions. Integers, rational numbers, real numbers. Complex numbers. De Moivre's theorem and roots of unity. Polynomials and equations. Remainder theorem, fundamental theorem of algebra, conjugate roots.

Systems of linear equations, row reduction, echelon forms. Matrix operations, algebraic properties of matrices, inverses, elementary matrices, linear independence and homogeneous linear systems, matrices with special forms. Determinants, cofactor expansion, properties of determinants, Cramer's rule, eigenvalues, eigenvectors, and diagonalization.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Susanna S. Epp, *Discrete Mathematics with applications*, 5th edition, Cengage Learning, 2019.
2. Douglas E. Ensley, J. Winston Crawley, *Discrete Mathematics*, John Wiley and Sons. 2006.
3. K. Devlin, *Sets, Functions and Logic*, 2nd edition, Chapman & Hall, 1992.
4. H. Anton, C. Rorres, *Elementary Linear Algebra with Applications*, 11th edition, Wiley High Education Inc., 2014.
5. Larson, D.C. Falvo, *Elementary Linear Algebra*, 7th edition, Brooks/Cole Thomson Learning, 2012.

SIM1002 CALCULUS I

Functions and their graphs, combining functions, trigonometric functions. Rate of change and tangent lines to curves, limits of functions and limit laws, the precise definition of a limit, one-sided limits, continuity, limits involving infinity and asymptotes of graphs. Tangent lines and the derivative at a point, the derivative as a function, differentiation rules, derivatives of trigonometric functions, the chain rule, implicit differentiation. Extreme values of functions, the mean value theorem, monotonic functions and the first derivative test, concavity and curve sketching, antiderivatives. Sigma notation and limits of finite sums, the definite integral, the fundamental theorem of calculus, indefinite integrals and the substitution method, the definite integrals substitution and the area between curves, logarithms functions, exponential functions, indeterminate forms and L'hopital's Rule.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Joel R. Hass, Christopher E. Heil, Maurice D. Weir, *Thomas' Calculus*, 14th edition, Pearson Education, Inc. 2019.
2. J. Stewart, *Calculus*, 8th. edition, Cengage Learning, 2016.
3. Robert A. Adams, Christopher Essex, *Calculus: A complete course*, 8th edition with MyMathLab, Pearson Education, 2013.
4. R.T. Smith, R.B. Minton, *Calculus*, 4th ed., McGraw-Hill, 2012.

SIM1003 CALCULUS II

Inverses trigonometric functions, hyperbolic functions, inverses hyperbolic functions. Basic integration formulas, integration by parts, trigonometric integrals, trigonometric substitutions, integration of rational functions by partial fractions, improper Integrals. Sequence, infinite series, the integral test, comparison tests, absolute convergence, the ratio and root tests, alternating series test, conditional convergence, power series, Taylor and Maclaurin series. Calculus with parametric curves, polar coordinates. Three-dimensional coordinate systems, vectors, the dot product, the cross product, triple product, lines and planes, cylinder and quadric surfaces. Vector-valued functions, space curves, derivatives and integrals of vector functions.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Joel R. Hass, Christopher E. Heil, Maurice D. Weir, *Thomas' Calculus*, 14th edition, Pearson Education, Inc. 2019.
2. J. Stewart, *Calculus*, 8th. edition, Cengage Learning, 2016.
3. Robert A. Adams, Christopher Essex, *Calculus: A complete course*, 8th edition with MyMathLab, Pearson Education, 2013.
4. R.T. Smith, R.B. Minton, *Calculus*, 4th ed., McGraw-Hill, 2012.

SIM1004 FUNDAMENTALS OF COMPUTING

MATLAB - Matlab environment, matrices, constants and variables, operations, built-in functions, formatted output, plotting graphs, expressions and logical data, branches and loops, scripting, user-defined functions. Applications to selected mathematical problems.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Hahn, B. D., & Valentine, D. T. (2019). *Essential MATLAB for engineers and scientists.* Cambridge, MA: Academic Press.
2. *MATLAB ® Primer R2019a.* (2019). MathWorks, Inc.
3. Chapman, S. J. (2016). *MATLAB Programming for Engineers*. Cengage Learning.

SIM1005 FUNDAMENTALS OF SPREADSHEETS

Basics of worksheets, entering labels, numbers and formulae. Absolute and relative addressing, Excel functions. Graph plotting. Use of Excel Solver. Applications to some selected mathematical problems.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. *Engineering with Excel* by Ronald W. Larsen, Upper Saddle River, NJ: Pearson Prentice Hall, 5th edition, 2017.
2. *Excel for Engineers and Scientists* by S. C. Bloch and Sylvan Charles Bloch, John Wiley & Sons 2003.
3. *Excel for Scientists and Engineers: Numerical Methods* by E. Joseph Billo, Wiley-Interscience; 2007.

SIM1006 ORDINARY DIFFERENTIAL EQUATIONS

First order ODEs: Definitions, solution concepts, valid solution intervals. Solutions to separable equations, linear equations, Bernoulli, exact and non-exact, homogeneous equations. Some applications of first order ODEs.

Linear ODEs of second and higher orders: Definitions, solution concepts, linear independence, Wronskian. Solutions to homogeneous and non-homogeneous equations. Method of undetermined coefficients, Variation of parameters. Series solutions. Frobenius's method, Legendre and Bessel's equations.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Boyce, W. E., Diprima, R. C., & Meade, D. B. (2017). *Elementary Differential Equations and Boundary Value Problems*, 11th ed., John Wiley & Sons, Inc.
2. Trench, W. F. (2021). *Elementary Differential Equations with Boundary Values Problems.* LibreTexts Project (https://math.libretexts.org/).
3. Blanchard, P., Devaney, R. L., & Hall, G. R. (2012). *Differential Equations.* Cengage Learning.

SIM2001 ADVANCED CALCULUS

Partial derivatives. Differentiability and continuity. Linearization and differentials. The Chain Rule, Partial derivatives with constrained variables. Directional derivatives. Gradient, divergence and curl. Tangent planes. Taylor's Theorem. Extremum problems of functions of two variables. Lagrange multipliers.

Double integrals, iterated integrals and Fubini's Theorem. Applications to areas and volumes. Double integrals in polar form. Triple integrals, iterated integrals. Volumes and masses. Triple integrals in cylindrical and spherical coordinates forms. Substitution in multiple integrals, Jacobians.

Basic set theory. Functions, bijective functions, inverse functions. Finite and infinite sets, countable and uncountable sets. The Real Number system. Bounds, supremum and infimum. Archimedean property. Rational and irrational numbers. Properties of real numbers. Sequences of real numbers, convergence. Limit Theorems. Monotone sequences, Cauchy sequences and subsequences. Basic topology of the real line: Open and closed sets, accumulation points.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Joel R. Hass, Christopher E. Heil, Maurice D. Weir, *Thomas' Calculus*, 14th edition, Pearson Education, Inc. 2019.
2. J. Stewart, *Calculus*, 8th. edition, Cengage Learning, 2016.
3. R. G. Bartle & D. R. Sherbert, *Introduction to Real Analysis*, 4th ed., John Wiley & Sons, 2011.
4. R. Lay, *Analysis with an introduction to proof*, 5th ed., Pearson, 2014.
5. M. Field, *Essential Real Analysis*, Springer Undergraduate Mathematics Series, 2017.

SIM2002 LINEAR ALGEBRA

Vector spaces and subspaces, null spaces, sums and direct sums of subspaces. Linear independences, bases, dimension, the subspaces dimension theorem, row and column spaces, rank, ordered bases, coordinates, changes of basis. Linear transformations, kernel and range, the rank-nullity theorem, isomorphisms, matrix representations. Eigenvalues, eigenvectors, characteristic polynomials, diagonalizability, the Cayley-Hamilton Theorem.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Axler, S. (2015). *Linear algebra done right* (3rd ed.). New York: Springer-Verlag.
2. Friedberg, S.H., Insel, A.J., Spence, L.E. (2019). *Linear algebra* (5th ed.). New Jersey: Pearson Education.
3. Kwak, J.H., Hong, S.P. (2004). *Linear algebra* (2nd ed.). Boston: Birkhäuser.
4. Hoffman, K. M., Kunze, R. (1971). *Linear Algebra* (2nd ed.). New Jersey: Prentice Hall.
5. Zhang, F.Z. (2009). *Linear algebra – challenging problems for students* (2nd ed.). Baltimore: John Hopkins University Press.

SIM2007 APPRECIATION OF MATHEMATICS

This course exposes students to some aesthetic aspects of mathematics that they may not have encountered in other mathematics courses. The main aim is to promote appreciation of the beauty of mathematics and the role mathematics plays in society. The topics chosen for this course come from a variety of different areas, for example, mathematical puzzles and games, famous solved or unsolved mathematical problems and their history, mathematicians and their work, mathematics and music, mathematics and origami, mathematics in technology and mathematics in nature. Students will be put into groups and each group will work on a project related to any of the topics discussed in the lectures. Students collectively will use elements of mathematics to undertake the project. Each group is also required to identify and plan activities for a community partnership that will not only help them to enhance their understanding or gain a different perspective of their project but will also be beneficial to the community partner. Each student will be required to record a reflection of their experiences before, during and after the field work at the community partner and to submit their record with the group project report at the end of the semester. Students are also required to do a group presentation based on the project.

Assessment:
Continuous Assessment: 100%

References:

1. Kementerian Pendidikan Tinggi, Jabatan Pendidikan Tinggi (2019). *Chapter 1: Sulam as Community Engaged Pedagogy*.
2. Mathematical Moments from the American Mathematical Society, http://www.ams.org/publicoutreach/mathmoments/mathmoments

SIM2010 NUMERICAL COMPUTATION

Computer arithmetic: floating-point numbers, round off error, machine precision, overflow/underflow, numerical cancellation, truncation error.

Taylor polynomials and limits.

Interpolation: Lagrange interpolation, divided difference method, Hermite interpolation, cubic spline interpolation.

Roots of nonlinear equation: bisection method, fixed-point iteration, Newton – Raphson method, secant method.

Numerical differentiation: Forward, backward and central finite difference methods.

Numerical Integration: trapezoidal, Simpson's, Romberg's methods. Composite methods.

