Module Information Summary

Section 1
Module Description - General

Module Code	**ITS64304**
Module Name	**Theory of Computation**
Year Level (Module)	**2**
Credit Value	**4**
Semester(s) Offered	**March** **August**
Module Leader	**Raja Kumar Murugesan (RajaKumar.Murugesan@taylors.edu.my)**

Synopsis

Theory of Computation includes Formal Languages, Automata theory, Computability Theory, and Complexity Theory. Automata and Formal languages discuss the theory and properties of different computational models that include Finite Automata, Context Free Grammars and Turing Machines. Computability includes classifying problems as solvable and unsolvable, Turing Machines, Chomsky Hierarchy, and Undecidablity. Complexity theory discusses classifying problems according to their degree of difficulty in terms of execution time. Cryptography is an important application of Complexity theory. This module is taught using Guided Learning and Problem-based Learning through a combination of mainly tutorials, take home problem sets, and minimal face-to-face lectures where necessary. The learning is facilitated mostly through tutorials, blended learning, and reflection. With the motive “assessment for learning”, the assessments are spread as 60% in-course assessment and 40% final examination with a heavy concentration on problem solving in formal languages and automata theory. The in-course assessments involve assignments working as an individual and working in a group. The individual assessment expects a student to join a learning group, learn from each other in solving computational problems and report on self and peer the learning process. Hence, demonstrate their learning in solving problems through a written test. Group assignments expects students to write an essay on an advance topic in Theory of Computation and explain how cryptography is influencing change in today’s cybersecurity landscape.

General Pre-Requisite	-
Module Pre-requisite	- - - **Discrete Structures**
General Co-requisite	**None**
Module Co-requisite	-
General Anti-requisite	**None**
Module Anti-requisite	-

Module Owner	**School of Computer Science**
Domain Name (for free electives only)	**Science, Technology and Society**
Module Offered as	**Primary Major - Core**

Section 2
Module Description - Module Learning Outcomes (MLO)

No./ID	Description	MLO %
MLO1	Demonstrate capability to interact positively within a peer group, consider other viewpoints, and foster stable and harmonious relationships in solving computational problems related to automata theory.	20
MLO2	Write an essay by exploring an advanced topic in Theory of Computation and demonstrate an in-depth understanding of the topic studied.	20
MLO3	Demonstrate skills in encryption, decryption, and digital signatures using a public-key cryptosystem to influence change in the cybersecurity landscape.	20
MLO4	Construct grammar, simple finite state machines, push down automaton and Turing machine for a given language specification.	40
		100

Section 3
Module Description - Align MLO to PLO & TGC Sub-Attribute

No	Module Learning Outcomes (MLO)	MLO %	TGC Attributes	TGC Sub-Attributes	Description of sub-attributes
1	MLO1	20	TGC 6 Social Competencies	6.1	Take perspective and empathize with others (Measuring: Empathy)
				6.2	Recognize and appreciate individual and group similarities and differences. (Measuring: Social Awareness/Sensitivity)
				6.3	Build positive relationships, establish and maintain cooperative relationships and actively participate within a group (Measuring: Relationship Management and Active Participation)
2	MLO2	20	TGC 4 Lifelong Learning	4.1	Demonstrate self-directed learning
				4.2	Demonstrate self-inquiry in learning
3	MLO3	20	TGC 7 Entrepreneurialism	7.1	Demonstrate growth and entreprenuerial mindset
				7.2	Identify an opportunity that delivers value
				7.4	Execute solution to deliver value
4	MLO4	40	TGC 2 Problem Solving, Critical and Creative Thinking Skills		

