SCHOOL OF COMPUTER SCIENCES

POSTGRADUATE STUDENT HANDBOOK

Master of Science (Computer Science)
Mixed Mode
MSc (CompSc)

Master of Science in Digital Transformation
Coursework Mode
MScDT

Master of Science (Data Science and Analytics)
Coursework Mode
MSc (DSA)

2022/2023

STUDENT'S PERSONAL INFORMATION

Full Name	
I.C. No. / Passport No.	
Address	
E-Mail Address	
Telephone No. (Residence)	
Mobile Phone No.	
School	School of Computer Sciences
Programme	* MSc (Computer Science) Mixed Mode * MSc in Digital Transformation Coursework Mode * MSc (Data Science and Analytics) Coursework Mode * Delete where applicable

VISION OF UNIVERSITI SAINS MALAYSIA

Transforming Higher Education for Sustainable Tomorrow

MISSION OF UNIVERSITI SAINS MALAYSIA

USM is a pioneering, transdisciplinary research-intensive university that empowers future talents and enables the bottom billions to transform their socio-economic well-being

VISION OF SCHOOL OF COMPUTER SCIENCES

Towards holistic and sustainability-inspired computing for a better tomorrow

MISSION OF SCHOOL OF COMPUTER SCIENCES

Providing holistic and sustainability-inspired computing in the quest for knowledge and excellence in education and research that nurtures individuals who can contribute effectively towards the transformation of the nation

CONTENTS

1.0 UNIVERSITY ACADEMIC CALENDAR

2022/2023 Academic Year

Monday, 17 October 2022 – Sunday, 15 October 2023

First Semester ***Monday, 17 October 2022 – Sunday, 26 February 2023 (19 Weeks)***		
Activity	**Date**	**Duration**
Teaching and Learning	Monday, 17 October 2022 – Sunday, 04 December 2022	7 weeks
Mid-Semester Break	Monday, 05 December 2022 – Sunday, 11 December 2022	1 week
Teaching and Learning	Monday, 12 December 2022 – Sunday, 29 January 2023	7 weeks
Revision Week	Monday, 30 January 2023 – Sunday, 05 February 2023	1 week
Examination	Monday, 06 February 2023 – Sunday, 26 February 2023	3 weeks
Inter-Semester Break ***Monday, 27 February 2023 – Sunday, 26 March 2023 (4 Weeks)***		
Second Semester ***Monday, 27 March 2023 – Sunday, 6 August 2023 (19 Weeks)***		
Activity	**Date**	**Duration**
Teaching and Learning	Monday, 27 March 2023 – Sunday, 14 May 2023	7 weeks
Mid-Semester Break	Monday, 15 May 2023 – Sunday, 21 May 2023	1 week
Teaching and Learning	Monday, 22 May 2023 – Sunday, 09 July 2023	7 weeks
Revision Week	Monday, 10 July 2023 – Sunday, 16 July 2023	1 week
Examination	Monday, 17 July 2022 – Sunday, 06 August 2023	3 weeks
LONG VACATION ***Monday, 07 August 2023 – Sunday, 15 October 2023 (10 Weeks)***		

2.0 SCHOOL OF COMPUTER SCIENCES

2.1 Introduction

The School of Computer Sciences was established officially on the 1st of March 1995 after functioning for a period of 10 years as the Division of Computer Science, an independent and autonomous unit within the then School of Mathematical and Computer Sciences. The period had witnessed various advances, developments and achievements of Computer Science pertaining to academic programmes, research and development, consultancy, community engagement and others. The School of Computer Sciences will continue its efforts to strengthen its curricula and at the same time explore research areas that contribute significantly to the development of the nation.

Postgraduate Studies in Computer Science at USM started when the Division of Computer Science was formed. However, it was then offered as a research programme. In 1987/1988, MSc (Artificial Intelligence) was offered as a mixed mode programme comprising one semester of courses by coursework, and the rest of the year was dedicated to a dissertation. In 1995/1996, Postgraduate Diploma in Information Systems was offered In 1996/1997, MSc (Computer Science) by coursework and MSc (Information Technology) by coursework were offered to replace the two existing programmmes. Both programmes became very popular especially MSc (IT) which was offered to non-Computer Science/IT degree holders. After five years of running both programmes, the academic year 2001/2002 witnessed a revised version of both programmes to accommodate to the ever-changing technology. In 2007/2008 another revision was made to see the birth of two new mixed mode programmes, Master of Science (Computer Science) and Master of Science (Information Technology Technopreneurship) to replace the two coursework mode programmes. In 2014, the school introduced a new programme which is the Master of Informatics (MInf) by coursework replacing Master of Science (Information Technology Technopreneurship). In 2017, the school introduced a new programme which is Master of Science (Data Science and Analytics) by coursework focusing mainly on the field of big data analytics. In 2018, a new curriculum for the Master of Science (Computer Science) mixed mode programme was introduced. Master of Science in Digital Transformation was introduced in 2022 to replace Master of Informatics programme.

2.2 Staffs

2.2.1 Principal Officers

DEKAN | *DEAN*

Profesor Dato' Dr. Bahari Belaton
Professor Dato' Dr. Bahari Belaton

TIMBALAN-TIMBALAN DEKAN | *DEPUTY DEANS*

Prof. Madya Dr. Nurul Hashimah Ahamed Hassain Malim
Assoc. Prof. Dr. Nurul Hashimah Ahamed Hassain Malim
(Akademik, Kerjaya dan Antarabangsa)
(Academic, Career and International)

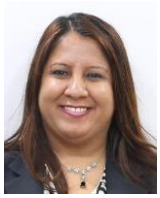
Prof.Madya Dr. Cheah Yu-N
Assoc. Prof. Dr. Cheah Yu-N
(Penyelidikan, Inovasi dan Libatsama Industri-Komuniti)
(Research, Innovation and Industry-Community Engagement)

PENGURUS-PENGURUS PROGRAM | *PROGRAMME MANAGERS*

Ts. Dr. Chew XinYing
Ts. Dr. Chew XinYing
(Sains Komputer)
(Computer Science)

Dr. Ahmad Sufril Azlan Mohamed
Dr. Ahmad Sufril Azlan Mohamed
(Latihan Industri, Aktiviti Pelajar dan Libatsama Komuniti
(Industrial Training, Student Activities and Community Engagement)

Prof. Madya Dr. Wong Li Pei
Assoc. Prof. Dr. Wong Li Pei
(Siswazah)
(Postgraduate)



Prof. Madya Dr. Manmeet Kaur Mahinderjit Singh
Assoc. Prof. Dr. Manmeet Kaur Mahinderjit Singh
(Ekosistem Penyelidikan, Pembangunan dan Inovasi)
(Research Ecosystem, Development and Innovation)

PENOLONG PENDAFTAR KANAN
SENIOR ASSISTANT REGISTRAR

Puan Mahfuzah Othman

PENOLONG PENDAFTAR
ASSISTANT REGISTRAR

Puan Zuhaida Ariffin

2.2.2 Staffs' Information

Professors

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Associate Professors

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Lecturers

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Honorary Professor

Name/Qualifications	Research Cluster: Specialisations	E-Mail/ Room No./Ext.
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Honorary Associate Professor

Name/Qualifications	Research Cluster: Specialisations	E-Mail/ Room No./Ext.
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Invited Lecturers

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Lokman Mohd Fadzil BSc,**WISCONSIN-MILWAUKEE** MSc, **USM** PhD, **UNIKL**	**National Advanced IPv6 Centre (NAV6):** • Manufacturing Intelligence and Optimization • Industrial Revolution 4.0 • Factory of The Future • Manufacturing Security	lokman.mohd.fadzil@usm.my 602E 4632
Mohammed F. R. Anbar BSE, **AL-AZHAR UNIV. – GAZA** MSc, **UUM** PhD, **USM**	**National Advanced IPv6 Centre (NAV6):** • Web & Android Applications • Internet Security • Internet of Things	anbar@usm.my 602D 4633

Name/Qualification	Institute/Centre: Specialisation	E-Mail/ Room No./Ext.
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Shankar Karupayyah BCompSc(Hons.), **USM** MSc., **KING MONGKUT'S UNIV. OF TECH. NORTH BANGKOK** PhD, **TU DARMSTADT**	**National Advanced IPv6 Centre (NAV6):** • Cyber Security • Malware and Botnets • Distributed Networks	kshankar@usm.my 602E 4632
Associate Prof. Dr. Asrulnizam Abd. Manaf BEng, M.Eng (**Toyohashi Univ. of Technology**) DEng, **Keio**	**CEDEC** : • Analog integrated Circuitry • MEMS • Lab on PCB • Printed Stretchable Electronics • IoT Devices	eeasrulnizam@usm.my 5610

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Assistant Information Technology Officer	
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2.3 Who's Who – CS Postgraduate Studies

2.3.1 Postgraduate Programme Coordinators

- Master of Science (Computer Science)
  - Assoc. Prof. Dr. Manmeet Kaur Mahinderjit Singh

- Master of Science in Digital Transformation
  - Assoc. Prof. Dr. Wong Li Pei

- Master of Science (Data Science and Analytics)
  - Dr. Ahmad Sufril Azlan Mohamed

2.3.2 Academic Advisory Panel

- Master of Science (Computer Science)
  - Prof. Dr. Putra Sumari
  - Dr. Mohd Adib Haji Omar

- Master of Science in Digital Transformation
  - Ts. Dr. Mohd Heikal Husin
  - Assoc. Prof. Dr. Cheah Yu-N

- Master of Science (Data Science and Analytics)
  - Assoc. Prof. Dr. Umi Kalsom Yusof
  - Assoc. Prof. Dr. Chan Huah Yong

2.3.3 Assistant Registrar

- Puan Zuhaida Ariffin

2.3.4 Administrative Assistant

- Puan Nur Syazwani Mohd Shariff

3.0 DETAIL OF THE PROGRAMMES

3.1 Master of Science (Computer Science) [MSc (CompSc)]

3.1.1 Introduction and Programme Educational Objective

This programme was first introduced as a coursework programme in 1996 to replace a mixed mode programme, MSc. (Artificial Intelligence) which was first offered in 1987. The curriculum was appropriately revised in 2001 and subsequently in 2007 academic year, resulting in a mixed mode programme which is the current mode of the programme. In 2018, a revised curriculum was introduced.

The goal of this programme is to produce computing practioners with advanced knowledge and research skills in Computer Science. Therefore, the programme educational objective of this programme is to produce computing practitioners who:

[PEO1] are competent with a firm grounding in Computer Science to foster research and development of new knowledge in the field.

[PEO2] have leadership skills, and are able to communicate as well as interact effectively with diverse stakeholders.

[PEO3] have positive attitudes, lifelong learning capabilities and entrepreneurial mind-set for successful career.

[PEO4] uphold and defend ethical and professional practices in maintaining self and professional integrity.

3.1.2 Programme Learning Outcomes

At the end of this programme, the students will be able to:

PLO1	C1 - Knowledge & Understanding	integrate advanced knowledge related to current research issues in Computer Science;
PLO2	C3A - Practical Skills	evaluate computing solutions and tools in terms of their usability, efficiency and effectiveness;
PLO3	C2 - Cognitive Skills	recommend innovative solutions and ideas that is at the forefront of developments in Computer Science;
PLO4	C3C - Communication Skills	communicate effectively within a group and with diverse audience by publishing and presenting technical materials in Computer Science;
PLO5	C3B - Interpersonal Skills	work together and interact effectively with different people in learning and working communities and other groups and networks.
PLO6	C5 - Ethics & Professionalism	uphold professional and ethical practices in conducting research and delivering services related to the field of Computer Science;
PLO7	C4A - Personal Skills	exhibit capabilities to extend knowledge through life-long learning related to Computer Science;
PLO8	C4B - Entrepreneurship Skill	exhibit entrepreneurial mind-set related to Computer Science;
PLO9	C3F - Leadership, Autonomy & Responsibility	demonstrate leadership, autonomy and responsibility in delivering services related to Computer Science;
PLO10	C3D - Digital Skill	competently use and adapt a wide range of suitable digital technologies and appropriate software to enhance computing practices; and
PLO11	C3E - Numeracy Skill	utilise numerical skills to acquire, interpret and extend knowledge in Computer Science.