System of linear equations. Matrix factorization, LU factorization.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. B. Allen, Eli L. Isaacson (2020). *Numerical Analysis for Applied Science* (Pure and Applied Mathematics: A Wiley Series of Texts, Monographs and Tracts), (2nd Ed.).
2. Atkinson, K. E. (2004), *Elementary Numerical Analysis*, John Wiley & Sons, (3nd Ed.).
3. Burden, R. L. & Faires, J. D. (2016), *Numerical Analysis*, Brooks/Cole, USA, (10th Ed.).
4. Brian Bradie, (2006), *A Friendly Introduction to Numerical Analysis*, Pearson Education, New Jersey.

SIM2011 STRUCTURED PROGRAMMING

Algorithms: Structured programming – sequence, decision statement and loops. Object-oriented design.

Programming: fundamental data types – int, double, char. Operators, precedence order. Pre-processor directives. In-built functions. User-defined functions – pass by value and reference. One- and two-dimensional arrays.

Introduction to user-defined data types – structures and classes.

Applications of numerical methods: integer and floating point arithmetic, root finding, solutions of ordinary differential equations. Use of random number generator.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:

1. Stroustrup, B. (2018). *A Tour of C++ - C++ In-Depth Series* (2nd ed.). Upper Saddle River, NJ: Addison-Wesley.
2. Hetland, M. L. (2017). *Beginning Python- From novice to professional* (3rd ed.). New York, NY: Springer Science+Business Media New York.
3. Johansson, R. (2019). *Numerical Python.* New York, NY: Springer Science+Business Media New York.
4. Barnes, D. J. & Kölling, M. (2017). *Objects first with Java- A practical introduction using BlueJ* (6th ed.). Pearson Education Limited.

5. Cosmina, J. (2019). *Java for absolute beginners-Learn to program the fundamentals the Java 9+ way.* New York, NY: Springer Science+Business Media New York.

SIM2012 BASIC OPERATIONS RESEARCH

Introduction to the problems in operations research, modelling, formulation and examples. Linear programming, transportation and assignment problems. Integer programming, game theory and dynamic programming.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Hamdy A. Taha (2017), *Operations Research: An Introduction*, 10th, Hoboken, New Jersey: Pearson,
2. F.S. Hillier and G.J. Lieberman. *Introduction to operations Research*, McGraw-Hill International Edition, 2011 (Eight Edition)
3. W.L. Winston, *Operational Research: Applications and Algorithm*, Duxbury Press, 1994.
4. Bernard W. Taylor: *Introduction to management science*, Pearson Prentice Hall, 2004. (Eight Edition)

SIM2013 INTRODUCTION TO COMBINATORICS

Ordered and equivalence relations, binomial and multinomial theorems, recurrence relations, principle of inclusion and exclusion, generating functions, Latin squares, magic squares, basic properties of graphs, circuits and cycles in graphs, trees and their applications.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. M. J. Erickson, *Introduction to Combinatorics*, 2nd Edition, Wiley, 2013.
2. R. A. Brualdi, *Introductory Combinatorics (Classic Version)*, 5th Edition, Pearson, 2017.
3. C.C. Chen & K.M. Koh, *Principles and Techniques in Combinatorics*, World Scientific, 1992.
4. L. Lovasz, J. Pelikan & K. Vesztergombi, *Discrete Mathematics: Elementary and Beyond*, Springer, 2003.
5. J. Matousek & J. Nesetril, *Invitation to Discrete Mathematics*, 2nd Edition, Oxford University Press, 2008.

SIM2014 ALGEBRA I

Group Theory - abstract groups, subgroups, cyclic and dihedral groups; order of an element and of a subgroup, Lagrange's theorem; cosets, normal subgroups and factor groups; group homomorphisms.

Ring Theory – rings, integral domains and fields; subrings, ideals and quotient rings; ring homomorphisms; polynomial rings, the Division algorithm and Euclidean algorithm in polynomial rings.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Gilbert, L., Gilbert, J. *Elements of Modern Algebra*, 8th edition, Brooks Cole, 2014.
2. Fraleigh, J.B. *First Course in Abstract Algebra*, 8th edition, Pearson eText, 2019.
3. Judson, T.W. *Abstract Algebra, Theory and Applications*, Open Source, 2019.

SIM2015 INTRODUCTION TO ANALYSIS

Sequences. Topology of the real line. Compactness. Properties of continuous functions. Uniform continuity. Derivative of a function. Properties of differentiable functions. Mean Value Theorems. Higher order derivatives. L'Hospital's Rules.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. S. R. Lay, *Analysis with an introduction to proof*, 5th ed., Pearson, 2014.
2. S. M. Oon, *A First Course in Real Analysis*, University of Malaya Press, 2017
3. W. Kosmala, *A Friendly Introduction to Analysis*, 2nd ed., Pearson, 2004.
4. R. Haggarty, *Fundamentals of Mathematical Analysis*. 2nd ed., Addison-Wesley Publ. Co., 1993.
5. R. G. Bartle & D. R. Sherbert, *Introduction to Real Analysis*, 4th ed., John Wiley & Sons Inc., 2011.

SIM2016 COMPLEX VARIABLES

Complex numbers, complex functions, limits, continuity. Differentiable and analytic functions, Cauchy-Riemann equations, harmonic functions. Sequences and series of complex numbers, convergence tests, power series. Elementary functions: the complex exponential function, complex logarithms, complex exponents, trigonometry functions. Complex integrals, contour integrals, the Cauchy-Goursat theorem, the fundamental theorems of integration, Cauchy's integral formula, Cauchy's integral formula for derivatives and Morera's theorem.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Mathews, J.H., Howell, R.W. (2012). *Complex analysis*: *for mathematics and engineering* (6th ed.). Sudbury: Jones & Bartlett Learning.
2. Saff, E.B., Snider, A.D. (2018). *Fundamental of complex analysis: with applications to engineering and science* (3rd ed.). New York: Pearson.
3. Churchill, R.V., Brown, J.W. (2014). *Complex variables and applications* (9th ed.). New York: McGraw-Hill Education.
4. Howie, J.M. (2003). *Complex analysis.* London: Springer-Verlag.
5. Asmar, N.H., Grafakos, L. (2018). *Complex analysis with applications*. Switzerland AG: Springer-Verlag.

SIM2017 GEOMETRY

Euclidean Geometry, congruence, parallelism, similarity, isometry, Incidence geometry of the hyperbolic plane, motions of the sphere.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. P. Ryan, *Euclidean and non-Euclidean geometry*, Cambridge Univ. Press, 2012.
2. H. P. Manning, *Non-Euclidean geometry*, Independently Publ. 2019.
3. M. Henle, *Modern Geometries: Non-Euclidean, Projective, and Discrete Geometry*, 2nd ed., Pearson, 2001.
4. J. Kappraff, *A Participatory Approach to Modern Geometry*, World Scientific, 2014.

SIM2018 PARTIAL DIFFERENTIAL EQUATIONS

Fourier series, introduction to partial differential equations, method of characteristics, separation of variables, Laplace transform method.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. W. E. Boyce, R. C. Prima & D. B. Meade, *Elementary Differential Equations and Boundary Value Problems*, 11th edition, John Wiley & Sons, 2017.
2. N. H. Asmar, *Partial Differential Equations with Fourier Series and Boundary Value Problems*, 3rd edition, Dover, 2017.
3. D. G. Zill & M. R. Cullen, *Differential Equations with Boundary-Value Problems*, 7th Edition, Brooks/Cole, 2005.

SIM2019 SYSTEMS OF ORDINARY DIFFERENTIAL EQUATIONS

Linear systems of first-order equations. Homogeneous linear systems. Nonhomogeneous linear systems.

Nonlinear autonomous systems. Stability. Locally linear systems. Liapunov's method. Applications

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Boyce, W. E., Prima, R. C., & Meade, D. B. (2017). *Elementary differential equations and boundary value problems* (11th ed.). John Wiley & Sons.
2. Zill, D. G., Wright, W. S., & Cullen, M. R. (2013). *Differential equations with boundary-value problems* (8th ed.). Brooks/Cole, Cengage Learning.
3. Nagle, R. K., Saff, E. B., & Snider, A. D. (2017). *Fundamentals of differential equations (9*th ed.). Pearson Education, Inc.
4. Jordan, D., & Smith, P. (2007). *Nonlinear ordinary differential equations: An introduction for scientists and engineers (4*th ed.). Oxford University Press.
5. Perko, L. (2001). *Differential equations and dynamical systems* (3rd ed.), Springer-Verlag, New York, Inc.

SIM2020 MANAGEMENT MATHEMATICS

Output function: Theory and some concepts. Break even model. Maximum profit for monopoly and oligopoly markets. Inventory model. EOQ Model, reordering point, finite input rate, shortage and discount quantity. Probabilistic model, safety stock and efficiency level.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Hamdy A. Taha (2017), *Operations Research: An Introduction*, 10th, Hoboken, New Jersey: Pearson.
2. Davies, K.R., McKeown, P.G. & Rakas, T.R. (1986), *Management Science: An Introduction,* Kent Publishing Company.
3. Winston, W.L. (1994), *Operations Research: applications and algorithms*, 3rd ed., Duxbury Press.
4. Hillier, Frederick S. (1995), *Introductory to Operations Research*, 6th edition, New York, McGraw-Hill.
5. C.D.J. Waters (2003), *Inventory Control and Management*, University of Calgary, Canada.

SIM2021 OPTIMIZATION TECHNIQUES

Unconstraint optimization, necessary and sufficient conditions for an extremum point. Constraint optimization. Types of constraints. Various techniques for solving nonlinear problems.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Yang, X. (2018). *Optimization techniques and applications with examples*. Hoboken, NJ: John Wiley & Sons, Inc.
2. Grill, P. E., Murray, E., & Wright, M. H. (1982). *Practical optimization*. Emerald Group Publishing Limited.
3. Mohan, C, & Deep, K. (2009). *Optimization techniques*. New Age Science
4. Foulds, L.R. (1981). *Optimization techniques: An Introduction*. Springer-Verlag New York Inc.
5. Rao, S. S. (2009). *Engineering optimization: Theory and practice*. John Wiley & Sons, Inc.

SIM3001 GRAPH THEORY

Graph theory and its applications.