Section 4
Module Description - Transferrable Skills

Transferable Skills

TGC	TGC Attribute	Description of TGC Attributes	Sub-Attribute	Description of sub-attributes
TGC 6	Social Competencies	Social Competencies refer to the ability to empathize with others, interact positively with them and foster stable and harmonious relationships.	6.1	Take perspective and empathize with others (Measuring: Empathy)
			6.2	Recognize and appreciate individual and group similarities and differences. (Measuring: Social Awareness/Sensitivity)
			6.3	Build positive relationships, establish and maintain cooperative relationships and actively participate within a group (Measuring: Relationship Management and Active Participation)
TGC 4	Lifelong Learning	Lifelong Learning refers to the ability to develop self-dispositions and skills with the aim of improving professional competence through self-directed learning, self-inquiry, self-assessment and self-reflection undertaken on an ongoing basis.	4.1	Demonstrate self-directed learning
			4.2	Demonstrate self-inquiry in learning
TGC 7	Entrepreneurialism	Entrepreneurialism refers to the ability to influence change by being proactive, resourceful and prudent in assuming risk.	7.1	Demonstrate growth and entreprenuerial mindset
			7.2	Identify an opportunity that delivers value
			7.4	Execute solution to deliver value
TGC 2	Problem Solving, Critical and Creative Thinking Skills	Problem Solving, Critical and Creative Thinking Skills refer to the ability to rationally, critically and creatively analyze, synthesize and evaluate evidence to arrive at a solution or conclusion.		

Section 5
Module Description - Align MLO to Assessment Tasks and T&L Strategies

Description of Assessment Components

The assessment for this module is external (Taylor's College)	**NO**
Resit Opportunity	**TU-UWE**

Assessment Tasks

Assessment Task	Weight	MLO Assessed	TGC Assessed	Due Date	Maximum Mark (Task Level)	Maximum Mark (MLO Level)
Assessment 1 (Individual)	20%	MLO1	6	7	20	20
Assessment 2 (Group)	20%	MLO2	4	10	20	20
Assessment 3 (Group)	20%	MLO3	7	13	20	20
Final Examination	40%	MLO4	2	15 or 16	40	40
	100%					

Section 6
Module Description - Resit Assessment

Description of Resit Assessment

Resit Opportunity **TU-UWE**

Assessment Tasks

Assessment Task	Weight	MLO Assessed	TGC Assessed	Maximum Mark (Task Level)	Maximum Mark (MLO Level)
Resit Coursework	60%	MLO1 MLO2 MLO3	TGC 6 TGC 4 TGC 7	60	20 20 20
Resit Final Examination	40%	MLO4	TGC 2	40	40
	100%				

Section 7
Module Description - Rubrics for Assessment Tasks

<table>
<tr><th>Assessment Task</th><th>MLO Assessed</th></tr>
<tr><td>Assessment 1 (Individual)</td><td>MLO1

Demonstrate capability to interact positively within a peer group, consider other viewpoints, and foster stable and harmonious relationships in solving computational problems related to automata theory.

<table>
<tr><th colspan="6">Assessment 1 (Individual): (MLO Assessed: MLO1)</th></tr>
<tr><th>Criteria</th><th>Weightage</th><th>Beginning: 0 – 49%</th><th>Developing: 50 – 64%</th><th>Mastering: 65 – 79%</th><th>Outstanding: 80 – 100%</th></tr>
<tr><td>Self and Peer Evaluation (5%) 1) Build positive relationships, and actively participate within a group in seeking a solution to a given computational problem (5%). Test (15%) 2) Constructing a grammar for a given language specification and evaluate whether the constructed grammar is ambiguous (5%). 3) Construct a finite automaton for a given scenario (5%) 4) Construct a PDA for the given language specification and validate the PDA constructed (5%).</td><td>20.00%</td><td>1) Showcase little to no ability to interact positively and cooperate with others, especially in group-work and cannot apply formal methods to solve a given problem. 2) No solution provided or Critical elements of the solution are missing or significantly flawed. Solution does not demonstrate sufficient understanding of the problem and/or any reasonable directions to solve the problem. 3) Unable to demonstrate or demonstrate a minimal understanding on finite automaton and hence cannot solve the given problem. 4) Unable to demonstrate or demonstrate a minimal understanding on PDA and hence cannot solve the given problem. Solution does not demonstrate sufficient understanding of the problem and/or any reasonable directions to solve the problem.</td><td>1) Developing ability to interact positively and cooperate with others, especially within a group and can apply formal methods to solve a given problem with some degree of effectiveness. 2) The grammar constructed demonstrates a viable approach toward solving the problem but contains some major errors or limitations. 3) Demonstrate basic understanding on finite automaton and can solve the given problem with some degree of success. 4) Demonstrate basic understanding on PDA and can solve the given problem with some degree of effectiveness. Computation done demonstrates a viable approach toward solving the problem but contains some major pitfalls, errors, or limitations.</td><td>1) Demonstrate frequent ability to interact positively and cooperate with others, especially within a group and can correctly apply formal methods to solve a given problem. 2) The grammar constructed is mostly correct but contains some minor errors or limitations. 3) Demonstrate a good understanding on finite automaton and can correctly solve the given problem. Contains some minor errors or limitations. 4) Demonstrate a good understanding on PDA and can correctly solve the given problem. Contains some minor errors or limitations. Computation done demonstrates that the PDA constructed works correctly meeting the requirements of the problem, but contains some minor pitfalls, errors, or limitations.</td><td>1) Display consistent ability to interact positively and cooperate with others, especially within a group, effectively, and correctly apply formal methods to solve a given problem. 2) The grammar constructed solves the problem stated correctly and meets all requirements of the problem. 3) Demonstrate a thorough understanding on finite automaton and can effectively and correctly solve the given problem. 4) Demonstrate a thorough understanding on PDA and can effectively and correctly solve the given problem. Computation done demonstrates clearly that the PDA constructed works correctly meeting all the requirements of the problem.</td></tr>
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<tr><td>Assessment 2 (Group)</td><td>MLO2