The following table provides the matrix for programme outcomes of this programme.

No.	Course Code/Unit	Course Title	Programme Outcomes										
			Knowledge & Understanding	Practical Skill	Cognitive Skill	Communication Skill	Interpersonal Skill	Ethics & Professionalism	Personal Skill	Entrepreneurship Skill	Leadership, Autonomy & Responsibility	Digital Skill	Numeracy Skill
CORE COURSES													
1.	CCS591/4	Research and Empirical Methods in Computer Science				✓	✓	✓	✓	✓	✓	✓	✓
2.	CCS592/4	Advanced Algorithms and Complexity	✓	✓	✓								✓
3.	CCS599/20	Dissertation			✓	✓		✓	✓	✓	✓	✓	
ELECTIVE COURSES													
4.	CDS503/4	Machine Learning	✓	✓	✓								✓
5.	CDS505/4	Data Visualisation and Visual Analytics	✓	✓					✓			✓	
6.	CDS521/4	Multimodal Information Retrieval	✓	✓					✓				
7.	CDS522/4	Text and Speech Analytics	✓		✓				✓				
8.	CDS523/4	Forensic Analytics and Digital Investigations	✓	✓	✓			✓					
9.	CCS516/4	Computational Intelligence	✓	✓	✓		✓						
10.	CCS525/4	Advanced Cloud Computing Platform	✓	✓	✓							✓	
11.	CCS526/4	Mobile and Wireless Communication	✓	✓									✓
12.	CCS527/4	Internet of Things	✓		✓							✓	
13.	CCS528/4	Information Security and Cryptography	✓	✓									✓

3.1.3 Programme Structure

This mixed mode programme requires a minimum duration of one (1) year and a maximum of two (2) years for full-time study or a minimum duration of two (2) years and a maximum of four (4) years for part-time study. It consists of two distinct components; a taught component and a research component resulting in a dissertation.

Two focus areas are offered:

- Data and Knowledge Engineering
- Enabling Technologies and Infrastructures

(i) **Core Courses (Taught courses): 8 units (Code: T)**

(a) CCS591/4 – Research and Empirical Methods in Computer Science
(b) CCS592/4 – Advanced Algorithms and Complexity

(ii) **Elective Courses: 12 units (Code: E)**

Choose three (3) elective courses with at least two (2) courses from a chosen focus area. The following table presents the list of elective courses under the two focus areas.

Data and Knowledge Engineering	
(a)	CCS516/4 – Computational Intelligence
(b)	CDS503/4 – Machine Learning +
(c)	CDS505/4 – Data Visualization and Visual Analytics +
(d)	CDS521/4 – Multimodal Information Retrieval +
(e)	CDS522/4 – Text and Speech Analytics +
Enabling Technologies and Infrastructures	
(f)	CCS525/4 – Advanced Cloud Computing Platform
(g)	CCS526/4 – Wireless and Mobile Communications
(h)	CCS527/4 – Internet of Things
(i)	CCS528/4 – Information Security and Cryptography
(j)	CDS523/4 – Forensic Analytics and Digital Investigations +

+ Courses offered under MSc (Data Science and Analytics).

(iii) **Dissertation (Core Course): 20 units (Code: T)**

CCS599/20 – Dissertation

The course aims to enhance students' knowledge and skills in planning and implementation of a research project in the field of computer science. Students can choose research topics in related areas in computer science but they are encouraged to choose research topic in their respective focus area, and then proceed to conduct extensive review of literature pertaining to the topic and eventually carry out the research under the supervision of a lecturer. At the end

of the course, students are required to produce a satisfactory dissertation in order to fulfill their degree requirements.

At the end of this course, the students will be able to:

- Perform computer science research project using a suitable methodology.
- Defend orally the research progress /outcomes convincingly.
- Perform the research tasks and processes in an ethical manner.
- Perform literature review relevant to domain of interest independently.
- Perform the research with proper planning to meet research milestone.
- Display autonomy and responsibility in delivering research project.
- Investigate the research problem and able to solve them.

Students need to plan early and consult prospective supervisors for a suitable research topic/title at the beginning of the pre-requisite course CCS591. CCS591 and CSS599 Dissertation must be taken in two consecutive semesters (CCS591 followed by CCS599). Students are strongly encouraged to choose a research topic from their chosen focus area. The research areas offered within the two focus areas are listed in the table below.

Focus Area	Research Areas
Data and Knowledge Engineering	COM11 – Enterprise Computing COM12 – Software Engineering COM13 – Social and Sustainable Computing COM14 – Multimedia Computing COM21 – Computational Intelligence COM22 – Computer Vision and Image Processing COM23 – Visual Computing COM24 – Language and Knowledge Engineering
Enabling Technologies and Infrastructures	COM31 – High Performance Computing COM32 – Networks COM33 – Information Security

Students may commence their dissertation during the Inter-Semester Break and complete the course at the end of the Long Vacation Session OR during the Long Vacation Session and complete the course at the end of Semester I. The duration for this course is approximately 30 weeks [including the evaluation process and submission of the final hardbound copy of the dissertation]. The following table presents duration and sessions involved in the course.

Activity		
Start	Inter-Semester Break	Long Vacation Session
Registration (Web-Based)	Semester II (February)	Semester I (September)
Duration	4 weeks (Inter-Semester Break) + 19 weeks (Semester II) + 7 weeks (Long Vacation)	10 weeks (Long Vacation) + 20 weeks (Semester I including 1st Week of the Inter-Semester Break)
Completion	7th Week of the Long Vacation Session	1st Week of the Inter-Semester Break

Students are expected to meet their supervisors as often as possible to discuss their research work and record their meetings in a logbook both during the pre-requisite course CCS591 and throughout CCS599.

Students are required to complete various activities/assessments by some specific deadlines. A monitoring process will be implemented during the dissertation for the benefit of the students. The activities are as follows.

CCCS591 (Pre-requisite Course) (All as part of CCS591 coursework)

Activity/Evaluation	Week of the Semester*
Confirmation of a Research Topic - Students need to identify a supervisor to work with and propose a research topic which is to be agreed upon by the supervisor. A proposal form must be filled by the student and signed by the supervisor.	5th
Submission of the Research Proposal - Chapter 1: Introduction, and Chapter 2: Literature Review	11th
Submission of the Extended Research Proposal – Refined Chapters 1 and 2, and Chapter 3: Research Methodology	17th
Poster Presentation	19th

CCS599 - Dissertation

Activity	Actual Week	Week of the Semester/Break*	
Start	1th	1st (Inter -semester Break)	1st (Long Vacation Session)
Submission of the Mid-Term Report - Refined Chapters 1 to 3 (From CCS591), and Chapter 4: Proposed Work (Three (3) copies, red cover)	9th	5th (Semester II - February)	9th (Long Vacation Session)
Presentation of the Mid-Term Report in a Seminar +	11th	7th (Semester II)	1st (Semester I - September)
Submission of the Draft of the Dissertation to be Checked by the Respective Supervisor – Refined Chapters 1 to 4, Chapter 5: Evaluation, and Chapter 6: Conclusion	21th	17th (Semester II)	11th (Semester I)
Submission of the Dissertation (Five (5) copies, red cover)	23rd	19th (Semester II)	13th (Semester I)
Viva Voce	26th	3rd (Long Vacation Session)	16th (Semester I)
Submission of Corrected Dissertation (Two (2) copies)	28th	5th (Long Vacation Session)	18th (Semester I)
Submission of Final Corrected Dissertation (Hardbound, three (3) copies, red cover). Students must also return the logbook.	30th	7th (Long Vacation Session)	1st (Inter -semester Break)

* These are tentative dates. The actual dates will be posted via the e-Learning portal

\+ Students who could not produce a feasible piece of work after the evaluation of the mid-term report will be advised to drop CCS599.

Detailed guidelines of the course will be uploaded to the e-learning portal.

A panel of examiners will be formed, and the main objective of this panel is to ensure that the research has achieved a certain standard. The dissertation will be evaluated by two examiners. Students are expected to produce an original piece of work that enhances existing work and contributes to the body of knowledge. Students are also required to use the standard format for the dissertation.

3.1.4 Study Schemes

The period of candidature for a full-time programme is between one (1) to two (2) years, and for a part-time programme is between two (2) to four (4) years. The following tables show the various study schemes.

1 year (applicable to full-time study scheme only):

Course Type (Code) (Unit)	**Sep/Oct Intake:** 1 Year (2 semesters + 1 Inter-Semester Break + 1 Long Vacation Session)			
	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit
Core (T) (28 Units)	CCS591+	4	CCS599+ (3 + 12 + 5 units) [4 (Inter-Semester Break) + 19 (Semester II) + 7 (Long Vacation) = 30 weeks]	20
			CCS592	4
Elective (E) (12 Units)	Elective I	4		
	Elective II	4		
	Elective III	4		
Total: 40 Units		16		24

+ Must be taken in two consecutive semesters, CCS591 followed by CCS599

Course Type (Code) (Unit)	**Feb/Mar/Apr Intake:** 1 Year (2 semesters + 1 Long Vacation Session)			
	Year I Sem II (Feb/Mar/Apr)	Unit	Year I Sem I (Sep/Oct)	Unit
Core (T) (28 Unit)	CCS591+	4	CCS599+ (8 + 12 units) [10 (Long Vacation) + 20 (Semester I) = 30 weeks]	20
	CCS592	4		
Elective (E) (12 Units)	Elective I	4	Elective III	4
	Elective II	4		
Total: 40 Units		16		24

+ Must be taken in two consecutive semesters, CCS591 followed by CCS599

1.5 years (applicable to full-time study scheme only):

Course Type (Code) (Unit)	Sep/Oct Intake: 1.5 Years (3 Semesters + 1 Long Vacation Session)					
	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit
Core (T) (28 Unit)			CCS591+	4	CCS599+ (8 +12 units) [10 (Long Vacation) + 20 (Semester I) = 30 weeks]	20
			CCS592	4		
Elective (E) (12 Units)	Elective I	4	Elective III*	4		
	Elective II	4				
	Elective III*	4				
Total: 40 Units		8/12		8/12		20

+ *Must be taken in consecutive semesters - CCS591 followed by CCS599*
* *Alternative semester*

Course Type (Code) (Unit)	Feb/Mar/Apr Intake: 1.5 Years (3 Semesters + 1 Inter-Semester Break + 1 Long Vacation Session)					
	Year I Sem II (Feb/Mar/Apr)	Unit	Year I Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit
Core (T) (28 Unit)	CCS592	4	CCS591+	4	CCS599+ (3 + 12 + 5 units) [4 (Inter-Semester Break) + 19 (Semester II) + 7(Long Vacation) = 30 weeks]	20
Elective (E) (12 Units)	Elective I	4	Elective II*	4		
	Elective II*	4	Elective III	4		
Total: 40 Units		8/12		8/12		20

+ *Must be taken in consecutive semesters - CCS591 followed by CCS599*
* *Alternative semester*

2 years (applicable to full-time and part-time study schemes):

Course Type (Code) (Unit)	Sep/Oct Intake: 2 Years (4 Semesters + 1 inter-Semester Break + 1 Long Vacation Session)							
	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit
Core (T) (28 Units)			CCS592	4	CCS591+	4	CCS599+ (3 + 12 + 5 units) [4 (Inter-Semester Break) +19 (Semester II +7 (Long Vacation) = 30 weeks]	20
Elective (E) (12 Units)	Elective I	4	Elective III	4				
	Elective II	4						
Total: 40 Units		8		8		4		20