Topics will be selected from the following:
Eulerian graphs, trees, planar graphs, graph colouring and chromatic polynomials, Hamiltonian graphs, matching theory, directed graphs and the shortest path problem, network theory.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. G.Chartrand, L.Lesniak and P.Zhang, *Graphs and digraphs*, 6th.ed. CRC Press, 2015,
2. R.Diestel, *Graph Theory*, Springer, 2017.
3. K.M.Koh, F.Dong, K.L.Ng and E.G.Tay, *Graph Theory: Undergraduate Mathematics*, World Scientific, 2015.
4. J.L. Gross, J.Yellan and P.Zhang, *Handbook of Graph Theory*, 2nd. ed. (Discrete Mathematics and Its Applications), CRC Press, 2013.

SIM3002 COMBINATORIAL MATHEMATICS

Enumerative Combinatorics: Permutations and combinations, Catalan numbers, Stirling numbers and partition numbers.

Existential Combinatorics: Pigeonhole principle, Ramsey theory of graphs and systems of distinct representatives.

Combinatorial Designs: Block designs, balanced incomplete block designs, Steiner triple systems and Hadamard matrices.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. R.A. Brualdi, *Introductory Combinatorics (Classic Version)*, 5th ed., Pearson, 2017.
2. R.P. Stanley, *Enumerative Combinatorics*, Volume 1, 2nd ed., Cambridge University Press, 2011.
3. P.J. Cameron, *Combinatorics: Topics, Techniques, Algorithms*, Cambridge University Press, 1994.
4. J.M. Harris, J.L. Hirst & M.J. Mossinghoff, *Combinatorics and Graph Theory*, Springer, 2008.
5. A. Tucker, *Applied Combinatorics*, 6th ed., John Wiley and Sons, 2012.

SIM3003 NUMBER THEORY

Prime Numbers. The Division Algorithm and Unique Factorization Theorem for Integers. Linear Diophantine Equations. Theory of congruence and the Chinese Remainder Theorem. RSA encryption. Quadratic reciprocity and the Legendre symbol. Arithmetic functions. Primitive roots.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. D. M. Burton, *Elementary Number Theory*, 7th ed., McGraw-Hill, 2011.
2. J. Silverman, *Friendly Introduction to Number Theory, A (Classic Version)*, 4th ed., Pearson Addison Wesley, 2018.
3. R. M. Hill, *Introduction to Number Theory, Essential Textbooks in Mathematics*, World Scientific Publishing, 2018.
4. B. Hutz, *An Experimental Introduction to Number Theory, Pure and Applied Undergraduate Texts*, American Mathematical Society, 2018.

SIM3004 ADVANCED LINEAR ALGEBRA

Inner product spaces, the Cauchy-Schwarz inequality, the Gram-Schmidt orthogonalization process, orthogonal complements, orthogonal projections. Adjoint operators, normal operators, self-adjoint operators, unitary operators, positive definite operators. Bilinear forms, congruence, rank, Sylvester's law of inertia, classification of symmetric bilinear forms, real quadratic forms. The Schur triangularization theorem, the primary decomposition theorem, the Jordan canonical form.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Friedberg, S.H., Insel, A. J., Spence, L.E. (2019). *Linear Algebra* (5th ed.). New Jersey: Pearson Education.
2. Hoffman, K. M., Kunze, R. (1971). *Linear Algebra* (2nd ed.). New Jersey: Prentice Hall.
3. Cooperstein, B.N. (2015). *Advanced Linear Algebra* (2nd ed.). Boca Raton: CRC Press.
4. Roman, S. (2008). *Advanced Linear Algebra* (3rd ed.). New York: Springer-Verlag.
5. Weintraub, S. H. (2011). *A Guide to Advanced Linear Algebra*. Washington, DC: The Mathematical Association of America.

SIM3005 MATRIX THEORY

Rank and nullity of matrices, Sylvester's law inequality, the Frobenius inner product, the Gram-Schmidt process, the continuity argument. Rank and full rank decompositions, LU and QR decompositions, spectral decompositions, singular value decompositions, polar decompositions, Cholesky decompositions. Generalized inverses, Moore-Penrose inverses, the best approximation solutions, least squares solutions. Kronecker products of matrices, permutations, matrix functions of Kronecker products, Schmidt rank and decompositions.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Zhang, F.Z. (2011). *Matrix theory*: *basic results and techniques* (2nd ed.). New York: Springer-Verlag.
2. Horn, H., John, C.R. (2013). *Matrix analysis* (2nd ed.). Cambridge, NY: Cambridge University Press.
3. Zhan, X.Z. (2013). *Matrix theory*. Providence, RI: American Mathematical Society.
4. Gentle, J.E. (2017). *Matrix algebra: theory, computations and applications in statistics* (2nd ed.). New York: Springer-Verlag.
5. Randall E. C. (1979*). Elements of the theory of generalized inverses of matrices*. Basel: Birkhäuser.

SIM3006 ALGEBRA II

This is a second course in abstract algebra and will cover more advanced topics on groups and rings. Topics on groups include the isomorphism theorems, various subgroups such as the centre and commutator subgroups, finitely generated abelian groups, automorphism groups, permutation groups, and p-groups.

For rings, the focus is on commutative rings. Topics on rings include the maximal and prime ideals, polynomial rings, irreducible polynomials and the Unique Factorization Theorem.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Fraleigh, J.B. *First Course in Abstract Algebra*, 8th edition, Pearson eText, 2019.
2. Gallian, J. *Contemporary Abstract Algebra*, *Brooks/Cole Cengage Learning*, 8th edition, 2013.
3. Hungerford, T. W. *Abstract Algebra: An Introduction*, 3rd edition, Brooks/Cole Cengage Learning, 2014.
4. Judson, T.W. *Abstract Algebra, Theory and Applications*, Open Source, 2019.

SIM3007 RING THEORY

This course includes both commutative and non-commutative rings. Topics that will be discussed include subrings, subfields and ideals; internal direct sum and external direct product; nil ideals, nilpotent ideals; modules and submodules; prime ideals, maximal ideals; prime radical and Jacobson radical; semiprime and semiprimitive rings; rings with chain conditions; group rings.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. P.M. Cohn, *Introduction to Ring Theory*, Springer Undergraduate Mathematics Series, 2002.
2. I.N. Herstein, *Noncommutative Rings*, Carus Mathematical Monographs No. 15, Math Assoc. of America, 2005.
3. J.A. Beachy, *Introductory Lectures on Rings and Modules*, London Maths. Soc. Student Texts 47, Cambridge University Press, 2012.
4. Fraleigh, J.B. *First Course in Abstract Algebra*, 8th edition, Pearson eText, 2019.
5. T.Y. Lam, *Exercises in Classical Ring Theory* (Problem Books in Mathematics), Springer, Second Edition, 2010.

SIM3008 GROUP THEORY

The three isomorphism theorems. Cyclic groups. Direct product of groups. Introduction to the three Sylow's Theorem. Classification of groups up to order 8. Finitely generated abelian groups. Permutation groups.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Hall, M., *The theory of Groups*. Dover Publications; Reprint edition, New York, 2018.
2. Barnard, T., Neill, H., *Discovering Group Theory: A Transition to Advanced Mathematics*, Taylor & Francis Ltd, London, 2016.
3. Rotman, J.J., *An introduction to the theory of groups*, 4th edition. Springer-Verlag, New York, 1999.

SIM3009 DIFFERENTIAL GEOMETRY

Vector algebra on Euclidean space. Lines and planes. Change of coordinates. Differential geometry of curves. Frenet Equations. Local theory of surfaces in Euclidean space. First and second fundamental forms. Gaussian curvatures and mean curvatures. Geodesics. Gauss-Bonnet Theorem.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. M. Lipschutz, *Schaum's Outline of differential geometry*, McGraw-Hill, 1969.
2. M. Umehara; K. Yamada, *Differential Geometry of Curves and Surfaces*, World Scientific, 2017.
3. K. Tapp, *Differential Geometry of Curves and Surfaces*, Springer, 2016.

SIM3010 TOPOLOGY

Topological Spaces. Continuity, connectedness and compactness. Separation axioms and countability. Metric spaces. Product spaces.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Armstrong, M.A. (2010). *Basic topology* (Undergraduate Texts in Mathematics). Springer.
2. Munkres, J. (2000). *Topology* (2nd ed.). Prentice Hall Inc.
3. McCluskey, A., & McMaster, B. (2014). *Undergraduate topology: A working textbook*. Oxford University Press.

SIM3011 COMPLEX ANALYSIS

Infinite series expansions: convergence and divergence and region of convergence. Taylor and Laurent theorems. Classification of isolated singularities. Zeroes and Poles. Calculus of residues; calculation of definite integrals. Residue Theory. Evaluation of certain Integrals. Arguments Principle, Rouche's Theorem. Maximum Modulus Principle. Conformal Mappings.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. John H. Mathews and Russell W. Howell. (2012). *Complex Analysis: for Mathematics and Engineering*, 6th ed. Jones & Bartlett Pub. Inc.
2. E.B. Saff, A.D. Snider. (2003). *Fundamental of Complex Analysis*, Pearson Education Inc.
3. Rosihan M. Ali and V. Ravichandran. (2007). *Complex Analysis*, Universiti Sains Malaysia Press.
4. A. I. Markushevich. (1985). *Theory of functions of complex variables*, Chelsea Publ. Co.
5. Nakhle H. Asmar and Laukas Grafakos. (2018). *Complex Analysis with Applications* (Undergraduate Texts in Mathematics), Springer.

SIM3012 REAL ANALYSIS

Infinite series, convergence. Tests of convergence. Absolute and conditional convergence. Rearrangement of series. Pointwise and uniform convergence. Properties of uniform convergence. Superior limit and inferior limit. Power series, radius of convergence. Taylor series. Riemann integral. Integrable functions. Properties of the Riemann integral. Integration in relation to differentiation. Differentiation of integrals. Improper integrals. Sequences and series of functions.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. W.P. Ziemer, *Modern Real Analysis*, Springer 2017.
2. Witold A.J. Kosmala, *A friendly introduction to analysis*, 2nd Edition, Pearson International 2004.
3. B.S, Schroder, *Mathematical Analysis: A concise introduction*, John-Wiley 2008.
4. L.F. Richardson, *Advanced Calculus: An introduction to linear analysis*, John-Wiley 2008.
5. D.S. Kurtz and C.W. Swartz, *Theories of Integration*, World Scientific 2004.