Write an essay by exploring an advanced topic in Theory of Computation and demonstrate an in-depth understanding of the topic studied.

<table>
<tr><th colspan="6">Assessment 2 (Group): (MLO Assessed: MLO2)</th></tr>
<tr><th>Criteria</th><th>Weightage</th><th>Beginning: 0 – 49%</th><th>Developing: 50 – 64%</th><th>Mastering: 65 – 79%</th><th>Outstanding: 80 – 100%</th></tr>
<tr><td>1) Relevance of topic chosen and demonstrate independent learning (10%) 2) Arguments and Clarity in explaining the topic chosen demonstrating self-inquiry (10%)</td><td>20.00%</td><td>1) Demonstrate limited commitment to learn independently. No attempt is made to establish relevance of the content to the topic. 2) Explore a topic at a surface level, providing little insight and/or information beyond the very basic facts indicating low interest, initiative, and effort on the topic. There are very little arguments described in a way that fellow students would not be able to understand.</td><td>1) Demonstrate commitment to learn independently. The essay gestures to the importance of the content to the topic. 2) Explore a topic with some evidence of depth, providing occasional insight and/or information indicating slight interest, initiative, and effort on the topic. There are some arguments described in a way that would make at least some sense to fellow students.</td><td>1) Demonstrate autonomy and a continued commitment to learn independently, at various occasions. The essay offers clear and compelling reason on the relevance of the topic and content. 2) Explore a topic in depth with insight and/or information indicating interest, initiative, and effort on the topic. Arguments made are sufficient and described in a way that would be mostly clear to fellow students</td><td>1) Demonstrate autonomy and a continued commitment to learn independently in a consistent manner. The essay offers more than clear and compelling reason on the relevance of the topic and content. 2) Explore a topic in-depth, producing a rich awareness with intense interest, initiative, and effort on the topic. Arguments made are commendable and described in a way that would be very clear to fellow students.</td></tr>
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<tr><td>Assessment 3 (Group)</td><td>MLO3

Demonstrate skills in encryption, decryption, and digital signatures using a public-key cryptosystem to influence change in the cybersecurity landscape.

<table>
<tr><th colspan="6">Assessment 3 (Group): (MLO Assessed: MLO3)</th></tr>
<tr><th>Criteria</th><th>Weightage</th><th>Beginning: 0 – 49%</th><th>Developing: 50 – 64%</th><th>Mastering: 65 – 79%</th><th>Outstanding: 80 – 100%</th></tr>
<tr><td>1) Demonstrate how RSA is used for data encryption, decryption, and digital signatures. (10%) 2) Identify, and explain how cryptosystems and digital signatures are influencing change today in the cybersecurity landscape exhibiting entrepreneurial mindset. (5%) 3) Identify trends, opportunity and challenges of cryptography and digital signatures that delivers value in today's modern world. (5%)</td><td>20.00%</td><td>1) No solution provided or Critical elements of the solution are missing or significantly flawed. Solution does not demonstrate sufficient understanding of the problem and/or any reasonable directions to solve the problem. 2) Demonstrates minimal awareness on how cryptosystems and digital signatures are influencing change in the cybersecurity landscape today. 3) Identify trend, opportunities and challenges in today's world that delivers value.</td><td>1) Solution demonstrates a viable approach toward solving the problem but contains some major errors or limitations. 2) Demonstrates Heightened on how cryptosystems and digital signatures are influencing change in the cybersecurity landscape today. 3) Identifies trend, opportunities, challenges, ideas, and solutions in today's world that attempts to create and capture value in a novel way.</td><td>1) Solution is mostly correct but contains some minor errors or limitations. 2) Occasionally demonstrate innovativeness on how cryptosystems and digital signatures are influencing change in the cybersecurity landscape today. 3) Consistently identifies trend, opportunities, challenges, ideas, and solutions in today's world that somewhat creates and captures value in a novel way.</td><td>1) Solution presented solves the problem stated correctly and meets all requirements of the problem. 2) Consistently demonstrate innovativeness on how cryptosystems and digital signatures are influencing change in the cybersecurity landscape today. 3) Consistently identifies trend, opportunities, challenges, ideas, and solutions in today's world that creates and captures value in a novel way.</td></tr>
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</td></tr>
<tr><td>Final Examination</td><td>MLO4