+ *Must be taken in two consecutive semesters, CCS591 followed by CCS599*

Course Type (Code) (Unit)	**Feb/Mar/Apr Intake:** 2 Years (4 Semesters + 1 Long Vacation Session)							
	Year I Sem II (Feb/Mar/Apr)	Unit	Year I Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit
Core (T) (28 Units)	CCS592	4			CCS591+	4	CCS599+ (8 + 12 units) [10 (Long Vacation) + 20 (Semester I) = 30 weeks]	20
Elective (E) (12 Units)	Elective I	4	Elective II	4				
			Elective III	4				
Total: 40 Units		8		8		4		20

+ *Must be taken in consecutive semesters, CCS591 followed by CCS599*

2.5 years (applicable to part-time study scheme only):

Course Type (Code) (Unit)	**Sep/Oct Intake:** 2.5 Years (5 Semesters + 1 Long Vacation Session)									
	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit	Year III Sem I (Sep/Oct)	Unit
Core (T) (28 Unit)			CCS592	4			CCS591+	4	CCS599+ (8+12 units) [10 (Long Vacation) + 20 (Semester I) = 30 weeks]	20
Elective (E) (12 Units)	Elective I	4								
	Elective II*	4	Elective II*	4	Elective III	4				
Total: 40 Units		4/8		4/8		4		4		20

+ *Must be taken in consecutive semesters, CCS591 followed by CCS599*
* *Alternative semester*

Course Type (Code) (Unit)	**Feb/Mar/Apr Intake:** 2.5 Years (5 Semesters +1 Inter-Semester Break 1 Long Vacation Session)									
	Year I Sem II (Feb/Mar/Apr)	Unit	Year I Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit	Year III Sem II (Feb/Mar/Apr)	Unit
Core (T) (28 Units)					CCS592	4	CCS591+	4	CCS599+ (3+12+5 units) [4(Inter-Semester Break) +19 (Semester II +7 (Long Vacation) = 30 weeks]	20
Elective (E) (12 Units)	Elective I	4	Elective II*	4						
	Elective II*	4	Elective III	4						
Total: 40 Units		4/8		4/8		4		4		20

* *Alternative semester*
+ *Must be taken in consecutive semesters - CCS591 followed by CCS599*

Course offering is given in the table below:

Semester I (Sep/Oct)	Semester II (Feb/Mar/Apr)
CCS516	CCS525
CCS526	CCS591*
CCS527	CCS592
CCS528	CCS599*
CCS591*	CDS503*
CCS599*	CDS521
CDS503*	CDS523
CDS505	
CDS522	

** Offered in both semesters*

3.1.5 Graduation Requirements

All students are required to choose a focus area (preferably upon entry) and pursue courses related to the chosen focus area for the elective courses (at least two courses should be chosen from the chosen focus area). Students are encouraged to prepare the dissertation in their chosen focus area. A student should accumulate a total of 40 credits as shown in the following table with a CGPA $\geq$ 3.00 for graduation.

Components	Credit
2 Core Courses	8
1 Dissertation (Core)	20*
3 Elective Courses	12
TOTAL	**40**

** Dissertation is graded as Pass/Fail*

3.2 Master of Science in Digital Transformation [MScDT]

3.2.1 Introduction and Programme Educational Objective

The goal of this programme is to produce workforce/human resources who are capable of using digital technology and applications to improve existing processes and workforce efficiency, enhance customer experience, and launch new products or business models. Therefore, the objectives of this programme are to produce computing practitioners who:

- have advanced knowledge in Digital Transformation who are capable of adopting best methodologies and techniques in providing innovative solutions across various sectors
- have leadership skills and are able to communicate as well as interact effectively with diverse stakeholders
- have positive attitudes, engaging in lifelong learning activities and having entrepreneurial mind-set for successful career
- uphold and defend ethical and professional practices in maintaining self and professional integrity

3.2.2 Programme Learning Outcomes are missing

At the end of this programme, the students will be able to:

PLO1	C1 - Knowledge & Understanding	integrate advanced knowledge related to current research issues in Computer Science;
PLO2	C3A - Practical Skills	evaluate computing solutions and tools in terms of their usability, efficiency and effectiveness;
PLO3	C2 - Cognitive Skills	recommend innovative solutions and ideas that is at the forefront of developments in Computer Science;
PLO4	C3C - Communication Skills	communicate effectively within a group and with diverse audience by publishing and presenting technical materials in Computer Science;
PLO5	C3B - Interpersonal Skills	work together and interact effectively with different people in learning and working communities and other groups and networks.
PLO6	C5 - Ethics & Professionalism	uphold professional and ethical practices in conducting research and delivering services related to the field of Computer Science;
PLO7	C4A - Personal Skills	exhibit capabilities to extend knowledge through life-long learning related to Computer Science;
PLO8	C4B - Entrepreneurship Skill	exhibit entrepreneurial mind-set related to Computer Science;
PLO9	C3F - Leadership, Autonomy & Responsibility	demonstrate leadership, autonomy and responsibility in delivering services related to Computer Science;
PLO10	C3D - Digital Skill	competently use and adapt a wide range of suitable digital technologies and appropriate software to enhance computing practices; and
PLO11	C3E - Numeracy Skill	utilise numerical skills to acquire, interpret and extend knowledge in Computer Science.

The following table provides the matrix for programme outcomes of this programme.

No.	Course Code/Unit	Course Title	Programme Outcomes									
			Knowledge & Understanding	Practical Skill	Cognitive Skill	Communication Skill	Interpersonal Skill	Ethics & Professionalism	Personal Skill	Entrepreneurship Skill	Leadership, Autonomy & Responsibility	Digital Skill	Numeracy Skill
CORE COURSES													
1.	CDT541/4	Industrial Digital Transformation	✓	✓	✓	✓							
2.	CDT542/4	Digital Entrepreneurship	✓	✓		✓				✓		✓	
3.	CDS501/4	Principles and Practices of Data Science and Analytics	✓	✓		✓							✓
4.	CDT543/4	Systematic & Lean Innovation Management	✓	✓	✓				✓				
5.	CDT544/4	Enterprise Architecture for Digital Business Transformation	✓	✓			✓					✓	
6.	CDS506 /4	Research Consultancy and Professional Skills			✓		✓	✓		✓	✓		✓
7.	CDT594 /4	Digital Transformation Project & Practicum			✓	✓	✓	✓	✓	✓	✓		
ELECTIVE COURSES													
8.	CDS511/4	Consumer Behavioural and Social Media Analytics*	✓	✓					✓			✓	
9.	CDT545/4	Cyber Security in Digital Transformation*	✓	✓	✓							✓	
10.	CDS504/4	Enabling Technologies & Infrastructures for Big Data*	✓	✓	✓								✓
11.	CDS512 /4	Business Intelligence & Decision Analytics	✓	✓	✓					✓			

3.2.3 PROGRAMME STRUCTURE

Credit requirements: 44 units

(i) Core Courses: 24 units (Code: T)

(a) CDT541/4 – Industrial Digital Transformation
(b) CDT542/4 – Digital Entrepreneurship
(c) CDT543/4 – Systematic and Lean Innovation Management
(d) CDT544/4 – Enterprise Architecture for Digital Business Transformation
(e) CDS501/4 – Principles and Practices of Data Science and Analytics +
(f) CDS506/4 – Research, Consultancy and Professional Skills +

(ii) Elective Courses: 8 Units (Code: E)

Choose any two (2) courses from the electives below:

Digital Infrastructure	
(a)	CDT545/4 – Cyber Security in Digital Transformation
(b)	CDS504/4 – Enabling Technologies and Infrastructures for Big Data +
Business and Organisation	
(a)	CDS511/4 – Consumer Behavioural and Social Media Analytics +
(b)	CDS512/4 – Business Intelligence and Decision Analytics +

\+ *Courses offered under MSc (Data Science and Analytics).*

(iii) Project (Core): 12 units (Code: T)

CDT594/12 – Digital Transformation Project and Practicum

This experiential work-based learning course designed to equip students to confidently help conceive, lead and execute digital transformation initiatives and develop new business models for existing organizations through the implementation of a consultancy project. Students are required to complete the practicum at their respective workplaces or their chosen/assigned organisations. Students work under the supervision of a lecturer and an industry supervisor. The students are required to solve a real-world problem or tap opportunities related to digital transformation during their practicum. The prerequisite of this course is CDS506 which must be taken in the preceding semester. The students are required to secure practicum placement together with project proposal during CDS506.

3.2.4 STUDY SCHEMES

The period of candidature for a full-time programme is between one-and-a-half (1.5) to three (3) years, and for a part-time programme is between two (2) to four (4) years.

The study schemes are as follows:

1.5 years (applicable to full-time study scheme only):

Course Type (Code) (Unit)	**Sep/Oct Intake:** 1.5 Years (3 Semesters)					
Core (T) (36 Units)	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit
	CDT541	4	CDT543	4	CDT594+	12
	CDT542	4	CDT544	4		
	CDS501	4	CDS506+	4		
Elective (E) (8 Units)	Elective I	4	Elective II	4		
Total: 44 Units		16		16		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDT594

Course Type (Code) (Unit)	**Feb/Mar/Apr Intake:** 1.5 Years (3 Semesters)					
Core (T) (36 Units)	Year I Sem II (Feb/Mar/Apr)	Unit	Year I Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit
	CDT543	4	CDT541	4	CDT594+	12
	CDT544	4	CDT542	4		
	CDS501	4	CDS506+	4		
Elective (E) (8 Units)	Elective I	4	Elective II	4		
Total: 44 Units		16		16		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDT594

2 years (applicable to full-time and part-time study schemes):

Course Type (Code) (Unit)	**Sep/Oct Intake:** 2 Years (4 Semesters)							
Core (T) (36 Units)	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit
	CDT541	4	CDT543	4	CDS506+	4	CDT594+	12
	CDT542	4	CDT544	4				
	CDS501	4						
Elective (E) (8 Units)			Elective I	4	Elective II	4		
Total: 44 Units		12		12		8		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDT594

Course Type (Code) (Unit)	**Feb/Mar/Apr Intake:** 2 Years (4 Semesters)							
Core (T) (36 Units)	Year I Sem II (Feb/Mar/Apr)	Unit	Year I Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit
	CDT543	4	CDT541	4	CDS506+	4	CDT594+	12
	CDT544	4	CDT542	4				
	CDS501	4						
Elective (E) (8 Units)			Elective I	4	Elective II	4		
Total: 44 Units		12		12		8		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDT594

2.5 years (applicable to full-time and part-time study schemes):

Course Type (Code) (Unit)	**Sep/Oct Intake:** 2.5 Years (5 Semesters)									
Core (T) (36 Units)	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar /Apr)	Unit	Year II Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar/ Apr)	Unit	Year III Sem I (Sep/Oct)	Unit
	CDT541	4	CDT543	4	CDS501	4	CDS506 +	4	CDT594 +	12
	CDT542	4	CDT544	4						
Elective (E) (8 Units)					Elective I	4	Elective II	4		
Total: 44 Units		8		8		8		8		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDT594

Course Type (Code) (Unit)	**Feb/Mar/Apr Intake:** 2.5 Years (5 Semesters)									
Core (T) (36 Units)	Year I Sem II (Feb/Mar /Apr)	Unit	Year I Sem I (Sep/Oct)	Unit	Year II Sem II (Feb/Mar /Apr)	Unit	Year II Sem I (Sep/Oct)	Unit	Year III Sem II (Feb/Mar/ Apr)	Unit
	CDT543	4	CDT541	4	CDS501	4	CDS506 +	4	CDT594 +	12
	CDT544	4	CDT542	4						
Elective (E) (8 Units)					Elective I	4	Elective II	4		
Total: 44 Units		8		8		8		8		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDT594

Course offering is given in the table below:

Semester I (Sep/Oct)	Semester II (Feb/Mar/Apr)
CDS501*	CDS501*
CDS506*	CDS504
CDS511	CDS506*
CDT541	CDS512
CDT542	CDT543
CDT545	CDT544
CDT594*	CDT594*

* Offered in both semesters

3.2.5 Graduation Requirements

A student should accumulate a total of 44 units as shown in the table below with a CGPA $\geq$ 3.00 for graduation.