SIM3020 INDUSTRIAL TRAINING

Candidates are required to spend a minimum 16 weeks working with selected companies in selected areas of industry.

Assessment:
Continuous Assessment: 100%

References:
University of Malaya Guidebook for Industrial Training

SIM3021 MATHEMATICAL SCIENCE PROJECT

Subject to supervising lecturer.

Assessment:
Continuous Assessment: 100%

References:
Refer to supervising lecturer.

SIM3022 CRYPTOGRAPHY

Basic concept of cryptography, data security, complexity theory and number theory. Encryption algorithms, secret key cryptography, public key cryptography, key management, hash functions, digital signature. Quantum cryptography. Applications of cryptography.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Martin, M.K., *Everyday Cryptography*, Oxford University Press, 2017.
2. Stinson, D.R., *Cryptography: Theory and Practice*, CRC Press, 2018.
3. Trappe, W., and Washington, L.C., *Introduction to Cryptography with Coding Theory*, 4th Edition, Pearson Prentice Hall, 2019.
4. Stallings, W., *Cryptography and Network Security: Principles and Practice*. 5th editon , Englewood Cliffs (NJ): Prentice Hall, 2016.
5. Schneder, B., *Applied Cryptography*, 4th Edition New York: John Wiley and Sons, 2016.

SIM3023 NUMERICAL METHODS AND ANALYSIS

Approximation methods: Discrete, linear and nonlinear least square, orthogonal polynomials, Chebyshev polynomials, Gram-Schmidt process.

Eigenvalue problem: Gershgorin circle, power method, Householder's methods, QR algorithm.

Initial value problems of ordinary differential equations: Euler, high order Taylor, Runge-Kutta and multistep methods. Analysis of convergence, stability and error control.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Sutton, B. (2019). *Numerical Analysis: Theory and Experiments*. Philadelphia: Society for Industrial and Applied Mathematics.
2. Ansari, K.A, & Dichone, B. (2018). *An Introduction to Numerical Methods Using MATLAB*. USA: SDC Publications.
3. Heister, T., Rebholz, L. G., & Xue, F. (2019). *Numerical Analysis: An Introduction.* USA: De Gruyter.

SIM3024 COMPUTATIONAL GEOMETRY

Vector algebra, introduction to differential geometry, design of surfaces for Bezier surfaces, triangular Bezier surfaces, rational B-splines for Bezier and Coons surfaces.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Michael E. Mortenson, *Geometric Modelling*, John Wiley & Sons, 2019
2. Farin, G., *Curves and Surfaces for Computer Aided Geometric Design*, Academic Press, Boston, 2018.
3. Hoschek, J. & Laser, D., *Fundamentals of Computer Aided Geometric Design*, AK Peters Ltd, 2018.
4. Farin, G., Hoschek, J and Kim., S.M., *Handbook of Computer Aided Geometric Design*, Elsevier, North Holland, 2019.
5. Patrikalakis, N.M. & Maekawa, T., *Shape Interogation for Computer Aided Design and Manufacturing*, Springer, 2019.

SIM3025 SCIENTIFIC COMPUTING

Functions. Data structures. Pointers/References. Classes and objects.

Programmatic modeling and analysis of selected problems from, but not limited to algebra, data processing and analysis, dynamical systems, graph theory, interpolation, linear algebra, linear and nonlinear equations, mathematical physics, optimization, and statistics.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Horton, I., & Weert, P. V. L. (2018). *Beginning C++- From novice to professional* (5th ed.). New York, NY: Springer Science+Business Media New York.
2. Hetland, M. L. (2017). *Beginning Python- From novice to professional* (3rd ed.). New York, NY: Springer Science+Business Media New York.
3. Johansson, R. (2019). *Numerical Python.* New York, NY: Springer Science+Business Media New York.
4. Barnes, D. J. & Kölling, M. (2017). *Objects first with Java- A practical introduction using BlueJ* (6th ed.). Pearson Education Limited.
5. Cosmina, J. (2019). *Java for absolute beginners- Learn to program the fundamentals the Java 9+ way.* New York, NY: Springer Science+Business Media New York.

SIM3026 PRODUCTION AND INVENTORY CONTROL

Introduction
The importance of inventory in management.

Inventory model
Advanced EOQ models.
Inventory model for time-dependent demand: linear increase or decrease cases.

Solutions
Exact and approximate methods by minimizing ordering and holding costs.

Applications
Applications to real-world problems.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Hamdy A. Taha (2017), *Operations Research: An Introduction*, 10th, Hoboken, New Jersey: Pearson,
2. E. Naddor (1966), *Inventory Systems*, J. Wiley.
3. Hadley G. and Whitin T.M (1963), *Analysis of Inventory Systems*, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.
4. C.D.J. Waters (2003), *Inventory Control and Management*, University of Calgary, Canada.
5. Hillier, Frederick S. (2005), *Introductory to Operations Research*, 8th edition, New York, McGraw-Hill.

SIM3027 MATHEMATICAL PROGRAMMING

Introduction of linear programming in matrix form. Simplex method in matrix form, two phase simplex method in matrix form. Revised simplex method in matrix form. Two phase revised simplex method in matrix form. Sensitivity analysis. Dual simplex. Integer linear programming (cutting plane algorithms, binary (0-1)). Parametric linear programming. Upper bounded variables method. Goal programming (graphical method, simplex method), Karmarkar's interior point algorithm, Dantzig-Wolf decomposition principle.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Hamdy A. Taha (2017), *Operations Research: An Introduction*, 10th, Hoboken, New Jersey: Pearson,
2. Markland, R.E & Sweigart, J.R (1987), *Quantitative Methods: Applications to Managerial Decision Making*, John Wiley & Sons.
3. Moore, L.J, Lee, S.M & Taylor, B.W (1993), *Management Science*, 4th edition, Allyn and Bacon.
4. Winston, W.L (1994), *Operations Research: Applications and Algorithms*, 3rd edition, Duxbury Press.

SIM3028 INDUSTRIAL OPERATIONS RESEARCH

Introduction
Definition of a network, node, branch, path, chain, cycle and circuit.

Network flow
Shortest distance (path), minimum spanning tree, maximum flow and maximum flow-minimum cost.

Activity network
Critical Path Method (CPM). Project Evaluation. Review Technique (PERT). Probability analysis.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Hamdy A. Taha (2017), *An Introduction to Operational Research*, 10th, Hoboken, New Jersey: Pearson.
2. Markland, R.E & Sweigart, J.R (1987), *Quantitative Methods: Applications to Managerial Decision Making*, John Wiley & Sons.
3. Moore, L.J, Lee, S.M & Taylor, B.W (1993), *Management Science*, 4th edition, Allyn and Bacon.
4. Winston, W.L (1994), *Operations Research: Applications and Algorithms*, 3rd edition, Duxbury Press.

SIM3029 COMPUTATIONAL FLUID DYNAMICS

Concepts of fluid dynamics: types of fluids and flows. Solution approaches to fluid dynamics. Forces, laws governing fluid motion and conservation of momentum. Dynamics in one dimension and motion on a plane.

Derivation of stream function and equations of Euler, Bernoulli and Navier-Stokes. Dimensional analysis and dimensionless parameters. Dynamic similarity and boundary layer approximation.

Solutions of flow problems and initial/boundary conditions using computational fluid dynamics methods.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Sreenivas, J. (2018). *Computational Fluid Dynamics for Engineers and Scientists*. Netherlands: Springer.
2. Braithwaite, J. (2017). *Essential Fluid Dynamics for Scientists*. USA: Morgan & Claypool Publishers
3. Aref, H., & Balachandar, S. (2017). *A First Course in Computational Fluid Dynamics.* UK: Cambridge University Press.

SIM3030 DYNAMICAL SYSTEMS THEORY

Flows on the line. Flows on the circle.

Two-dimensional flows. Phase plane. Limit cycles. Bifurcations.

Three- and higher dimensional flows. Phase space. Chaos.

Numerical simulations. Applications.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Strogatz, S. H. (2018). *Nonlinear dynamics and chaos* (2nd ed.). Boca Raton, FL: CRC Press.
2. Chou, C, & Friedman, A. (2016). *Introduction to mathematical biology.* Switzerland: Springer International Publishing Switzerland.
3. Jordan, D, & Smith, P. (2007). *Nonlinear ordinary differential equations: An introduction for scientists and engineers* (4th ed.). New York, NY: Oxford University Press.
4. Hale, J. K., & Kocak, H. (1991). *Dynamics and bifurcations*. New York, NY: Springer-Verlag New Work Inc.
5. Hirsch, M. W., Smale, S., & Devaney, R. L. (2013). *Differential equations, dynamical systems and an introduction to chaos* (3rd ed.). Waltham, MA: Elsevier Inc.

SIQ1001 INTRODUCTION TO ACCOUNTING

Basic principles of accounting – including the role of accounting standards. Different types of business entity. Basic structure of company accounts. Interpretation and limitation of company accounts.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Reimers, Jane L. (2007). *Financial Accounting*. Pearson Prentice Hall
2. Hermanson, R.H. and J.D. Edwards (1995). *Financial Accounting: A Business Perspective*, 6th ed, Irwin.
3. Spieceland, D. J., Thomas, W., & Herrmann, D. (2013). *Financial accounting*. McGraw-Hill Higher Education.
4. Sangster, A., & Wood, F. (2019). *Frank Wood's Business Accounting* (Vol. 1). Pearson Higher Ed.
5. Deegan, C. (2012). *Australian financial accounting*. McGraw-Hill Education Australia.

SIQ2001 MICROECONOMICS

Fundamental principles of economics; price theory which covers the demand model, supply model and equilibrium point; shape of demand curve and consumer behavior; substitution effects and income; shape of supply curve and behavior of firms; theory of production and cost of production; analysis of competitive markets in the short term; monopoly and oligopoly.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Katz, Michael L. and Rosen, Harvey S. (1999). *Microeconomics*, 2nd ed., McGraw Hill.
2. Sloman, J., Hinde, K. and Garratt, D. (2013). *Economics for Business*, 6th ed., Pearson.
3. Begg, D. (2012). *Economics for business*. McGraw Hill Higher Education.
4. Bade, R., Parkin, M. (2014). *Foundation of Economics*. Pearson.
5. Mankiw G., (2018). *Macroecomics*. Pearson, 7th Edition.