Construct grammar, simple finite state machines, push down automaton and Turing machine for a given language specification.</td></tr>
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Section 8 Module Description - Hurdle Assessment

Hurdle Assessment Guideline

A student must achieve at least 40% for the Coursework and 40% for the Final examination separately, and 50% for the overall assessment and a final grade of C to pass the module. A student who obtains a minimum of 40% for the overall assessment and overall grade of D or higher for the module may be allowed to resit the examination. The maximum passing grade awarded for the resit examination will be a grade C. A student who obtains 39% and below for the final assessment, will result in failing the module irrespective of the overall marks earned, even though he/she has achieved 50% or more in the overall assessment. He/she will not be allowed to resubmit the final assessment.

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	Physical F2F (Interactive Lecture)	Physical F2F (Tutorial)	Physical F2F (Practical)	Physical F2F (Other)	Online Synchronous F2F (Interactive Lecture)	Online Synchronous F2F (Tutorial)	Online Synchronous F2F (Practical)	Online Synchronous F2F (Other)	NF2F Independent Learning	Assessment Task (Physical F2F)	Assessment Task (Online Synchronous F2F)	Assessment Task Independent Learning for Assessment (Asynchronous)	Student Learning Time (SLT)
	HOUR												
Week - 1	1	1				2			6		2		12
	Introduction to Theory of Computation MLO1	Language and Grammars: Strings and languages, Regular languages and regular expressions, context free grammars and regular grammars. MLO1				Constructing grammars MLO1 MLO4			Language and Grammars: Strings and languages, Regular languages and regular expressions, context free grammars and regular grammars.		Assessment 1 (Individual) MLO1		12
Week - 2	1	1				2			6		2		12
	Constructing grammars, verifying grammars, parse trees, derivations, and ambiguity. MLO1 MLO4	Constructing grammars, verifying grammars, parse trees, derivations, and ambiguity. MLO1 MLO4				Verifying grammars for ambiguity MLO1 MLO4			Verifying grammars for ambiguity MLO1 MLO4		Assessment 1 (Individual) MLO1		12
Week - 3	1	1				2			6		2		12
	Finite Automata: Finite State Machines, Non-Deterministic Finite Automata MLO1 MLO4	Finite Automata: Finite State Machines, Non-Deterministic Finite Automata MLO1 MLO4				Constructing finite state machines MLO1 MLO4			Constructing finite state machines MLO1 MLO4		Assessment 1 (Individual) MLO1		12
Week - 4	1	1				2			6		2		12
	Deterministic Finite Automata, computation through derivations MLO1 MLO4	Deterministic Finite Automata, computation through derivations MLO1 MLO4				Doing computations MLO1 MLO4			Doing computations MLO1 MLO4		Assessment 1 (Individual) MLO1		12
Week - 5	1	1				2			6		2		12
	Finite Automata and Regular Expressions, Pumping Lemma for Regular languages. MLO1 MLO4	Finite Automata and Regular Expressions, Pumping Lemma for Regular languages. MLO1 MLO4				Verifying whether a language is regular using pumping Lemma MLO1 MLO4			Verifying whether a language is regular using pumping Lemma MLO1 MLO4		Assessment 1 (Individual) MLO1		12
Week - 6	1	1				2			6		2		12
	Pushdown Automata MLO1 MLO4	Pushdown Automata MLO1 MLO4				Constructing Pushdown automatons MLO1 MLO4			Constructing Pushdown automatons MLO1 MLO4		Assessment 1 (Individual) MLO1		12
Week - 7	1	1				2			4	2	2	2	14
	Computability: Turing Machines (TM), TM as language acceptor, TM as computing device, Nondeterministic TMs, variations of TM MLO1 MLO4	Computability: Turing Machines (TM), TM as language acceptor, TM as computing device, Nondeterministic TMs, variations of TM MLO1 MLO4				Constructing Turing machines MLO1 MLO4			Constructing Turing machines MLO1 MLO4	Assessment 1 (Individual) MLO1	Assessment 1 (Individual) MLO1	Assessment 1 (Individual) MLO1	14
Week - 8								4	8				12
								Decidability: Decision problems, Church Turing Thesis, Universal Turing Machine, Halting Problem, and Undecidability. MLO2	Decidability: Decision problems, Church Turing Thesis, Universal Turing Machine, Halting Problem, and Undecidability. MLO2				12
Week - 9	1	1				2			4				8
	Chomsky Hierarchy, Unrestricted Grammar, Context Sensitive Grammars. MLO1	Chomsky Hierarchy, Unrestricted Grammar, Context Sensitive Grammars. MLO1				Chomsky Hierarchy, Unrestricted Grammar, Context Sensitive Grammars. MLO1			Chomsky Hierarchy, Unrestricted Grammar, Context Sensitive Grammars. MLO1				8
Week - 10	1	1				2			2			8	14
	Time Complexity: Measurement of Complexity, Rates of Growth, Complexity classes, Classes P and NP, P vs NP MLO2 MLO3	Time Complexity: Measurement of Complexity, Rates of Growth, Complexity classes, Classes P and NP, P vs NP MLO2 MLO3				Time Complexity: Measurement of Complexity, Rates of Growth, Complexity classes, Classes P and NP, P vs NP MLO2 MLO3			Time Complexity: Measurement of Complexity, Rates of Growth, Complexity classes, Classes P and NP, P vs NP MLO2 MLO3			Assessment 2 (Group) MLO2	14
Week - 11	1	1				4			4				10
	Cryptography: Complexity and cryptography, Classical Cryptography MLO3	Cryptography: Complexity and cryptography, Classical Cryptography MLO3				Cryptography: Complexity and cryptography, Classical Cryptography MLO3			Cryptography: Complexity and cryptography, Classical Cryptography MLO3				10
Total	13	13	0	0	0	24	0	4	60	4	14	28	