Components	Units
6 Core Courses	24
1 Consultancy Project & Practicum (Core)	12
2 Elective Courses	8
TOTAL	**44**

3.3 Master of Science (Data Science and Analytics) [MSc (DSA)]

3.3.1 Introduction and Programme Educational Objective

This programme was introduced in the 2017/18 academic year to meet the ever-growing demand of professional practitioners in the field of Big Data Analytics.

The goal of this programme is to produce workforce/professional practioners in the field of Big Data Analytics who are capable of making right decisions based on the availability of comprehensive data. Therefore, the educational objective of this programme is to produce computing practitioners who:

[PEO1] have advanced knowledge in the field of Data science and Analytics capable of adopting best methodologies, tools and techniques to provide innovative solutions across various sectors.

[PEO2] have leadership skills, and are able to communicate as well as interact effectively with diverse stakeholders.

[PEO3] have positive attitudes, lifelong-learning capabilities and entrepreneurial mind-set for successful career.

[PEO4] uphold and defend ethical and professional practices in maintaining self and professional integrity.

3.3.2 Programme Learning Outcomes

At the end of this programme, the students will be able to:

PLO1	C1 - Knowledge & Understanding	integrate advanced knowledge related to current practices and research issues in Data Science and Analytics;
PLO2	C3A - Practical Skills	conduct standard approaches and apply practical skills, tools or investigative techniques which are at the forefront of Data Science and Analytics;
PLO3	C2 - Cognitive Skills	recommend innovative solutions and ideas that is at the forefront of developments in Data Science and Analytics;
PLO4	C3C - Communication Skills	communicate clearly the knowledge, skills, ideas, critique and rationale using appropriate methods to peers, experts and nonexperts;
PLO5	C3B - Interpersonal Skills	work together and interact effectively with different people in learning and working communities and other groups and networks;
PLO6	C5 - Ethics & Professionalism	uphold professional and ethical practices in conducting research and delivering services related to the field of Data Science and Analytics;
PLO7	C4A - Personal Skills	exhibit capabilities to extend knowledge through life-long learning related to Data Science and Analytics;
PLO8	C4B - Entrepreneurship Skill	exhibit entrepreneurial mind-set related to Data Science and Analytics;
PLO9	C3F - Leadership, Autonomy & Responsibility	demonstrate leadership, autonomy and responsibility in delivering services related to Data Science and Analytics;
PLO10	C3D - Digital Skill	competently use and adapt a wide range of suitable digital technologies and appropriate software to enhance professional practice in Data Science and Analytics; and
PLO11	C3E - Numeracy Skill	utilise numerical skills to acquire, interpret and extend knowledge in Data Science and Analytics.

The following table provides the matrix for programme learning outcomes of this programme.

No.	Course Code/Unit	Course Title	Programme Learning Outcomes										
			Knowledge & Understanding	Practical Skill	Cognitive Skill	Communication Skill	Interpersonal Skill	Ethics & Professionalism	Personal Skill	Entrepreneurship Skill	Leadership, Autonomy & Responsibility	Digital Skill	Numeracy Skill
CORE COURSES													
1.	CDS501/4	Principles and Practices of Data Science and Analytics	✓	✓		✓							✓
2.	CDS502/4	Big Data Storage and Management	✓	✓					✓			✓	
3.	CDS503/4	Machine Learning	✓	✓	✓								✓
4.	CDS504/4	Enabling Technologies and Infrastructures for Big Data	✓	✓	✓								
5.	CDS505/4	Data Visualisation and Visual Analytics	✓	✓					✓			✓	
6.	CDS506/4	Research, Consultancy and Professional Skills			✓		✓	✓		✓	✓		✓
7.	CDS590/8	Consultancy Project and Practicum			✓	✓	✓	✓	✓	✓	✓		
ELECTIVE COURSES													
8.	CDS511/4	Consumer Behavioural and Social Media Analytics	✓		✓	✓						✓	
9.	CDS512/4	Business Intelligence and Decision Analytics	✓	✓	✓					✓			
10.	CDS513/4	Predictive Business Analysis	✓	✓	✓					✓		✓	
11.	CDS521/4	Multimodal Information Retrieval	✓	✓					✓				
12.	CDS522/4	Text and Speech Analytics	✓		✓				✓				
13.	CDS523/4	Forensic Analytics and Digital Investigations	✓	✓	✓			✓					

3.3.3 Programme Structure

Credit requirements: 44 units

(i) Core Courses (Taught Courses): 24 units (Code: T)

(a) CDS501/4 – Principles and Practices of Data Science and Analytics
(b) CDS502/4 – Big Data Storage and Management
(c) CDS503/4 – Machine Learning
(d) CDS504/4 – Enabling Technologies and Infrastructures for Data Science
(e) CDS505/4 – Data Visualisation and Visual Analytics
(f) CDS506/4 – Research, Consultancy and Professional Skills

(ii) Elective Courses: 12 Units (Code: E)

Choose any **three** (**3**) courses from the table below:

Business Analytics	
(a)	CDS511/4 – Consumer Behavioural and Social Media Analytics
(b)	CDS512/4 – Business Intelligence and Decision Analytics
(c)	CDS513/4 – Predictive Business Analytics
Multimodal Analytics	
(d)	CDS521/4 – Multimodal Information Retrieval
(e)	CDS522/4 – Text and Speech Analytics
(f)	CDS523/4 – Forensic Analytics and Digital Investigations

(iii) Project (Core): 8 units (Code: T)

CDS590 – Consultancy Project and Practicum

This experiential work-based learning course prepares students to be a data scientist/analytics consultant by enhancing students' knowledge and skills in research, planning and implementation of a consultancy project in the field of data science/analytics, which can be applied to real life situation. Students are required to complete the practicum at their respective workplaces or their chosen/assigned organisations. Students work under the supervision of a lecturer and an industry supervisor. The students are required to solve a real-world problem or tap opportunities related to data science and analytics during their practicum.

The prerequisite of this course is CDS506 which must be taken in the preceding semester. The students are required to secure practicum placement together with project proposal during CDS506.

At the end of this course, the students will be able to:

- Devise a solution to a real-world problem using data science technique appropriately.

- Practice effective communication orally, the progress and achievement of the practicum.
- Perform work collaboratively in a multi-ethnic environment with superior, colleagues, staff and supervisors.
- Display professional behaviours such as trust, honest and non-violation of the predefined policy at the workplace.
- Display confidence and ability to overcome challenges in completing the project and practicum.
- Perform project tasks with proper planning to meet project milestone.
- Display high level of responsibility and accountability to lead the project independently.

3.3.4 Study Schemes

The programme is offered on full-time basis with a minimum period of candidature of three (3) semesters and a maximum of six (6) semesters. The study schemes are as follows:

1.5 year (applicable to full-time study scheme only):

Course Type (Code) (Unit)	**Sep/Oct Intake**: 1.5 Years (3 Semesters)					
	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit	Year II Sem I (Sep/Oct)	Unit
Core (T) (32 Unit)	CDS501	4	CDS504	4	CDS590+	8
	CDS502	4	CDS506+	4		
	CDS503	4				
	CDS505	4				
Elective (E) (12 Units)			Elective I	4	Elective III	4
			Elective II	4		
Total: 44 Units		16		16		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDS590

Course Type (Code) (Unit)	**Feb/Mar/Apr Intake**: 1.5 Years (3 Semesters)					
	Year I Sem II (Feb/Mar/Apr)	Unit	Year I Sem I (Sep/Oct)	Unit	Year I Sem II (Feb/Mar/Apr)	Unit
Core (T) (20 Unit)	CDS501	4	CDS502	4	CDS590+	8
	CDS503	4	CDS505	4		
	CDS504	4	CDS506 +	4		
Elective (E) (24 Units)	Elective I	4	Elective II	4	Elective III	4
Total: 44 Units		16		16		12

+ Must be taken in two consecutive semesters, CDS506 followed by CDS590

2 years (applicable to full-time study scheme only):

Course Type (Code) (Unit)	**September Intake**: 2 Years (4 Semesters)							
	Year I Semester I (September)	Unit	Year I Semester II (February)	Unit	Year II Semester I (September)	Unit	Year II Semester II (February)	Unit
Core (T) (20 Unit)	CDS501	4	CDS504	4	CDS505	4	CDS590+	8
	CDS502	4			CDS506+	4		
	CDS503	4						
Elective (E) (24 Units)			Elective I	4	Elective III*	4	Elective III*	4
			Elective II	4				
Total: 44 Units		12		12		8/12		8/12

+ Must be taken in two consecutive semesters, CDS506 followed by CDS590
** Alternative Semester*

Course Type (Code) (Unit)	**February Intake**: 2 Years (4 Semesters)							
	Year I Semester II (February)	Unit	Year I Semester I (September)	Unit	Year II Semester II (February)	Unit	Year II Semester I (September)	Unit
Core (T) (20 Unit)	CDS501	4	CDS502	4	CDS506+	4	CDS590+	8
	CDS503	4	CDS505	4				
	CDS504	4						
Elective (E) (24 Units)			Elective I	4	Elective II	4	Elective III*	4
					Elective III*	4		
Total: 44 Units		12		12		8/12		8/12

+ Must be taken in two consecutive semesters, CDS506 followed by CDS590
** Alternative Semester*

2.5 year (applicable to full-time study scheme only):

Course Type (Code) (Unit)	**September Intake**: 2.5 Years (5 Semesters)									
	Year I Semester I (Sep)	Unit	Year I Semester II (Feb)	Unit	Year II Semester I (Sep)	Unit	Year II Semester II (Feb)	Unit	Year III Semester I (Sep)	Unit
Core (T) (20 Unit)	CDS501	4	CDS504	4	CDS502	4	CDS506+	4	CDS590+	8
	CDS503	4			CDS505	4				
Elective (E) (24 Units)			Elective I	4			Elective II	4	Elective III*	4
							Elective III*	4		
Total: 44 Units		8		8		8		8/12		8/12

+ Must be taken in two consecutive semesters, CDS506 followed by CDS590
** Alternative Semester*

Course Type (Code) (Unit)	**February Intake:** 2.5 Years (5 Semesters)									
	Year I Semester II (Feb)	Unit	Year I Semester I (Sep)	Unit	Year II Semester II (Feb)	Unit	Year II Semester I (Sep)	Unit	Year III Semester II (Feb)	Unit
Core (T) (20 Unit)	CDS501	4	CDS502	4	CDS504	4	CDS506+	4	CDS590+	8
	CDS503	4	CDS505	4						
Elective (E) (24 Units)					Elective I	4	Elective II		Elective III*	4
							Elective III*	4		
Total: 44 Units		8		8		8		8/12		8/12

+ Must be taken in two consecutive semesters, CDS506 followed by CDS590
** Alternative Semester*

Course offering is given in the table below:

Semester I (September)	Semester II (February)
CDS501*	CDS501*
CDS502	CDS503*
CDS503*	CDS504
CDS505	CDS506
CDS506*	CDS512
CDS511	CDS513
CDS522	CDS521
CDS590	CDS523
	CDS590

** Offered in both semesters*

3.3.5 Graduation Requirements

A student should accumulate a total of 44 units as shown in the table below with a CGPA $\geq$ 3.00 for graduation.