SIQ2002 MACROECONOMICS

Macroeconomic issues and problems; fundamental concepts of national income; method of calculating national income; simple Keynesian model; derivation of IS curve, LM curve, aggregate demand curve, and aggregate supply curve; relationship between interest rates, monetary demand, consumption and investments; relationship between price levels, monetary demand, aggregate demand and aggregate supply in a Keynesian model.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Richard T. Froyen (2002). *Macroeconomics: Theories and Policies*, 7th ed., Prentice Hall.
2. Case, Karl E. et. al. (2013). *Principles of Macroeconomics*, Prentice Hall.
3. Sloman, J., Hinde, K. and Garratt, D. (2013). *Economics for Business*, 6th ed., Pearson.
4. Bade, R., Parkin, M. (2014). *Foundation of Economics*. Pearson.
5. Mankiw. G (2019), *Macroeconomics*. Pearson

SIQ2003 FINANCIAL MATHEMATICS AND DERIVATIVES

Time Value of Money: simple interest, compound interest, present and accumulated values, nominal rate of interest, force of interest, equation of value.

Annuities: annuity immediate, annuity due, perpetuity, m-thly annuity, continuous type annuity, deferred annuities, varying annuities.

Loans: Amortization, sinking funds, amortization with continuous payments.

Bonds: Types of bonds, pricing formula, callable and serial bonds, other securities.

Cash flows: Discounted cash flows, internal rate of return, money-weighted and time weighted rate of return.

Term Structure of Interest Rate: Yield curves, spot and forward rates, duration, convexity, immunization.

Introduction to Derivatives: Forward and futures, short and long positions, arbitrage, put and call options, interest rate and currency swaps, put-call parity, hedging.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Garrett, S. J. (2013). *Introduction to the Mathematics of Finance. A Deterministic Approach* (Second Edition), Butterworth-Heinemann.
2. Kellison, S.G. (2009) *The Theory of Interest* (Third Edition), Irwin/McGraw-Hill.
3. Broverman, S.A. (2017). *Mathematics of Investment and Credit* (Seventh Edition), ACTEX Publications.
4. Vaaler, L. J. F., Harper, S. K., and Daniel, J. W. (2019). *Mathematical Interest Theory* (Third Edition), The Mathematical Association of America.
5. Chan, W. S., and Tse, Y. K. (2018). *Financial Mathematics for Actuaries* (Second Edition), World Scientific Publishing Company.

SIQ3001 ACTUARIAL MATHEMATICS I

Survival distributions: lifetime probability functions, force of mortality, moments and variance, parametric survival models, percentiles, recursions, fractional ages, select and ultimate life tables.

Life Insurances: continuous type life insurances, discrete type life insurances, probabilities, percentiles, recursive formula, m-thly payments, varying insurance.

Life Annuities: continuous type life annuities, discrete type life annuities, expectation and variance, probabilities, percentiles, recursive formulas, m-thly payments, varying annuities.

Premiums: expectation and variance of loss random variable, fully continuous and discrete premiums, semicontinuous premiums, m-thly premiums, gross premiums, probabilities, percentiles.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Bowers, N., Gerber, H., Hickman, J., Jones, D., Nesbitt, C. (1997). *Actuarial mathematics*, 2nd ed., Society of Actuaries.
2. Dickson, D. C., Hardy, M. R., & Waters, H. R. (2020). *Actuarial mathematics for life contingent risks* (3rd edition). Cambridge University Press.
3. Cunningham, R. J. (2011). *Models for quantifying risk*. Actex Publications.
4. Promislow, S. D. (2011). *Fundamentals of actuarial mathematics*. John Wiley & Sons.

SIQ3002 PORTFOLIO THEORY AND ASSET MODELS

Utility theory: Features of utility functions, expected utility theorem, risk aversion.

Stochastic dominance: Absolute, first and second order stochastic dominance.

Measures of investment risk: Variance, semi-variance, probability of shortfall, value-at-risk, expected shortfall.
Portfolio theory: Mean-variance portfolio, diversification, efficient frontier, optimal portfolio selection, efficient portfolio identification.

Models of asset returns: Single-index models, fitting a single index model, multi-index models.

Asset Pricing Model: Capital Asset Pricing Model, Arbitrage Pricing Theory.

Efficient market hypothesis.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Francis, J. C., and Kim, D. (2013). *Modern Portfolio Theory: foundations, analysis, and new developments*. John Wiley & Sons.
2. Elton, E.J., Gruber, M.J., Brown, S.J., and Goetzmann, W.N. (2014). *Modern Portfolio Theory and Investment Analysis*, 9/E. John Wiley & Sons.
3. Bodie, Z., Kane, A., and Marcus, A. J. (2018). *Investments* 11/E. McGraw-Hill/Irwin
4. Joshi, M. S., & Paterson, J. M. (2013). *Introduction to Mathematical Portfolio Theory*. Cambridge University Press.
5. Bodie, Z., Merton, R.C., and Cleeton, D (2008). *Financial Economics*, 2/E. Prentice Hall.

SIQ3003 ACTUARIAL MATHEMATICS II

Reserves: fully continuous and discrete reserves, semicontinuous reserves, prospective and retrospective reserves, expense reserves, variance of loss, special formulas, recursive formulas.

Markov Chains: discrete and continuous Markov chains, Kolmogorov's forward equations, premiums and reserves using Markov chains, multiple-state models.

Multiple Decrement Models: discrete and continuous decrement models, probability functions, fractional ages, multiple and associated single decrement tables, uniform assumption.

Multiple Life Models: joint life, last survivor and contingent probabilities, moments and variance of multiple life models, multiple life insurances and annuities.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Bowers, N., Gerber, H., Hickman, J., Jones, D., Nesbitt, C. (1997). *Actuarial mathematics*, 2nd ed., Society of Actuaries.
2. Dickson, D. C., Hardy, M. R., & Waters, H. R. (2020). *Actuarial mathematics for life contingent risks* (3rd edition). Cambridge University Press.
3. Cunningham, R. J. (2011). *Models for quantifying risk*. Actex Publications.
4. Promislow, S. D. (2011). *Fundamentals of actuarial mathematics*. John Wiley & Sons.

SIQ3004 MATHEMATICS OF FINANCIAL DERIVATIVES

Introduction to derivatives: Call and put options, forwards, futures, put-call parity.

Binomial models: one-step model, arbitrage, upper and lower bounds of options prices, construction of multi-step binomial tree.

The Black-Scholes model: Pricing formula, options Greeks, trading strategies, volatility.

Hedging: Market making, delta hedging, Black-Scholes partial differential equation, delta-gamma-theta approximation.

Exotic options: Asian options, barrier options, compound options, gap options, all-or-nothing options, exchange options.

Brownian motion and Itô's lemma: Brownian motion, Itô's lemma, Sharpe ratio, martingale representation theorem,

Term structure of interest rate: Vasicek model, Cox-Ingersoll-Ross model, Black-Derman-Toy binomial tree.

Models for credit risk: Structural, reduced form and intensity based models, Merton model, valuing credit risky bonds.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. McDonald, R.L. (2013). *Derivatives markets*, (3rd ed), Pearson Education.
2. McDonald, R.L. (2009). *Fundamentals of Derivative Markets*, Pearson Education.
3. Hull, J.C. (2018). *Options, Futures and other Derivatives* (9th ed), Pearson.
4. Hull, J.C. (2014). *Fundamentals of Futures and Options Markets* (8th ed), Pearson.
5. Weishaus, A. (2012). *ASM Study Manual for Exam MFE/Exam 3F: Financial Economics* (8th ed), Society of Actuaries.

SIQ3005 LIFE INSURANCE AND TAKAFUL

Insurance products and unit-linked insurance; Group Life insurance; Operation of a Life Insurance company: underwriting, claims, marketing and distribution methods; Profit testing; Takaful insurance; Regulations: Insurance Act, taxation and role of Bank Negara in Insurance Industry.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Fisher, Omar Clark (2013). *A Takaful Primer: Basics of Islamic Insurance*. Thomson Reuters.
2. Archer, S., Karim, R. A. A., & Nienhaus, V. (Eds.). (2011). *Takaful Islamic Insurance: Concepts and Regulatory Issues* (Vol. 764). John Wiley & Sons.
3. Yusof, Mohd Fadzli (2006). *Mengenali Takaful*, IBS Buku Sdn Bhd.
4. Gonulal, S. O. (Ed.). (2012). *Takaful and Mutual Insurance: Alternative Approaches to Managing Risks*. World Bank Publications.
5. Muhammad Jamalul Alam (2015). *Life Assurance*. 1st Edition. The Malaysian Insurance Institute.
6. Azman Ismail (2015). *Takaful.* 1st Edition. The Malaysia Insurance Institute.

SIQ3006 RISK THEORY

Loss distributions: Claim frequency and claim severity distributions, creating new distributions, parameter estimation methods, goodness-of-fit tests, risk sharing arrangements.

Aggregate risk models: Individual risk models, collective risk models, reinsurance.

Run-off triangle: Chain ladder method, average cost per claims method, Bornheutter-Ferguson method.

Credibility theory: Bayesian credibility methods, credibility premium formula, empirical Bayes credibility theory.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Klugman, S. A., Panjer, H. H., & Willmot, G. E. (2019). *Loss models: from data to decisions* (5th Edition). John Wiley & Sons.
2. Cunningham, R. J. (2011). *Models for quantifying risk*. Actex Publications
3. Dickson, D. (2010). *Insurance Risk and Ruin*. Cambridge University Press
4. Tse, Y. K. (2009). *Nonlife actuarial models: theory, methods and evaluation*. Cambridge University Press.

SIQ3007 INDUSTRIAL TRAINING

Candidates are required to spend a minimum of 16 weeks working with selected companies in selected areas of industry.