Week - 12	1	1				2			2				6
	RSA algorithm, and Digital Signatures **MLO3**	RSA algorithm, and Digital Signatures **MLO3**				RSA algorithm, and Digital Signatures **MLO3**			RSA algorithm, and Digital Signatures **MLO3**				6
Week - 13	1	1										10	12
	Review of week 1 to 12 **MLO4** **MLO3**	Review of week 1 to 12 **MLO4** **MLO3**										Assessment 3 (Group) **MLO3**	12
Week - 14	1	1											2
	Performance Review and Discussion **MLO4**	Performance Review and Discussion **MLO4**											2
Week - 16										2		8	10
										Final Examination **MLO4**		Final Examination **MLO4**	10
Total	13	13	0	0	0	24	0	4	60	4	14	28	

Section 10
Module Description - Reference

Main references supporting the module

No	Author	Year of Publication	Title	Edition	Publisher	ISBN	ISSN	Form Source
1	Michael Sipser	2021	Introduction to the Theory of Computation	3rd	Course Technology Inc	0357670582	-	manual

Other Additional Information

No	Author	Year of Publication	Title	Edition	Publisher	ISBN	ISSN	Form Source
1	Peter Linz, and Susan H. Rodger	2022	An Introduction to Formal Languages and Automata	7th	Jones & Bartlett Learning.	1284231607	-	manual
1	Jonathan Katz, and Yehuda Lindell	2020	Introduction to Modern Cryptography:	Third Edition	Chapman, and Hall/CRC.	0815354363	-	manual

Section 11
Module Description - Approval Details

Effective Study Intake/Semester	**202303**
Revision Number	**1.05**

Special Requirements to deliver the Module

None

☐ Please tick ( ) if this module is Latihan Industri/Clinical Placement/Practicum/WBL using 2 weeks, 1 credit for SLT

Approved by SPC	**School of Computer Science**
SPC Approval Date	**Feb 16 2023**
Discipline Code	**-**
Stream	

None