Components	Units
6 Core Courses	24
1 Consultancy Project & Practicum (Core)	8
3 Elective Courses	12
TOTAL	**44**

4.0 RESEARCH CLUSTERS

Current research and development activities are organised under three research clusters:

4.1 Service Computing

Cluster Head: Dr. Nor Athiyah Abdullah
(athiyah@usm.my)

COM11 – Enterprise Computing

Research Fields:
01 Service Science and Innovation
02 Management of Information Systems (MIS)
03 Human Computer Interaction (HCI)
04 IT Operations and Management
05 Technopreneurship

COM12 – Software Engineering

Research Fields:
01 Service Systems Engineering (SSE)
02 Software Analysis and Design Patterns
03 Software Productivity and Quality
04 Value-Based Software Engineering
05 Sustainable and Evolutionary Software Systems

COM13 – Social and Sustainable Computing

Research Fields:
01 Social Informatics
02 Computer Ethics
03 Collaborative Computing
04 Information Evaluation
05 Usability Engineering

COM14 – Multimedia Computing

Research Fields:
01 Virtual Reality and Animation
02 Multimedia Retrieval, Processing and Analysis
03 Distributed Multimedia and Multimedia Communication
04 E-Learning
05 Multimedia Tools and Applications

4.2 Data to Knowledge

Cluster Head: Dr. Gan Keng Hoon
(khgan@usm.my)

COM21 – Computational Intelligence

Research Fields:
01 Intelligent System Techniques
02 Scheduling/Timetabling/Planning
03 Evolutionary Computing
04 Collective Intelligence
05 Brain Inspired Computing

COM22 – Computer Vision and Image Processing

Research Fields:
01 Image Analysis
02 Semantic Image and Video Knowledge Extraction
03 Image Retrieval
04 Multimodal Integration

COM23 – Visual Computing

Research Fields:
01 Data Visualisation
02 Information Visualisation
03 Knowledge Visualisation
04 Computer Graphics
05 Visual Analytics
06 Virtual Environment

COM24 – Language and Knowledge Engineering

Research Fields:
01 Natural Language Processing
02 Automated Translation
03 Speech Recognition
04 Speech Synthesis
05 Semantic Web Search
06 Text Summarisation
07 Health Informatics
08 Knowledge Management and Engineering
09 Data Mining

4.3 Enabling Technologies and Infrastructures

Cluster Head: Ts. Dr. Mohd Najwadi Yusoff
(najwadi@usm.my)

COM31 – High Performance Computing

Research Fields:
01 Distributed Systems
02 Parallel Tools and Applications
03 Cluster and Multicore Computing
04 Grid Computing
05 Peer-to-Peer Computing
06 Parallel Sequence Analysis Algorithms
07 Parallel Structure Prediction Algorithms
08 Concurrency Theory in Biology
09 Parallel Biological Data Mining

COM32 – Networks

Research Fields:
01 Embedded System
02 Wireless and Mobile Computing
03 Quality of Service
04 Network and Communication Protocols
05 Network Modeling
06 Wireless Sensor Networks

COM33 – Information Security

Research Fields:
01 Network Security
02 Malware
03 Cryptology
04 Steganography
05 Data Privacy and Preservation
06 Security Management
07 Digital Forensic

5.0 FACILITIES

There are three main types of computing laboratories for students, the Teaching Labs, Final Year Undergraduate Project labs and Postgraduate Research Labs. The School of Computer Sciences has its own LAN and servers for running internet and database services for the School.

5.1 Computer Lab Facilities for Teaching

The School offers five teaching labs, located on the 3rd floor. Each lab consists of an average of 45-60 personal computers (pc) and teaching aids such as the projector, screen and PA system. Each lab is equipped with integrated door access system and CCTV to manage access control and lab security.

There are nine technical staff who are responsible to operate the labs. The labs are open during office hours, semester breaks, and are open until 11:00 pm during the semester. The General Office for the lab is located on Level 3 (Room 305).

Specification and software for each computer for the teaching lab are as follows:

Labs	Location	Description/Software
Computer Lab 1	301	iMac Computer Model 17 inch - Intel Core 2 Duo 1.83 GHz - 2.5GB Ram - 18 Unit IMac Computer Model 21.5 Inch - 2.7GHz Intel Core i5 - 8GB Ram - Mac OS Sierra version 10.12.3 *All Dual boot Mac OS or Windows OS
Computer Lab 2	302	HP Prodesk 400 - Intel Core i5 6500 3.2Ghz - 8GB DDR4 Ram - 1TB Hardisk - OS: Windows 10 Enterprise 64Bit - Software: • Adobe CS6 Master Collection • Codeblocks • Bloodshed DEV C++ • JDK+, NetBeans IDE and J Creator LE • Microsoft Office 2016 • Microsoft SQL Server 2008 • Microsoft Visual Studio 2016 • Oracle 11g Client • Oracle Database 11g Express Edition • SAP 7.20 • SWI-Prolog • SQL Developer • MATLAB R2013a • Activestate Active python 2.7

Labs	Location	Description/Software
		• Win Prolog • Active Perl 5.8.8.8 Build 817
Computer Lab 3	303	Dell OptiPlex 790 - Intel Core i5 2400 3.1Ghz - 8GB DDR3 Ram - OS: Windows 10 Enterprise 64Bit - Software: • Microsoft Office Pro 2013 • Adobe Acrobat 9 Pro • Cisco Packet Tracer 6.2 Student • Dev C++ • Weka 3.6.13 • WinPcap 4.1.3 • Wireshark 1.12.1
Computer Lab 4	312	Dell OptiPlex 780 - Intel Core 2 Duo 2.93GHz - 8GB DDR3 Ram - OS: Windows 7 Enterprise 64bit - Software: • Microsoft Office 2010 • MatLab R2014a • Cisco Packet Tracer 6.0.1 • CodeBlocks • Scratch 2 • Blender • JCreator LE 5.00 • WinPcap 4.1.3 • Wireshark 1.10.2 • Win Prolog 4200
Computer Lab 5	313	HP Prodesk 400 - Intel Core i5 6500 3.2Ghz - 8GB DDR4 Ram - 1TB Hardisk - OS: Windows 10 Enterprise 64Bit - Software: • Adobe CS6 Master Collection • Codeblocks • Bloodshed DEV C++ • JDK+, NetBeans IDE and J Creator LE • Microsoft Office 2016 • Microsoft SQL Server 2008 • Microsoft Visual Studio 2016 • Oracle 11g Client • Oracle Database 11g Express Edition • SAP 7.20 • SWI-Prolog • SQL Developer • MATLAB R2013a • Activestate Active python 2.7 • Win Prolog • Active Perl 5.8.8.8 Build 817

The regulations on the lab usage are as follows:

- Students must scan their student/staff card to enter the labs using the door access system.
- Students are not allowed to eat, drink and bring in any food or drinks into the lab.
- Students can enter the lab according to the times and periods as allocated through course scheduling in each lab.
- Students must use the equipment properly and ensure that all documents, software and hardware are protected from virus attacks or infected by virus.
- Students are not allowed to bring in or take out any lab equipment (computers, printers, etc.) except with permission from the lab staff.
- Students must switch off the equipment used before leaving the lab.
- Students must dress properly conforming to the university's dress code when entering the lab.
- Students are not allowed to unplug any type of cables attached to the computer.
- Students must always keep the lab clean.
- Students are not allowed to install any kind of software without permission of the lecturers or technicians of the lab.

5.2 Network Facilities

Each computer laboratory has its own Virtual LAN which is networked over gigabit Ethernet link. Fibre optic cabling is employed throughout our building risers to uplink lab switches to the main network core routers. Multimode optical fibre is available in the majority of research labs and utilized only where distance or speed is required. The School Cisco routers are configured in such a way that they are able to receive and redistribute (route) multicast traffic to any School's network.

The School provide robust, reliable and secure LAN (Local Area Network) and a connection to the WAN (Wide Area Network) services to support all ICT requirements.

The network facilities in the School of Computer Sciences are each equipped with network switches which are connected to an internal Gigabit Ethernet School backbone. A group of Cisco Catalyst 6500 switches form the core of the network. The School is uplinked using redundant Gigabit connections to the USMNet.

The main campus network (USMNet) is connected to the Internet through a 1GB/s TM leased line and 2GB/s MyREN (Malaysian Research Network) leased line. MyREN Internet line also provides dedicated interconnection between local universities and non-local universities for research and academic purposes.

Wireless 802.11n access is available in the entire school building. The wireless network service is managed by the School's Technical Support. Access to wireless network is available to all staff, students and guests.

5.3 Data Centre

Our data centre servers are located at level 3 and they are connected directly through switched Gigabit Ethernet ports, supplying excellent bandwidth for network services such as file services, file hosting and digital multimedia content. There are more than 40 physical and virtual servers assigned for networking purposes, services, teaching/learning and research. The servers are also available for the final year project students to use as it will be an exposure for the students to get the real experience in project implementation with most high-end platforms and technologies.

5.4 Active Directory and Email Accounts

Each student of the school is automatically enrolled in the Active Directory (AD) account. This account provides services such as an e-mail account, cloud storage, and various communication and collaboration tools.

Each student is entitled to one email account with 50GB mailbox storage and 1TB cloud storage (Microsoft OneDrive).

AD account is used as single sign-on id for accessing the hundreds/thousands of applications and services supported by the University such as Web-based/LAN based Library Access, Wi-Fi access, Campus Online access, E-learning portal and Microsoft Azure for Teaching access.

5.5 Licensed Software

All free licensed software for registered students are provided by Microsoft Azure for Teaching. Students can download most of the latest software, operating systems (for personal computer, workstation, and/or server), developer tools, and databases. Follow these few steps for the activation of Microsoft Azure for Teaching:

Step 1: Log into the following URL:
https://portal.azure.com/#blade/Microsoft_Azure_Education/EducationMenuBlade/software using your USM identity account.

Step 2: If the list shows less than 30 software, then access the following URL https://azureforeducation.microsoft.com/devtools for activation. Tick all checkboxes and Accept Terms.

Step 3: Reload page in Step 1. Click on the software you like to download/use and view the key. Use the key during activation of the software. Some software may need you to login using your USM identity account.

5.6 Computer Labs Facilities for Postgraduate Research

There are three main research clusters and labs for postgraduate students as shown in the table below. The research labs are open 24 hours a day to students who have been given permission to use the labs and the list of the students will be posted on each lab. Each lab is supervised by security personnel who are supposed to patrol the designated area.

Research Cluster (Head)	Room Number
Service Computing (Dr. Nor Athiyah Abdullah)	404-1, 405-1 & 406-1
Data to Knowledge (Dr. Gan Keng Hoon)	401 & 402
Enabling Technologies and Infrastructures (Ts. Dr. Mohd Najwadi Yusoff)	402-1 & 404

All applications based on Intel processor with Windows operating systems can be loaded into the computers in the labs for research purposes and project work. Respective supervisors should be informed on installations and related activities involving facilities at the research labs.

5.7 Lecture Halls and Tutorial Rooms

Most lectures are conducted at DKG31 that is located at the ground floor of the Schools of Computer Sciences and Mathematical Sciences building (G31). The School of Computer Sciences shares the lecture hall mainly with the School of Mathematical Sciences. Other lectures or tutorials are conducted at dedicated lecture halls and tutorial rooms around the campus.

Some tutorials and lectures for smaller group of students are conducted at the following rooms in the G31 building:

- ELL (Room 045)
- Tutorial Room (Room 507)
- Teaching Lounge - SCL 2 (Room 211-1)
- Teaching Room - SCL 3 (Room 211-2)
- Auditorium (Room 211-3)

Students are not allowed to eat and drink in the lecture halls and the tutorial rooms. In addition, students must dress properly, conforming to the university's dress code when entering any lecture halls and tutorial rooms when attending their lectures or tutorials. The lecturers have the right to prohibit students who do not wear proper attire when attending their lectures or tutorials. Students should not use the facility provided in the rooms without the permission of the respective lecturer.

5.8 Postgraduate Student Lounge

Postgraduate Student Lounge is located at room 410 level 4 which is exclusively meant for postgraduate students. They can meet, socialise, study and hang out with fellow colleagues. This room provides a few facilities for students such as high tables, small tables, sofas and other amenities.

Please note the basic rules to use the room.

- Keep the room clean and tidy.
- Be courteous and respect others whilst using the room.
- Switch off the light when nobody is in the room.

6.0 GENERAL INFORMATION

6.1 Period of Candidature and Residential Requirements

Candidature period for Master of Science (Computer Science) Mixed Mode

Full-time Scheme		Part-time Scheme	
Minimum	**Maximum**	**Minimum**	**Maximum**
12 months	24 months	24 months	48 months

Candidature period for Master of Science in Digital Transformation Coursework Mode

Full-time Scheme		Part-time Scheme	
Minimum	**Maximum**	**Minimum**	**Maximum**
18 months	36 months	24 months	48 months

Candidature period for Master of Science (Data Science and Analytics) Coursework Mode

Full-time Scheme	
Minimum	**Maximum**
18 months	36 months

6.2 Registration

Briefings and course registration for new students will normally be conducted before commencement of the semester (September and February semesters). Please refer to Section 1.0 for the academic calendar for the respective semester dates.