Assessment:
Continuous Assessment: 100%

References:
Universiti Malaya Guidebook untuk Latihan Industri

SIQ3008 FOUNDATION OF ISLAMIC FINANCE

Introduction to Islamic finance and its practices; Riba, gharar and maisir; Musharkah, mudharabah and murabahah; Ijarah, salam and istisna'; Çomparison of Islamic and conventional financial systems; Islamic financial institutions and products, Islamic banking and takaful, Islamic investment instruments; Capital market in an Islamic framework, leasing, securitization and sukuk; Modeling Islamic financial products using mathematical software; Regulatory framework for Islamic financial institutions in Malaysia.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Taqi Usmani, M. (2004). *An introduction to Islamic finance*. Arham Shamsi.
2. El-Gamal, M. A. (2006). *Islamic finance: Law, economics, and practice*. Cambridge University Press.
3. Iqbal, Z., & Mirakhor, A. (2011). *An introduction to Islamic finance: theory and practice*. Vol. 687. John Wiley & Sons.
4. Mirakhor, A., & Krichene, N. (2014). *Introductory Mathematics and Statistics for Islamic Finance*. John Wiley & Sons.
5. Habib, S. F. (2018). *Fundamentals of Islamic Finance and Banking*. John Wiley & Sons.

SIQ3009 PENSION MATHEMATICS

Pension benefit: defined benefits, defined contributions

Valuation of pension plan: unit credit, entry age normal, individual level, frozen initial liability, aggregate

Ancillary benefits: disability pensions, survivor pensions, death benefits, temporary early-retirement pensions and severance benefits

Asset valuations: market value, smoothed market values, group annuity contracts and individual life insurance contracts.

Actuarial assumptions: the Service Table, secondary decrements, interest, inflation, and salary Increases.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:

1. Anderson, A. W. (2006). *Pension mathematics for actuaries*, (3rd Edition). Actex Publications.
2. Booth, P., Chadburn, R., Haberman, S., James, D., Khorasanee, Z., Plumb, R. (2005). *Modern Actuarial Theory and Practice*, (2nd Edition). CRC Press.
3. Aitken, W. H. (1996), *A Problem-Solving Approach to Pension Funding and Valuation*, (2nd Edition). Actex Publications.
4. Dickson, D. C., Hardy, M. R., & Waters, H. R. (2020). *Actuarial mathematics for life contingent risks*, (3rd Edtion). Cambridge University Press.
5. Micocci, M., Gregoriou, G. N., & Masala, G. B. (Eds.). (2010). *Pension Fund Risk Management: financial and actuarial modeling*. CRC Press.
6. Allen, E., Melone, J., Rasenbloom, J., & Mahoney D. (2017). *Retirement Plans: 401(k)s, IRAs, and Other Deferred Compensation Approaches*, (12th Edition). McGraw-Hill Education.

SIQ3010 SURVIVAL MODELS

Estimation of lifetime distributions: lifetime distributions, cohort studies, censoring, Kaplan-Meier estimates, Cox regression model and its estimation.

Markov models: Multi-state Markov models, Kolmogorov forward equations, estimation of the force of mortality, estimation of multi-state model transition intensities.

Binomial and Poisson models of mortality: Binomial model of mortality, uniform and constant force of mortality assumptions, maximum likelihood estimator for the rate of mortality, Poisson models.

Graduation and statistical tests: methods of graduating crude estimates, Chi-square test, standardised deviation test, sign test, grouping of sign test, serial correlations test.

Exposed to risk: Exact exposed to risk, approximate exposed to risk using census data.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Elandt-Johnson, R. C., & Johnson, N. L. (1999). *Survival models and data analysis*. John Wiley.
2. Benjamin, B., & Pollard, J. H. (1993). *The analysis of mortality and other actuarial statistics*. Institute and Faculty of Actuaries.
3. London, Dick (1998). *Survival Models and their Estimation*. ACTEX Publications.
4. Lawless, J. F. (2011). *Statistical models and methods for lifetime data*. John Wiley & Sons.
5. Macdonald, A. S., Richards, S. J., & Currie, I. D. (2018). *Modelling mortality with actuarial applications*. Cambridge University Press.

SIQ3011 BUSINESS FINANCE

This couse enables the students to understand and deepen their knowledge of business finance theories. In addition, it will enable them to understand various advance techniques related to risk and return capital structure, dividend policy, long-term financing instruments such as bonds and equities, risk management and mergers and acquisitions.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Berk, DeMarzo & Harford, (2019), *Fundamental of Corporate Finance*, 4th ed. Pearson.
2. Brealey, Myers & Marcus, (2018), *Fundamental of Corporate Finance*, 9tth ed. McGraw-Hill: New York.
3. Ross, Westerfield & Jaffe, (2016), *Corporate Finance*, 11th ed. McGraw-Hill.
4. Brealey & Myers, (2017), *Principle of Corporate Finance*, 12th ed. McGraw-Hill: New York.

SIQ3012 FINANCIAL AND BUSINESS MANAGEMENT

This course discusses the various financial tools employed to effectively manage a company's financial condition and strategic thinking in financial management. Other topics discussed are financial statement and analysis, time value of money, bonds and stocks, capital budgeting and its techniques and short-term working capital management and basic legal principles relevant to the work of actuary and practical implications.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Gitman, L.J. & Zutter C. J. (2015). *Principles of Managerial Finance*, 14th ed. Pearson.
2. Berk, J. and, DeMarzo, P. (2014). *Corporate Finance*, 3rd edition, Pearson.
3. Ross. S. A, et. al. (2007). *Financial Management Fundamentals in Malaysia*. McGraw Hill.
4. Gupta, C.B (2014). *Strategic Management*, 2nd Edition.

SIQ3013 STOCHASTIC MODELS

Introduction to probability theory, conditional probability and expectation.

Markov chains: Chapman–Kolmogorov equations random walk models, classification of states, limiting probabilities, mean time spent in transient states, branching processes and time reversible Markov chains.

Poisson process: exponential distribution, counting processes, distribution of inter-arrival time and waiting time, conditional distribution of the arrival time, nonhomogeneous Poisson process and compound Poisson process.

Continuous time Markov chains: birth-and-death process, transition probabilities and transition rates, limiting probabilities and time reversibility.

Brownian motion and stationary processes: Brownian motion, martingale, hitting time and maximum variable, maximum of Brownian motion with drift, geometric Brownian motion, white noise, Gaussian processes and stationary, weakly stationary Processes.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Ross, S. M. (2014). *Introduction to Probability Models* (11th Edition), Academic Press.
2. Durrett, R. (2016). *Essentials of Stochastic Processes* (3rd Edition), Springer.
3. Serfozo, R. (2009). *Basics of Applied Stochastic Processes*, Springer.

SIT1001 PROBABILITY AND STATISTICS I

Axioms of probability. Counting techniques. Conditional probability. Independent events. Bayes Theorem.

Discrete random variables and its mathematical expectation. Discrete distributions: uniform, hypergeometric, Bernoulli, binomial, geometric, negative binomial and Poisson.

Continuous random variables and its mathematical expectation. Continuous distributions: uniform, exponential, gamma, chi-square and normal.

Moment generating functions. Distributions of functions of one random variable. Independent random variables. Distributions of sum of independent random variables. Functions related to normal random variables. Central limit theorem. Approximation for discrete distributions. Limiting moment generating functions.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Hogg, R.V. & Tanis, E.A. (2015). *Probability & Statistics Inference*, 9th ed., Pearson.
2. Hogg, R.V., McKean, J.W. & Craig A.T. (2019). *Introduction to Mathematical Statistics*, 8th ed., Pearson.
3. Larson, H.J. (1982). *Introduction to Probability Theory & Statistical Inference*, 3rd ed., Wiley.

SIT1002 STATISTICAL PROGRAMMING

Introduction to the statistical programming software. Logical operations. Vector, matrices and arrays. Sequence, decision statement and loops. Writing functions. Data inputs. Data frames. Graphics. Random number generation. Applications to statistics.

Assessment:
Continuous Assessment: 70%
Final Examination: 30%

References:
1. Crawley, M. (2013). *The R Book* (2nd ed.). Chichester, UK: John Wiley & Sons.
2. Crawley, M. (2019). *Statistics: An Introduction using R* (2nd ed.). Chichester, UK: John Wiley & Sons.
3. Matloff, N. (2011). *The Art of R Programming: A Tour of Statistical Software Design*. San Francisco, CA: No Starch Press.

SIT1003 ANALYSIS OF DATA AND STATISTICAL REPORT WRITING

Descriptive statistics. Hypothesis testing, confidence interval and tests of independence. Regression and Correlation: continuous response data, simple and multiple linear model.

Statistical tests: Goodness of fit tests, ANOVA, Nonparametric test.

Statistical Report Writing.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Tibco Spotfire S-PLUS Guide to Statistics Volume 1, TIBCO Software Inc.
2. Mann, P. S. (2013). *Introductory Statistics*, John Wiley & Sons.
3. Peck, R., Short, T., & Olsen C (2020). *Introduction to Statistics and Data Analysis* 6th ed. Cengage Learning
4. Evans, J.R. & Olson, D.L. (2002). *Statistics, Data Analysis and Decision Modeling and Student CD-ROM* (2nd Edition). Prentice Hall.

SIT2001 PROBABILITY AND STATISTICS II

Distributions of two and more dimensional random variables. Correlation coefficient. Conditional distributions. Bivariate normal distribution. Transformation of two random variables. Distributions of order statistics.

Biased and unbiased estimators. Method of moments. Method of maximum likelihood. Confidence interval for: mean, proportion and variance of single population; difference between two means, difference between two proportions and ratio of variances.

Hypothesis testing for: mean, proportion and variance of single population; difference between two means, difference between two proportions and ratio of variances. Chi-square goodness-of-fit tests and contingency tables.

Power of a statistical test. Best critical region. Likelihood ratio test. Chebyshev's inequality. Convergence in probability and distribution. Asymptotic distribution of maximum likelihood estimator. Rao-Cramer's inequality.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Hogg, R.V., & Tanis, E.A. (2015). *Probability & Statistics Inference*, 9th ed., Pearson.
2. Hogg, R.V., McKean, J.W., & Craig, A.T. (2019). *Introduction to Mathematical Statistics*, 8th ed., Pearson.
3. Wackerly, D., Mendenhall, W., & Scheaffer, R.L. (2008). *Mathematical and Statistics with Applications,* 7th ed., Thomson.