Students need to register for courses before the start of a new semester. Registration of the courses must be done in consultation with the Advisory Panel (see Section 6.6.1). The Deputy Dean (Postgraduate) will handle exceptional cases like registering more or less than the maximum and minimum number of units allowed.

Student are **not allowed** to register more than two (2) courses that have been scheduled on the same day and time.

6.3 Re-Registration and Fees Payment

Candidates are required to re-register and pay their course fees every semester in order to maintain their status as registered postgraduate students of USM.

6.4 Examination and Evaluation

6.4.1 Examination

All courses taught in a semester will be evaluated in the same semester. The duration of the semester examinations for all 4-unit courses is 2 hours.

6.4.2 Barring from Examination

Students will be barred from sitting for the final examination if they do not fulfil the Course requirements, such as absence from lectures and tutorials of at least 70%, and have not completed/fulfilled the required components of coursework. Students will also be barred from sitting for the final examination if they have not settled the academic fees. An 'X' grade would be awarded for a course in which a student is barred. Students will not be allowed to repeat the course during the *Courses during the Long Vacation* (KSCP) period.

6.4.3 Assessment

The taught component of the course is assessed by 50-60% coursework and 40-50% terminal examination for MSc (CompSc); and 60% coursework and 40% examination for MScDT and MSc (DSA). The dissertation component for MSc (CompSc), consultancy project & practicum component for MScDT and MSc (DSA) are assessed by 100% coursework.

6.4.4 Grading System

Evaluation is based on the following alphabetic grades and the corresponding grade points.

Alphabetic Grades	Grade Points
A	4.00
A–	3.67
B+	3.33
B	3.00
B–	2.67
C+	2.33
C	2.00
C–	1.67
D+	1.33
D	1.00
D–	0.67
F	0.00

Dissertation for MSc (CompSc) is graded based on Pass/Fail.

6.4.5 Repeating Courses

(i) The passing grade for all coursework and mixed mode degree programmes is C+.
(ii) A student who obtained a grade 'B-' and below for a particular course is allowed to repeat a course to improve the CGPA for graduation purposes as long as the duration of his/her candidature is still active.
(iii) Students are allowed to repeat a course either during the regular semester (Semester I or II) or during the Long Vacation Session depending on his/her duration of candidature. For Long Vacation Session, students only re-sit the final examination and the coursework component will be taken from the best achievement from coursework component of previous attempt(s).

6.4.6 Postponement of Studies

A student is NOT allowed to postpone his/her studies during the first semester. Students are allowed to postpone their studies maximum of two (2) semesters throughout the entire duration of the candidature period. The application for postponement can be made online via student campus online.

6.4.7 Dropping of Courses

A student is allowed to drop courses within the first six weeks of the semester. However, a student must maintain a minimum of 8 units per semester for a full-time student during the first year of his/her studies. A student may choose to register any number of units /courses after satisfying the minimum period of candidature as follows:

- MSc (CompSc): 12 months for full-time student and 24 months for part-time student.
- MScDT: 18 months for full-time student and 24 months for part-time student.
- MSc (DSA): 18 months for full-time student.

In order to drop a course, the student must obtain the signature of the course lecturer first (supervisor in the case of dissertation before forwarding the request to the Deputy Dean (Postgraduate)).

6.4.8 Leave of Absence

Students are not allowed to be absent for more than 30% of class contact hours. If a student has to be away, please inform the course lecturer. If a student has to be away for more than three (3) weeks, the student is advised to postpone his/her studies for that semester. However, postponement is not allowed in the first semester of study.

6.5 Academic Integrity

"Integrity without knowledge is weak and useless. Knowledge without integrity is dangerous and weak" – Samuel Johnson

Being a student of the School of Computer Sciences requires a firm adherence to the basic values, integrity, purpose and meaning of a university education. The most essential values in academia are rooted on the principles of truth seeking in knowledge and honesty with regards to the intellectual property of oneself and of others. Thus, students must bear the responsibility of maintaining these principles in all work done in their academic endeavour.

Academic dishonesty violates the fundamental purpose of preserving and maintaining the integrity of university education and will not be tolerated. The following, although not exhaustive, are examples of practices or actions that are considered dishonest acts in academic pursuit.

6.5.1 Cheating

Cheating is the unauthorised use of information or other aids in any academic exercise. There are numerous *"infamous"* ways and methods of cheating including:

- Copying from others during a test or an exam.
- Using unauthorised materials or devices (calculator, PDA, mobile phone, pager, etc. during a test or an exam).
- Asking or allowing another student to take a test or an exam for you and vice-versa.
- Sharing answers or program for an assignment or project.
- Tampering with marked/graded work after it has been returned, then resubmitting it for remarking/regrading.
- Allowing others to do the research, writing, programming, or other types of assignment.
- Submitting identical or similar work in more than one course without consulting or prior permission from the lecturers involved.

6.5.2 Plagiarism

Plagiarism is "academic theft". It violates the intellectual property rights of the author. Simply put, it is the use, in part or whole, of other's words or ideas and claiming it as yours without proper attribution to the original author. It includes:

- Copying and pasting information, graphics or media from the Internet into your work without citing the source.
- Paraphrasing or summarising other's written or spoken words that are not common knowledge, without referencing the source.
- Not putting quote marks around parts of the source that you copy exactly.
- Using someone else's work or acquiring papers, assignment, project or research you did not do and turning it in as if you had done the work yourself.
- Giving incorrect information about the source of reference.
- Not acknowledging collaborators in an assignment, paper, project or research.

Plagiarism is, however, often misunderstood. There are numerous sources in the Internet that describe plagiarism and explain acceptable ways for using borrowed words; one of which is at: http://www.indiana.edu/~wts/pamphlets/plagiarism.shtml.

Below is an excerpt from the *University and University College Act 1971, Universiti Sains Malaysia, Discipline of Students, Rule 1999* regarding prohibition against plagiarism (Part II, Rule 6):

> *6. (1) A student shall not plagiarise any idea, writing, data or invention belonging to another person.*
>
> *(2) For the purpose of this rule, plagiarism includes:*
>
> *(a) the act of taking an idea, writing, data or invention of another person and claiming that the idea, writing, data or invention is the result of one's own findings or creation; or*
>
> *(b) an attempt to make out or the act of making out, in such a way, that one is the original source or the creator of an idea, writing, data or invention which has actually been taken from some other source.*

(3) Without prejudice to the generality of sub rule (2), a student plagiarises when he/she:

(a) publishes, with himself/herself as the author, an abstract, article, scientific or academic paper, or book which is wholly or partly written by some other person;

(b) incorporates himself/herself or allows himself/herself to be incorporated as a co-author of an abstract, article, scientific or academic paper, or book, when he/she has not at all made any written contribution to the abstract, article, scientific or academic paper, or book;

(c) forces another person to include his/her name in the list of co-researchers for a particular research project or in the list of co-authors for a publication when he/she has not made any contribution which may qualify him/her as a co-researcher or co-author;

(d) extract academic data which are the result of research undertaken by some other person, such as laboratory findings or field work findings or data obtained through library research, whether published or unpublished, and incorporate those data as part of his/her academic research without giving due acknowledgement to the actual source;

(e) uses research data obtained through collaborative work with some other person, whether or not that other person is a staff member or a student of the University, as part of another distinct personal academic research of his/her, or for a publication In his/her own name as sole author, without obtaining the consent of his/her co-researchers prior to embarking on his/her personal research or prior to publishing the data;

(f) transcribes the ideas or creations of others kept in whatever form, whether written, printed or available in electronic form, or in slide form, or in whatever form of teaching or research apparatus, or in any other form, and claims whether directly or indirectly that he/she is the creator of that idea or creation;

(g) translates the writing or creation of another person from one language to another whether or not wholly or partly, and subsequently presents the translation in whatever form or manner as his/her own writing or creation; or

(h) extracts ideas from another person's writing or creation and makes certain modifications without due reference to the original source and rearranges them in such a way that it appears as if he/she is the creator of those ideas.

6.5.3 Fabrication

Unauthorised invention, alteration, falsification or misleading use of data, information or citation in any academic work constitutes fabrication. Fabricated information neither represent the student's own effort nor the truth concerning a particular investigation or study thus violates the principle of truth seeking in knowledge. Some examples are:

- Making up or changing of data or result, or using someone else's result, in an experiment, assignment or research.
- Citing sources that are not actually used or referred to.
- Intentional listing of incorrect or fictitious references.
- Falsifying of academic records or documents to gain academic advantage.
- Forging signatures of authorisation in any academic record or other university document.

6.5.4 Collusion

The School does not differentiate between those who commit an act of academic dishonesty with those who knowingly allow or help others in performing those acts. Some examples of collusion include:

- Paying, bribing or allowing someone to do an assignment, test/exam, project or research for you.
- Doing or assisting others in an assignment, test/exam, project or research for something in return.
- Permitting your work to be submitted as the work of others.
- Providing material, information, or sources to others knowing that such aids could be used in any dishonest act.

6.5.5 Unfair Advantage

A student may obtain an unfair advantage over another, which is also a breach of academic integrity, in several ways including:

- Gaining access to, stealing, reproducing or circulating of test or exam material prior to its authorised time.
- Depriving others of the use of library material by stealing, defacing, destroying or hiding it.
- Intentionally interfering with other's effort to do their academic work.
- Altering or destroying work or computer files/programs that belong to others or those that are meant for the whole class.

6.5.6 Consequences of Violating Academic Integrity

Both students and academic staff must assume the responsibility of protecting and upholding the academic integrity of the university. In the event that a student encounters any incident that denotes academic dishonesty, the student is expected to report it to the relevant lecturer. The lecturer is then responsible to substantiate the violation and is encouraged to confront the perpetrator(s) to discuss the facts surrounding the allegation, and report the matter to the Deputy Deans or the Dean of the School.

If the lecturer found that the student is guilty, an appropriate punitive grading may be applied, depending on the extent of the violation. Examples of punitive grading are giving lower grade or "F" on the assignment, test, project, or lower grade or "F" for the whole course.

If the violation is deemed serious by the lecturer, the matter will be brought to the attention of the University Disciplinary Authority where appropriate action will be taken. If a student is caught in an examination, the University Examination Board will pursue the matter according to the university's procedure. The consequence then may range from a warning, fine not exceeding RM200, exclusion from any specific part or parts of the University for a specified period, suspension from being a student of the University for a specified period, or expulsion from the University *(University and University College Act 1971, Universiti Sains Malaysia, Discipline of Students, Rule 1999.*

6.6 Links

- School of Computer Sciences: www.cs.usm.my
- E-Learning Portal: http://elearning.usm.my
- Institute of Postgraduate Studies: www.ips.usm.my
- Universiti Sains Malaysia: www.usm.my

7.0 REGISTRATION GUIDELINES

7.1 Courses Offered in Semester I

No.	Course Code	Course Title	Unit	C'work %	Exam %
1.	CCS516	Computational Intelligence *(Kecerdasan Komputan)*	4	50	50
2.	CCS526	Wireless and Mobile Communications *(Komunikasi Mudah Alih dan Tanpa Wayar)*	4	60	50
3.	CCS527	Internet of Things (*Internet of Things*)	4	60	40
4.	CCS528	Information Security and Cryptography *(Keselamatan Maklumat dan Kriptografi)*	4	50	50
5.	CCS591	Research and Empirical Methods in Computer Science *(Kaedah Penyelidikan dan Empirik Dalam Sains Komputer)*	4	100	–
6.	CCS599	Dissertation *(Disertasi)*	20	100	–
7.	CDS501*	Principles and Practices of Data Science & Analytics *(Prinsip dan Amalan Sains Data & Analitik)*	4	60	40
8.	CDS502	Big Data Storage and Management *(Storan dan Pengurusan Data Raya)*	4	60	40
9.	CDS503^	Machine Learning *(Pembelajaran Mesin)*	4	60	40
10.	CDS505^	Data Visualisation and Visual Analytics *(Visualisasi Data dan Analitik Visual)*	4	60	40
11.	CDS506*	Research, Consultancy and Professional Skills *(Kemahiran Penyelidikan, Konsultansi dan Profesional)*	4	100	–
12.	CDS511*	Consumers Behavioural and Social Media Analytics *(Analitik Perilaku Pengguna dan Media Sosial)*	4	60	40
13.	CDS522^	Text and Speech Analytics *(Analitik Teks dan Pertuturan)*	4	60	40
14.	CDS590	Consultancy Project dan Practicum *(Projek Konsultansi and Praktikum)*	8	100	–
15.	CDT541	Industrial Digital Transformation *(Transformasi Digital Industri)*	4	60	40

No.	Course Code	Course Title	Unit	C'work %	Exam %
16.	CDT542	Digital Entrepreneurship *(Keusahawanan Digital)*	4	60	40
17.	CDT545	Cyber Security in Digital Transformation	4		
18.	CDT594	Digital Transformation Project and Practicum	12		

Note:
^ Also for Master of Science (Computer Science)
* Also for Master of Science in Digital Transformation

7.2 Courses Offered in Semester II

No.	Course Code	Course Title	Unit	C'work %	Exam %
1.	CCS525	Advanced Cloud Computing Platform *(Pelantar Perkomputeran Awan Maju)*	4	50	50
2.	CCS591	Research and Empirical Methods in Computer Science *(Kaedah Penyelidikan dan Empirik Dalam Sains Komputer)*	4	100	–
3.	CCS592	Advanced Algorithms and Complexity *(Algoritma Lanjutan dan Kekompleksan)*	4	50	50
4.	CCS599	Dissertation *(Disertasi)*	20	100	–
5.	CDS501*	Principles and Practices of Data Science & Analytics *(Prinsip dan Amalan Sains Data dan Analitik)*	4	60	40
6.	CDS503^	Machine Learning (*Pembelajaran Mesin*)	4	60	40
7.	CDS504*	Enabling Technologies and Infrastructures for Big Data *(Teknologi Pengupayaan dan Prasarana untuk Data Raya)*	4	60	40
8.	CDS506*	Research, Consultancy and Professional Skills *(Kemahiran Penyelidikan, Konsultansi dan Profesional)*	4	100	–
9.	CDS512*	Business Intelligence and Decision Analytics *(Kecerdasan Perniagaan dan Analitik Keputusan)*	4	60	40
10.	CDS513	Predictive Business Analytics *(Analitik Perniagaan Berdaya Ramalan)*	4	60	40
11.	CDS521^	Multimodal Information Retrieval *(Dapatan Semula Maklumat Berbilang Mod)*	4	60	40

12.	CDS523^	Forensic Analytics and Digital Investigations *(Analitik Forensik dan Penyiasatan Digital)*	4	60	40
13.	CDS590	Consultancy Project and Practicum *(Projek Konsultansi dan Praktikum)*	8	100	–
14.	CDT543	Systematic and Lean Innovation Management *(Pengurusan Inovasi Bersistem dan Langsing)*	4	60	40
15.	CDT544	Enterprise Architecture for Digital Business Transformation *(Seni Bina Perusahaan untuk Transformasi Dgital Perniagaan)*	4	60	40
16.	CDT594	Digital Transformation Project and Practicum	12		

Note:

^ Also for Master of Science (Computer Science)
* Also for Master of Science in Digital Transformation

Appendix 1

Course Synopsis and Learning Outcomes for Master of Science (Computer Science) Courses

See Appendix 3 for details on the following courses:

- CDS503/4 – Machine Learning
- CDS505/4 – Data Visualization and Visual Analytics
- CDS521/4 – Multimodal Information Retrieval
- CDS522/4 – Text and Speech Analytics
- CDS523/4 – Forensic Analytics and Digital Investigation

CCS516/4 – Computational Intelligence

The course introduces computational intelligence. It begins with an introduction to evolutionary algorithms, artificial neural networks, and fuzzy system. Various variants of evolutionary algorithms, artificial neural networks, and fuzzy system are explored. Several issues within evolutionary algorithms (e.g., parameter tuning and control), artificial neural networks (e.g., learning rules, architecture and deep learning), and fuzzy system (e.g., fuzzy assessment, fuzzy reasoning) are pursued.

At the end of this course, the students will be able to:

- Analyse basic principles and concepts of evolutionary algorithms, artificial neural networks and fuzzy systems.
- Integrate evolutionary algorithms, artificial neural networks and fuzzy systems as hybrid intelligent system
- Apply evolutionary algorithms, artificial neural networks and fuzzy systems in problem solving.
- Work on a project in a team with full responsibility.

CCS525/4 – Advanced Cloud Computing Platform

This course focuses on concepts, principles and issues that arise in the design and implementation of high-performance cloud applications that use advanced cloud computing platforms. Topics covered includes virtualization technologies, cloud system architectures, cloud service models, cloud computing platforms, cloud infrastructure services, and advanced topics.

At the end of this course, the students will be able to:

- Evaluate application, selection and construction issues of advanced cloud computing platform.
- Adapt cloud computing platform basic services for construction of cloud applications.
- Propose suitable components of cloud computing platform

CCS526/4 – Wireless and Mobile Communications

This course introduces the fundamental theory and concepts in wireless and mobile communications. This course is designed to focus on wireless and mobile radio technologies, its architectures and MAC protocols, and mobility in the Internet layer. Important topics such as wireless and mobile transmission, radio propagation, mobile radio technologies and mobility are covered. The course relates to emerging standards such as 4G LTE Advanced and 5G, recent advancements in WiFi and long range IoT networks such as LoRA. It attempts to relate to some interesting applications of the future such as connected and autonomous vehicle

At the end of this course, the students will be able to:

- Distinguish different Quality of Service (QoS) classes and related use cases, mobility and limitations of wireless and mobile networks.
- Construct advanced heterogeneous wireless and mobile access and core architecture based on multiple services, radio environments, cell structures and mobility considerations.
- Evaluate the many wireless and mobile communications radio technologies and the fundamental theories behind them.

CCS527/4 – Internet of Things

This course focuses on the existing and potential applications of the Internet of Things (IoT). Standards, protocols, and application stacks for IoT will be introduced. Access to the IoT devices via Internet Gateways and related security issues will be studied. Data Analytics, Data Management and Privacy Issues of IoT will be covered.

At the end of this course, the students will be able to:

- Identify theory of principle and application of Internet of Things (IoT) in daily life.
- Modify IoT data processing algorithms for solving problem based on certain scenario
- Customise control and detection systems by using IoT.

CCS528/4 – Information Security and Cryptography

The course presents an overview of history, concepts, practice and theoretical foundations of modern cryptographic algorithms. The first part of the course covers basic concepts and symmetric cryptography. The second part covers asymmetric. In the third part, the class will analyse the popular implementations of cryptography used on the Internet.

At the end of this course, the students will be able to:

- Explain given computer security issues in order to apply cryptographic concepts and computer security in problem solving.
- Select critically potential publications to generate new ideas.
- Adapt cryptographic algorithms in the development of computer security protocols.

CCS591/4 – Research and Empirical Methods in Computer Science

This course aims to introduce techniques in conducting research, academic writing and presentation especially in the field of Computer Science. It will guide students to choose a title or a research problem, understand the process and the related technique and also tools that can be used to support research. Students will conduct

literature review, synthesise reference sources, argue logically and evaluate scientific literature critically. It also covers the explanation on common methods used in research such as survey, comparison, case study and experiment and how to produce a research methodology and pre-proposal of high-quality research project. This includes methods in data analysis and conducting evaluation towards the obtained results either qualitatively or quantitatively to prove a research contribution based on research design and hypothesis. This course will also give guidance in techniques to present research materials, paper writing and high-quality thesis. Students should work under the supervision of a lecturer. This course is a pre-requisite for the dissertation.

At the end of this course, the students will be able to:

- Design research proposal.
- Defend the research proposal and expected contribution of the research in the form of poster presentation.
- Critique research and research proposal of their peers.
- Practice the research tasks, writing and publications in an ethical manner.
- Identify research problem based on reference materials in the chosen field.
- Perform research comfortably and responsibly.
- Propose a research project with proper planning, judgements and decisions as well as correct planning of empirical data analysis.

CCS592/4 – Advanced Algorithms and Complexity

This course provides a strong foundation in the theory of algorithms by giving the fundamentals of algorithm analysis and complexity. The course covers several major strategies in algorithm design such as the greedy method, divide and conquer, dynamic programming, randomized algorithms and approximation algorithms. This course also discusses in detail, important algorithms in several areas of computer science such as graph connectivity, shortest paths, minimum spanning trees, network flow and matching, string matching, Fast-Fourier transform, and NP-Complete problems.

At the end of this course, the students will be able to:

- Critique various algorithms and designs of algorithms.
- Adapt suitable algorithmic techniques and algorithmic designs in problem solving.
- Perform complexity analysis of algorithm.

CCS599/20 – Dissertation

See Section 3.1.3(iii) for detail on this course.

Appendix 2

Course Synopsis and Learning Outcomes for Master of Science in Digital Transformation Courses

See Appendix 3 for details on the following courses:

- CDS501/4 – Principles and Practices of Data Science and Analytics
- CDS504/4 – Enabling Technologies and Infrastructures for Big Data
- CDS506/4 – Research, Consultancy and Professional Skills
- CDS511/4 – Consumer Behavioural and Social Media Analytics
- CDS512/4 – Business Intelligence and Decision Analytics

CDT541/4 – Industrial Digital Transformation

This course introduces the concepts and process of industrial digital transformation by leveraging the emerging and next-generation technologies to accelerate the adoption of digital transformation across industries. This course navigates the world of digital ecosystem, understand the collision between traditional and digital business model, understand how technologies disrupted the industries and the impact of transformation on innovation and decision-making within industries.

At the end of this course, the students will be able to:

- Describe the concepts, process and journey of digital transformation, the importance of digital transformation, transformation ecosystem, and case studies of both public and private sectors.
- Leveraging digital transformation technologies and techniques to recommend a strategy to meet the demands of digitalisation across industries.
- Identify the role of technology in digital transformation, the disruptions within industries and learn how transformation can be achieved to facilitate better interaction and decision-making.
- Demonstrate the ability to communicate and present the transformation process effectively.

CDT542/4 – Digital Entrepreneurship

Technology has enabled a new age of entrepreneurship as entrepreneurs find digital tools that enable new ventures in order to exploit commercial opportunities around the world. This course provides students with expert guidance on using digital technology platforms to start new ventures. In addition, this course also gives students a background into digital entrepreneurship, some of the established models used in constructing a marketing strategy and a focus on how they can apply digital technology.

At the end of this course, the students will be able to:

- Investigate the concepts of digital entrepreneurship.
- Design an innovative digital business idea with proper digital entrepreneurship strategy.

- Demonstrate negotiation skills when pitching new digital business ventures to potential investors.
- Initiate digital businesses prototype with minimal resources.
- Perform digital business experiments, analytics, and reporting.

CDT543/4 – Systematic & Lean Innovation Management

The TRIZ methodology focuses on systematic innovation and problem solving. All TRIZ tools including structured problem solving, function analysis, cause and effect chain analysis, ideality, S-curve analysis, etc., will be introduced. For Lean processes techniques, it introduces the concepts and principles of Lean processes techniques. Students will be introduced to the integration of Lean processes techniques with Six Sigma.

At the end of this course, the students will be able to:

- Identify and apply various TRIZ tools for problem solving and innovation.
- Create systematic innovation through applying the various TRIZ tools.
- Differentiate the usage and application of various Lean process techniques, their integration with Six Sigma, and demonstrate them in industry projects.
- Develop the conceptual framework with respect to the main constructs and relationship between Lean processes techniques.