SIT2007 FOUNDATIONS OF DATA SCIENCE

Introduction to data science; Differences between experimental and observational data; Characteristics of big data sets; Sources of biases in data sets; Introduction to industry-level, open source computing tools such as R; Data management; Graphical visualisation including spatial data; Analysis and interpretation of real data sets with varying degrees of complexity using appropriate statistical methods.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Irizarry, R. (2019). *Introduction to Data Science: Data Analysis and Prediction Algorithms with R*. Boca Raton, FL: CRC Press.
2. Crawley, M. (2019). *Statistics: An Introduction using R* (2nd ed.). Chichester, UK: John Wiley & Sons.
3. Matloff, N. (2011). *The Art of R Programming: A Tour of Statistical Software Design*. San Francisco, CA: No Starch Press.

SIT2008 FURTHER MATHEMATICAL STATISTICS

The exponential family; sufficient, complete and ancillary statistics; minimum variance unbiased estimators; Bayesian estimation; Delta method for asymptotic approximation; distributions of certain quadratic forms-one and two factors analysis of variance; probability measure space; law of large numbers; Borel-Cantelli lemma.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Hogg, R.V., & Craig, A.T. (2013). *Introduction to Mathematical Statistics* (7th ed.). New York: Wiley.
2. Hogg, R., Tanis, E., & Zimmerman, D. (2019). *Probability and Statistical Inference* (10th ed.). USA: Pearson Education.
3. Taylor, J.C. (1997). *An Introduction to Measure and Probability Theory*. Springer.

4. Casella, G., & Berger, R.L. (2002). *Statistical Inference* (2nd ed.). Pacific Grove, CA: Thompson Learning.

SIT2009 REGRESSION ANALYSIS

Simple linear regression: Estimation, hypothesis testing, analysis of variance, confidence intervals, correlation, residuals analysis, prediction. Model inadequacies, diagnostics, heterogeneity of variance, nonlinearity, distributional assumption, outliers, transformation. Selected topics from matrix theory and multivariate normal distribution. Multiple linear regressions: Estimated multiple linear regression. Hypothesis testing, ANOVA, Confidence Interval, Model selection criteria, Diagnostics for influential observations and multicollinearity. Introduction to logistic and Poisson regression.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Montgomery, D.C., Peck, E. A., & Vining, G.G. (2012). *Introduction to Linear Regression Analysis* (5th ed.). Hoboken, NJ: John Wiley.
2. Weisberg, S. (2014). *Applied Linear Regression* (4th ed.). John Wiley & Sons, Inc.
3. Dobson, A. J., & Barnett, A.G. (2018). *An Introduction to Generalized Linear Models* (4th ed.). Boca Raton, FL: Chapman and Hall/CRC.
4. Faraway, J. J. (2016). *Extending the Linear Model with R: Generalized Linear, Mixed effects and Nonparametric Regression Models* (2nd ed.). Boca Raton, FL: Chapman and Hall/CRC.
5. Fox, J. (2015). *Applied Regression Analysis and Generalized Linear Models* (3rd ed.). Thousand Oaks, CA: SAGE Publications.
6. Draper, N. R. and Smith, H. (1998). *Applied Regression Analysis* (3rd ed.). John Wiley & Sons, Inc.

SIT2010 STOCHASTIC PROCESSES

Definition and examples of stochastic processes: Gambler's ruin problem, Brownian motion and Poisson process. Introduction to simple random walk. Discrete time Markov Chains. Transition probability. Properties of class. Transience and recurrence properties. Absorbing probability. Stationary distribution and limiting probability. Markov chain simulations and applications.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Durrett, R. (2016). *Essentials of Stochastic Processes*, 3rd ed. Springer
2. Lefebvre, M. (2007) *Applied Stochastic Processes*. Springer.
3. Ross, S. M. (1996). *Stochastic Processes*. Wiley.
4. Ross, S. M. (2007) *Introduction to Probability Models*, 9th edition. Academic Press.
5. Jones, P. W., & Smith, P. (2001). *Stochastic Processes: An Introduction*. Arnold Texts in Statistics.

SIT2011 STATISTICS AND COMMUNITY

This course exposes students to some aspects of statistics in community. The main aim is to highlight the role of official statistics in society. The topics chosen for this course come from a variety of different areas, for example, statisticians and their work, statistics and technology, and statistics and society. Students will work in groups on projects related to the topics discussed in lectures. Students will use elements of statistics in the planning a community project including designing questionnaire, collecting/managing/analyzing data and reporting the findings. Each group is required to identify and plan activities for a community partnership that will not only help them to enhance their understanding or gain a different perspective of their project but will also be beneficial to the community partner. Each student will be required to record a reflection of their experiences before, during and after the field work at the community partner and to submit their record with the group project report at the end of the semester. Students are also required to do a group presentation based on the project.

Assessment:
Continuous Assessment: 100%

References:
1. Kementerian Pendidikan Tinggi, Jabatan Pendidikan Tinggi (2019) *Chapter 1: Sulam as Community Engaged Pedagogy*.
2. Harris, D.F. (2014). *The Complete Guide to Writing Questionnaires: How to Get Better Information for Better Decisions*, I&M Press.
3. Beatty, P.C., Collins, D., & Kaye, L. (2019). *Advances in Questionaire Design, Development, Evaluation and Testing*, Wiley.
4. Laaribi, A. & Peters, L. (2019). *GIS and the 2020 Census: Modernizing Official Statistics*, Esri Press.
5. Patel, G.S. (2012). *Qualitative Research in Education: Concept, Methods, Data Analysis and Report Writing*, LAP LAMBERT Academic Publishing.

SIT3003 COMPUTER INTENSIVE METHODS IN STATISTICS

Computer generation of uniform and non-uniform random variables. Monte Carlo evaluation of integrals. Variance reduction techniques. Bootstrap and jackknife methods; Applications in confidence interval construction. Maximum likelihood estimation of model parameters via the Expectation-Maximization (EM) algorithm. The Markov Chain Monte Carlo method.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Dagpunar, J. S. (2007). *Simulation and Monte Carlo*. Chichester: John Wiley.
2. Gentle, J. E., Härdle, W. K. & Mori, Y. (2012). *Handbook of Computational Statistics: Concepts and Methods* (2nd ed.). Berlin: Springer-Verlag.
3. Rubinstein, R. Y. & Kroese, D. P. (2016). *Simulation and the Monte Carlo method* (Vol. 10). John Wiley & Sons.
4. Roberts, C.P. & Casella, G. (2005). *Monte Carlo Statistical Methods*. New York: Springer.
5. Ross, S. M. (2012). *Simulation* (3rd ed.). San Diego, CA: Academic Press.

SIT3004 APPLIED STOCHASTIC PROCESSES

Time reversible Markov chains. Poisson processes. Continuous-time Markov chains and birth and death processes. Brownian motion. Application to real-world phenomena, such as in finance.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Durrett, R. (2016). *Essentials of stochastic processes*, Second Edition, Springer.
2. Ross, S. M. (2003). *An introduction to probability models*, Eighth Edition, Academic press.
3. Kao, E. P. C. (1997). *An introduction to stochastic processes*. Duxbury Press.
4. Ross, S. M. (1996). *Stochastic processes*, Second Edition, John Wiley.

SIT3005 TIME SERIES AND FORECASTING METHODS

Introduction to time series and forecasting. Time series graphics. Simple forecasting methods. Transformation and adjustments. Fitted values, residuals and prediction intervals. Time series regression. Time series decomposition. Exponential smoothing. ARIMA models. ARCH and GARCH models.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Hyndman, R. J., & Athanasopoulos, G. (2018). *Forecasting: Principles and Practice*. Website: https://www.otexts.org/fpp.
2. Makridakis, S., Wheelwright, S.C., & Hyndman, R.J. (1998). *Forecasting Methods and Applications*.
3. Montgomery, D. C., Jennings, C. L. & Kulahci, M. (2008). *Introduction to Time Series Analysis and Forecasting*.
4. Brockwell, P.J. & Davis, R. A. (2002). *Introduction to Time Series Analysis and Forecasting*, 2nd edition. Springer.
5. Box, G.E.P., Jenkins, G.W., & Reinsel, G. (1994). *Time series analysis, forecasting and control*, 3rd edition. Prentice Hall.

SIT3008 INTRODUCTION TO SURVEY SAMPLING

This course focuses on statistical sampling methods with applications in the analysis of sample survey data. The sampling methods include simple random sampling, stratified random sampling, systematic sampling and cluster sampling. Estimation of population parameters for different sampling methods will be fully discussed. Special estimation techniques including ratio and regression estimations will be introduced in the context of simple random sampling and stratified random sampling. Areas of application may include social science and official statistics.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Scheaffer, R., Mendenhall, L. W., Ott, R. L. & Gerow, K. G. (2012). *Elementary Survey Sampling*, 7th ed, Cengage Learning.
2. Lohr, S. L. (2019). *Sampling: Design and Analysis*, 2nd ed, CRC Press.
3. Thompson, S. K. (2012). *Sampling*, 3th ed, Wiley.
4. Cochran, W. (1977). *Sampling Techniques*, 3rd ed, Wiley.

SIT3009 STATISTICAL PROCESS CONTROL

Methods and philosophy of statistical process control. Control charts for variables and attributes. Time-weighted control charts. Process capability analysis. Multivariate control charts. Acceptance sampling plans.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Montgomery, D. C. (2019). *Introduction to Statistical Quality Control*, 8th ed., Wiley.
2. Grant, E. L. & Leavenworth, R. S. (1999). *Statistical Quality Control*, 6th ed., McGraw Hill.
3. Kenett, R. S. and Zacks, S. (1998). *Modern Industrial Statistics: Design and control of quality and reliability*, Duxbury Press.

SIT3012 DESIGN AND ANALYSIS OF EXPERIMENTS

Philosophy related to statistical designed experiments. Completely randomized one-factor design. Randomized block designs. Latin squares. Incomplete block designs. Factorial designs. Confounding. Fractional factorial designs.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Montgomery, D.C. (2017). *Design and Analysis of Experiments*. Ninth Edition, Wiley.
2. Box, G.E.P., Hunter, J.S. and Hunter, W.G. (2005). *Statistics for Experimenters: Design, Innovation, and Discovery*, Second Edition, Wiley-Interscience.
3. Tabachnick, B.G. and Fidell, L.S. (2007). *Experimental Designs Using ANOVA*, Duxbury.
4. Myers, R.H. (1990). *Classical and Modern Regression Analysis with Applications*. Second Edition, Duxbury.

SIT3013 ANALYSIS OF FAILURE AND SURVIVAL DATA

Survival distributions, hazard models. Reliability of systems, stochastic models. Censoring and life-tables. The product-limit estimator. Parametric survival models under censoring. Cox proportional hazards model and other models with covariates.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Smith, D.J. (2011). *Reliability Maintainability and Risk, Practical Methods for Engineers*, 8th Ed., Elsevier Ltd.
2. Moore, D.F. (2016). *Applied Survival Analysis using R*. Springer.
3. Lee, E.T. (2013). *Statistical methods for survival data analysis*, John & Wiley
4. Collet, D. (2015). *Modelling survival data in medical research*. Chapman & Hall.
5. Karim, M.R., & Islam, M.A. (2019). *Reliability and Survival Analysis*. Springer Singapore.

SIT3015 INTRODUCTION TO MULTIVARIATE ANALYSIS

Matrix algebra and random vectors. Multivariate normal distribution. Wishart distribution and Hotelling distribution. Multivariate linear regression, canonical correlation analysis. Dimensional reduction methods: principal component analysis, and linear discriminant analysis. Clustering methods for unsupervised learning. Application of linear discriminant analysis, classification and regression trees for supervised learning.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Johnson, R.A. & Wichern, D.W. (2015). *Applied Multivariate Statistical Analysis* (6th ed). India: Pearson.
2. Everitt, B. & Hothorn, T. (2011). *An Introduction to Applied Multivariate Analysis with R*. New York: Springer.
3. Anderson, T.W. (2003). *An Introduction to Multivariate Statistical Analysis* (3rd ed.). Hoboken, NJ: Wiley-Interscience.

SIT3016 GENERALIZED LINEAR MODELS

Introduction to generalized linear model based on the exponential family. For example, multiple linear regression for normal data, logistic regression for binary data, Poisson regression for counts, log linear for contingency table, and gamma regression for continuous non-normal data.

Study the theory of GLM including estimation and inference.

Introduction to fitting GLM in R.

Focus on the analysis of data: binary, count and continuous, model selection, model evaluation, interpretation, prediction and residual analysis.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Dobson, A.J. & Barnett, A.G. (2008). *An Introduction to Generalized Linear Models*. 3rd Ed., Chapman & Hall/CRC.
2. McCullagh P. & Nelder J.A. (1989). *Generalized Linear Models*. 2nd Ed., Chapman & Hall.
3. Myers R.H., Montgomery D.C., Vining G.G., Robinson T.J. (2010). *Generalized Linear Models: with Applications in Engineering and the Sciences*. 2nd Ed., John Wiley & Sons.
4. Dunn P. & Smyth G. (2018). *Generalized Linear Models with Examples in R*. Springer-Verlag.

SIT3017 STATISTICAL LEARNING AND DATA MINING

This course prepares students for applied work in data science by building on students' foundations of data science skills. Students will learn advanced methods in statistical learning and data mining, using appropriate computing tools such as R. The strengths of the diversity of approaches are illustrated through analyses of real world data sets covering commonly encountered data types.

Exploratory analyses: dimensional reduction methods such as principal components analysis and linear discriminant analysis. Feature selection.

Supervised learning: artificial neural networks, k-nearest neighbours, logistic regression, naïve-Bayes, classification and regression trees, or support vector machine. Ensemble methods: bagging, random forest, and boosting. Unsupervised learning: K-means and hierarchical clustering.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Flach, P. (2012). *Machine Learning: The Art and Science of Algorithms that Make Sense of Data*. Cambridge: Cambridge University Press.
2. Irizarry, R. (2019). *Introduction to Data Science: Data Analysis and Prediction Algorithms with R*. Boca Raton, FL: CRC Press.
3. Witten, I.H., Frank, E., Hall, M.A. & Pal, C.J. (2017). *Data Mining: Practical Machine Learning Tools and Techniques* (4th ed.), Cambridge, MA: Morgan Kaufmann.
4. Hand, D., Mannila, H. & Smyth, P. (2001). *Principles of Data Mining*. Cambridge, MA: MIT Press.

SIT3018 NON-PARAMETRIC STATISTICS

Introduction to hypothesis testing, sign test and signed rank test, Mann-Whittney test, Kruskal-Wallis test, runs test, contingency tables, median test, goodness of fit test, Spearman's rank test, Kolmogorov Smirnov test, permutation test, kernel density estimation, spline regression estimation.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Sprent, P. & Smeeton, N.C. (2007). *Applied Nonparametric Statistical Methods*, 4th Edition, Chapman & Hall/CRC.
2. Myles, H., Douglas, A. W., Eric, C. (2014). *Nonparametric Statistical Methods*, 3rd Edition, John Wiley & Sons.
3. Daniel, W. W. (1990). *Applied Nonparametric Statistics*, 2nd Edition, Boston: PWS-Kent Publishing Company.
4. Mayer, A. & Philip, L. H. Y. (2018). *A Parametric Approach to Nonparametric Statistics*, 1st Edition, Springer.

SIT3019 INTRODUCTION TO BAYESIAN STATISTICS

Bayes' Theorem. Bayesian framework and terminology. Bayesian inference. Prior formulation. Implementation via posterior sampling. Bayesian decision theory. Hierarchical models. Application to real-world problems.

Assessment:
Continuous Assessment: 40%
Final Examination: 60%

References:
1. Gelman, A., Carlin, J. B., Stern, H. S., Dunson, D. B., Vehtari, A., & Rubin, D. B. (2014). *Bayesian data analysis*. Chapman and Hall/CRC.
2. Hoff, P. D. (2009). *A first course in Bayesian statistical methods*. Springer.

3. Turkman, M. A. A., Paulino, C. D., & Müller, P. (2019). *Computational Bayesian statistics: an introduction* (Vol. 11). Cambridge University Press.
4. Lee, P. M. (1997). *Bayesian statistics: an introduction*. Oxford University Press.

SIT3020 PYTHON FOR DATA SCIENCE

Description: Introduction to Python programming; Control statement and program development; Python data structures, strings and files; Functions; Lists and Tuples; Dictionaries and sets; Array-oriented programming with NumPy; Pandas series and DataFrame; Data wrangling; Object-oriented programming; Python libraries for data analysis such as Jupyter Notebook, SciPy, mglearn and matplotlib.

Data science: Basic descriptive statistics; Simulation and static/dynamic visualisation; data mining tools such as principal component analysis and discriminant analysis.

Big Data and Cloud case study: Deep learning; convolutional and recurrent neural networks; Reinforcement learning; Network analysis.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Deitel, P.J. & Dietal, H. (2019). *Introduction to Python for Computer Science and Data Science: Learning to Program with AI, Big Data and the Cloud*. UK: Pearson Education.
2. Müller, A.C. & Guido, S. (2016). *Introduction to Machine Learning with Python: A Guide for Data Scientists*. Sebastopol, CA: O'Reilly Media.
3. Raschka, S. & Mirjalili, V. (2019). *Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow 2* (3rd ed.). Birmingham, UK: Packt Publishing.

SIT3021 INDUSTRIAL TRAINING

Candidates are required to spend a minimum of 16 weeks working with selected companies in selected areas of industry.

Assessment:
Continuous Assessment: 100%

References:
Universiti Malaya Guidebook untuk Latihan Industri

SIT3022 PROBABILITY THEORY

Probability measure and space, sigma field. Lebesgue integration. Random variables, measurability, independence. Distribution functions. Inequalities, characteristic functions. Various modes of convergence of sequences of random variables. Classical limit theorems. Examples of applications.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Billingsley, P. (1995). *Probability and Measure* (3rd ed.). New York: John Wiley.
2. Durrett, R. (2019). *Probability: Theory and Examples* (5th ed.). Cambridge: Cambridge University Press.
3. Karr, A. F. (1993). *Probability*. New York: Springer-Verlag.
4. Rosenthal, J.S. (2006). *A First Look at Rigourous Probability Theory* (2nd ed.). Singapore: World Scientific Publishing Company.

SIT3023 STATISTICAL LABORATORY

Use of functions and commands in statistical packages for exploratory data analysis, modelling and statistical inferences. Coding and programming using statistical software to solve statistical problems.

Assessment:
Continuous Assessment: 50%
Final Examination: 50%

References:
1. Crawley, M. (2019). *Statistics: An Introduction using R* (2nd ed.). Chichester, UK: John Wiley & Sons.
2. Matloff, N. (2011). *The Art of R Programming: A Tour of Statistical Software Design*. San Francisco, CA: No Starch Press.
3. Deitel, P.J. & Dietal, H. (2019). *Introduction to Python for Computer Science and Data Science: Learning to Program with AI, Big Data and the Cloud*. UK: Pearson Education.

SIT3024 STATISTICAL CONSULTANCY AND DATA ANALYSIS

Introduction to consultancy activities and consulting methods. Related problems and issues. Exposure to the use of primary and secondary data from various sources. Application of suitable statistical methods such as multivariate analysis, regression and time series in the analysis of real data. Producing report and presenting the findings that suit the needs of the client.

Assessment:
Continuous Assessment: 100%

References:
1. Boen, J.R. & Zahn, D.A. (1982). *The Human Side of Statistical Consulting*. Belmont, CA: Lifetime Learning Publications.
2. Hand, D.J. & Everitt, B.S. (1987). *The Statistical Consultant in Action*. Cambridge: Cambridge University Press.
3. Tufte, E.R. (2001). *The Visual Display of Quantitative Information.* (2nd ed.). Connecticut, USA: Graphics Press.
4. Wickham, H. & Grolemund, G. (2017). *R for Data Science: Import, Tidy, Transform, Visualize, and Model Data*. Sebastopol, CA: O'Reilly Media.

SIT3025 STATISTICAL SCIENCE PROJECT

Subject to supervising lecturer.

Assessment:
Continuous Assessment: 100%

References:
Refer to supervising lecturer.