CDT544/4 – Enterprise Architecture for Digital Business Transformation

Enterprise architecture (EA) is required to address the digital innovation and transformation challenges faced by today's organizations. This course introduces students to an understanding of enterprise architecture concepts, design principles, practices, tools, and techniques so that they can stay ahead of the digital curve.

At the end of this course, the students will be able to:

- Evaluate the effectiveness of current EA business processes used in organizations.
- Design suitable EA improvements to current business processes based on the problems faced by organizations.
- Display appropriate role as an actor when managing information/data in an organization according to real life scenarios.
- Develop EA solution using an EA software tool (Essential Open Source).

CDT594/4 – Digital Transformation Project & Practicum

This experiential work-based course is designed to equip students to confidently help conceive, lead and execute digital transformation initiatives and develop new business models for existing organizations through the implementation of a consultancy project. Students are required to complete the practicum at their respective workplaces or their chosen/assigned organisations. Students work under the supervision of a lecturer and an industry supervisor. The students are required to solve a real-world problem or tap opportunities related to digital transformation during their practicum.

At the end of this course, the students will be able to:

- Devise a solution to the real-world problem using digital innovation and transformation techniques appropriately.

- Practice effective oral communication regarding the progress and achievements of the practicum.
- Perform work collaboratively in a multi-ethnic environment with superior, colleagues, staff and supervisors.
- Display professional behaviour such as trust, honesty, and not violating predefined policies at the workplace.
- Display confidence and the ability to overcome challenges in completing the project and practicum.
- Perform project tasks with proper planning to meet project milestones.
- Display high level of responsibility and accountability to lead the project independently.

CDT545/4 – Cyber Security in Digital Transformation

This course introduces students to the basic knowledge on cyber security and its applicability in digital transformation. Aspects and standard methods in related cyber security risk management will be explained. Students will be exposed to different applications of the knowledge on big data, cloud computing, Internet-of-Things, digital forensics, blockchain, etc.

At the end of this course, the students will be able to:

- Apply the basic principles of cyber security, standard security models, access control concept and requirement, and technologies use in cyber security.
- Reproduce solutions for an organization's cyber security risk management, digital forensics, and audit based on various cyber security models according to the suitability of the situation.
- Justify various standard methods, techniques, and approaches in cyber security risk management such as threat and attack identification, weaknesses or vulnerabilities assessment, and cyber risk valuation for an organization.
- Formulate factors which should be considered in solving cyber security issues relating to emerging technologies and applications.

Appendix 3

Course Synopsis and Learning Outcomes for Master of Science (Data Science and Analytics) Courses

CDS501/4 – Principles and Practices of Data Science & Analysis

This course introduces the basic goals and techniques in data science and analytics process with some theoretical foundations which include useful statistical and machine learning concepts so that the process can transform hypotheses and data into actionable predictions. The course provides basic principles on important steps of the process which include data collecting, curating, analysing, building predictive models and reporting and presenting results to audiences of all levels. Data science programming language and techniques are introduced in the course

At the end of this course, the students will be able to:

- Organize effectively all the necessary steps in any data science and analytics project.
- Adapt the data science programming language and useful statistical and machine learning techniques in data science and analytics projects.
- Demonstrate the ability to communicate and present the data science results effectively.
- Apply statistical approach for data exploration and modelling to draw conclusions in data science and analytics project

CDS502/4 – Big Data Storage and Management

Storing and managing big data addresses different issues compared to conventional databases. Big data involves huge amount of data (volume), supports heterogeneous data format (variety) and can be accessed at high speed (velocity). The course includes fundamental on big data storage and management related issues. Understanding of various storage infrastructure includes understanding of technologies ranging from traditional storage to cloud-based storage. The course provides exposure on recent technologies in manipulating, storing and analysing big data. The technologies include but not limited to Hadoop, MongoDB and Apache Cassandra.

At the end of this course, the students will be able to:

- Compare the various data storage infrastructures, advanced concepts and technologies.
- Build a database to support big data using related big data storage system.
- Differentiate the rules of modern and traditional in storing and managing large data.
- Evaluate recent tools in big data storage.

CDS503/4 – Machine Learning

Upon successful completion of the course, students will have a broad understanding of machine learning algorithms. Students will be acquiring skills of applying relevant machine learning techniques to address real-world problems. Students will be able to adapt or combine some of the key elements of existing machine learning algorithms. Topics which will be covered in this course include supervised and unsupervised learning techniques, parametric and non-parametric methods, Bayesian learning,

kernel machines, and decision trees. The course will also discuss recent applications of machine learning. Students are expected to obtain hands-on experience during labs, assignments and project to address practical challenges.

At the end of this course, the students will be able to:

- Describe concepts, theories and implementation of machine learning algorithms.
- Build machine learning models which can be adapted to more complex scenarios.
- Apply relevant machine learning algorithms for typical real-world problems.
- Apply mathematical concepts to solve machine learning problems.

CDS504/4 – Enabling Technologies and Infrastructures for Big Data

Data science is advancing the inductive conduct of science and is driven by big data available on the Internet. This course will explain the technologies and techniques to improve the access, security, and performance of big data processing, storage systems and networks.

At the end of this course, the students will be able to:

- Distinguish major concepts of data science related to high-performance parallel and distributed computing as well as computing with emerging technologies.
- Design distributed processing solution and big data network using efficient techniques.
- Analyse the needs and issues for big data networks, including security to protect sensitive data with suitable access controls.

CDS505/4 - Data Visualisation and Visual Analytics

This course discusses the use of computer-supported, interactive and visual representations of data in order to amplify cognition, help people reason effectively about information, find patterns and meaning in the data, and easily explore the datasets from different perspectives in particular in data-intensive environment. The course covers techniques from two branches of visual representation of data, namely data visualization and visual analytics. In data visualization, the course covers scientific visualisation techniques (representations of empirically-gathered scientific datasets) such as contours, iso-surface, and volume rendering as well as specific techniques in information visualisation (representations of abstract datasets) which include tables, networks and trees, and map-colour. In visual analytics, a visualization process features a significant amount of computational analysis and human-computer interaction. So, the topics covered in this part of the course include view manipulation, multiple views, reduction in items and attributes, and focus + context as well as analysis case studies involving a visualization system or tool.

At the end of this course, the students will be able to:

- Select the right visualization techniques for any given problems or applications.
- Adapt visualization techniques and idioms, and visual analytics techniques in certain domains
- Relate various visualization techniques with various domains and problems.

- Customise modern visualization software tools for applications in various domain

CDS506/4 - Research, Consultancy and Professional Skills

The course provides knowledge and effective skills that are required in research, consultancy and professional practice. For the research section, it will cover literature review, development of research questions, usage of theories, research design, data collection as well as related statistical analysis techniques including quantifying use experience and usability testing. For the consultancy skills, students will be equipped with the mindset tools and skills to provide effective consulting advice to clients. In the final section, professional issues, and different aspects such as ethical, legal and social in conducting research and consultancy will also be discussed.

At the end of this course, the students will be able to:

- Compose a research proposal /consultancy project to solve a real-world problem using data science and analytics technique.
- Identify communication traits in research and consultancy effectively.
- Correlate professional issues inherent in research methods and consultancy appropriately.
- Propose consultancy project with a potential client appropriately.
- Display good governance in consultancy project responsibly.
- Conclude the results from the statistical analysis appropriately.

CDS511/4 - Consumer Behavioural and Social Media Analytics

This course provides a broad and interdisciplinary research and practice focusing on two areas: behaviour and web & social media analytics. Specifically, behaviour analytics concerns the process of systematically utilizing multimodal data to model human behaviour when consuming products as consumers. This involves human-computer interaction (HCI), user behaviour modelling, computational models of emotions, and emotion sensing and recognition. Social media analytics concerns the strategies to leverage powerful social media data concerning customer needs, behaviour and preferences. Students will learn the strategies to derive insights from the above-mentioned data that are crucial for business decisions.

At the end of this course, the students will be able to:

- Describe concepts, theories, technologies and metrics related to consumer behaviour and social media analytics.
- Apply any programming language (e.g., Pyhton) to construct predictive models (by extracting, analysing and deriving insights) from the related social media data for data-informed decision-making within a business perspective using analytics model
- Explain the concept of consumer behaviour by studying the influence consumer behaviour and personality as the lifelong learning process.
- Identify human behavioural cues across a variety of contexts using digital tools to understand consumer behaviour, facilitate better interaction and decision making.

CDS512/4 - Business Intelligence and Decision Analytics

The course focuses on the knowledge and skills to select, apply and evaluate business intelligence and decision analytics techniques which discover knowledge that can add value to a company. The course will also discuss innovative applications and exploitation of the current techniques and approaches related to business intelligences and performance measurement, and mathematical model to facilitate decision-making process in business and operations.

At the end of this course, the students will be able to:

- Apply concepts, technologies and theories related to business intelligence and decision analytics.
- Design strategies relevant to business intelligence and decision analytics using appropriate technology and software.
- Assess the role of business intelligence and decision analytics in enhancing business performance.
- Propose a preliminary business model by articulating business ideas and perform a SWOT analysis to assess the strengths, weaknesses, opportunities and threats of an entrepreneurial decision.

CDS513/4 - Predictive Business Analytics

The course provides the theory behind predictive analytics, and methods, principles and techniques for conducting predictive business analytics projects. The course introduces the underlying algorithms as well as the principles and best practices that govern the art of predictive analytics that translate data into meaningful, usable business information.

At the end of this course, the students will be able to:

- Describe concepts, technologies and theories related to predictive business analytics.
- Design strategies relevant to predictive business analytics using appropriate technologies and tools.
- Assess the role of predictive business analytics in enhancing business performance.
- Propose a business model by incorporating predictive business analytic approaches.
- Evaluate predictive business analytics using recent tools.

CDS521/4 - Multimodal Information Retrieval

This course provides the basic concepts, principles and applications for multimodal (text, image, and video) retrieval. This course covers basic techniques for text, image and video retrieval such as indexing, representation, ranking, querying, GLCM, colour histogram, video shot detection and boundary detection and retrieval performance and evaluation. In addition, this course also covers machine learning retrieval approach techniques such as KNN, SVM and deep learning neural network for large dataset on the latest context such as mobile devices, social media and big data.

At the end of this course, the students will be able to:

- Discuss techniques to multimodal information retrieval.
- Adapt the models and techniques of multimodal information retrieval in real applications.
- Solve problems in emerging multimodal applications using the learned techniques.

CDS522/4 - Text and Speech Analytics

This course focuses on the theory and tools of text and speech processing to retrieve textual features, speech signal and annotation, and linguistic information from text and speech resources. Using these resources, theory and tools are then used to perform analytic tasks to solve real-world problem.

At the end of this course, the students will be able to:

- Demonstrate understanding of basic concepts and techniques in natural language text and speech processing, such as tokenization, ngram, tagging, parsing, word sense disambiguation, speech synthesis and speech decoding.
- Construct different levels of linguistics information such as word, sentence, semantics and spectrum for text and speech analytics using approaches in natural language text and speech processing.
- Propose custom solutions using natural language processing and speech processing techniques or text and speech analytics problems in organizations.

CDS523/4 - Forensic Analytics and Digital Investigations

This course introduces basic knowledge and techniques in computer forensics and digital investigation. Starting with an overview of the career of digital investigators, issues in digital forensics and investigations into public data, and current practices in the processing of criminal backgrounds and incidents will be described.

At the end of this course, the students will be able to:

- Apply the principles and techniques in forensics analytics and digital investigations.
- Conduct digital investigations in computer forensics, mobile forensics, network forensics, image forensics and big data forensics.
- Demonstrate the digital investigations that adheres to professional standards and investigation processes: identification, preservation, examination, and analysis.
- Report the potential security breaches of computer data that suggest violations of legal, ethical, moral, policy and/or societal standard.

CDS590/8 - Consultancy Project and Practicum

See Section 3.3.3(iii) for detail on this course